AGRO TECHNOLOGIES

2020-21

Natural Resource Management & Crop Production and Crop Protection

Professor Jayashankar Telangana State Agricultural University
Rajendranagar, Hyderabad - 500 030, Telangana State, India.
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FOREWORD

Agriculture plays a pivotal role in the economy of Telangana and the better performance of this sector is vital for inclusive growth. In order to achieve food and income security, the agriculture sector in the state has been prioritized,evidence of which can be seen in the several farmer welfare schemes implemented, the impact of which is being indicated by the sustained growth of primary sector contribution to the State economy over the years.

The efforts of PJTSAU in developing and disseminating various Agro technologies that are apt and timely have a profound role in achieving the above sustained agricultural growth in the State. The efforts of multidisciplinary team of scientists to produce competitive technology modules and their testing by the extension personnel on the farmers field is a continuous process in the university to meet the emerging demands of all its stakeholders. Robust crop improvement schemes have brought out superior cultivars, which have spread not only in the native state but also have become popular in neighboring states. Sustainable Development Goals have been the driving force for the agro technologies being rolled out by the University to ensure idealistic growth trends even in the face of adversities. Authentication and validation enabled by a research audit system through multiple check points has enabled us to realize the progress presently being experienced.

The University believes in maintaining the momentum of an efficient work ecosystem created with competent human resources and State of Art research infrastructure to tackle emerging field constraints in farming in a dynamic mode. I hope this publication **"Agro-Technologies 2020-21"** would be of immense practical value to all the stake holders in resolving the contemporary field problems and would meet the requirements of farming community. I take this opportunity to congratulate all the Scientists responsible for generating these solutions and appreciate all the personnel involved in bringing out this important document.

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PREFACE

The main inspiration for development of "Agro Technologies" by the research scientists of the University is to work out the solutions for the various production constraints encountered in regular field operations by the farming community of the state. These innovations are leading for the successful agrarian journey. The real cause of 'Research with Societal Relevance' is currently justified as being witnessed by the state in the form of huge productivity gains in major crops, economizing the production process, protecting the environment and above all ensuring remunerative returns to the practicing farmers.

PJTSAU through various research facilities has been constantly endeavoring to design and develop cost effective, farmer friendly technologies duly factoring from the feedback from extension outreach machinery and other stakeholders including the end users. Scientists are being encouraged to work across the disciplines and institutions in a participatory approach to develop technologies and fine - tune them in resolving emerging issues like climate change, ecosystem changes, shifts in economic priorities in a given time line.

Field implementation of such farm technologies has propelled the state's overall performance in terms of agriculture contribution to Gross State Domestic Product to be among the best in the country. Dynamic and solutions based technology packages involving interdisciplinary efforts have exhibited collateral benefits ensuring environmental safety, enhanced use efficiency of water, fertilizers and crop protection chemicals and mechanization of selective crop production activities leading to sustainability.

This compendium **"Agro-Technologies 2020-21"** contains such innovations aimed at consolidating the gains accrued in the agricultural scenario of the state on a sustainable basis covering natural resource management, crop production, crop protection and farm mechanization aspects of farming and post-harvest management technique for storage of the produce. I hope it will serve as a valuable reference for the farm fraternity striving for improving the state of the farmer. I extend my appreciations to all the contributing Scientists and the staff who are involved in bringing this compilation in the present form.

(R. JAGADEESHWAR)

1 *Rabi* Sunflower Based Cropping Systems in Telangana for Climate Resilience and Profitability

Salient Features

Crop diversification is a potential strategy to improve farm income, soil health and environmental quality. Cropping system diversification including oilseed as a component crop improves the production potential of the system. Sunflower is a short duration, fast growing and day-neutral plant. It is an edible oilseed crop with wider adaptability across diverse cropping systems and climatic conditions. Research was conducted to evaluate and identify sustainable and profitable *rabi* sunflower based cropping systems in Central Telangana Zone. Greengram (*kharif*) 20-50-0 kg $N:P_2O_5:K_2O$ ha^{-1}) and sunflower (*rabi*) with 100% recommended dose of fertilizers (75:90:30 kg $N:P_2O_5:K_2O$ ha^{-1}) can be recommended for Alfisols in Telangana state

Field view of *rabi* sunflower crop

Performance

Adopting greengram-sunflower cropping system resulted in significantly higher sunflower equivalent yield of 2,202 kg ha^{-1} over maize-sunflower (1,979 kg ha^{-1}), *Setaria* (korra)-sunflower (1,963 kg ha^{-1}) and redgram-sunflower (1,535 kg ha^{-1}). Among fertilizer levels, application of 100% RDF (75:90:30 $N:P_2O_5:K_2O$ kg ha^{-1})resulted in significantly high sunflower equivalent yield (2,054 kg ha^{-1}) which was on par with that of 100% STCR (132:16:41 kg $N:P_2O_5:K_2O$ ha^{-1}: 1946 kg ha^{-1}). The highest system gross returns and net returns (Rs.1,26,948 ha^{-1} and Rs.68,659 ha^{-1}) were attained with greengram-sunflower cropping system, whereas *Setaria* - sunflower cropping system recorded a higher B:C (2.21). Among fertilizer levels, 100% RDF level recorded highest system gross returns (Rs.1,18,064 ha^{-1}), net returns (Rs. 57,082 ha^{-1}) and B:C ratio (1.94).

Kharif greengram - *rabi* sunflower with 100% RDF

Cost of Technology

Cost of cultivation for greengram-sunflower cropping system was Rs.58,290 $ha^{-1}$and for 100% RDF is Rs.60,982 ha^{-1}.

Impact and Benefit

Greengram-sunflower is a remunerative cropping system with higher net monetary returns of 10%, 36% and 68% over *Setaria*, maize and redgram based sunflower cropping systems, respectively. Further, application of 100% RDF accrued additional profits of 12% over 100% STCR treatments.

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2 Profitable Cropping Systems with Broad Bed & Furrow and Ridge-Furrow Land Configuration for Vertisols

Cotton + pigeonpea sown on BBF

Soybean sown on BBF

Salient Features

Moisture conservation measures help to reduce the soil and runoff losses and are also useful for raising rainfed crops successfully in arid and semiarid regions. Land configurations such as broadbed and furrow (BBF) and ridges and furrow methods (RF) enhance rainfed crops' yield and water use efficiency by maintaining favourable moisture regimes during dryspells. Further, during intense rainfall events, these land configurations will help to quickly dispose off excess rain water from the field.

Performance

Among the different cropping systems, cotton + pigeonpea inter cropping (4:1) and soybean-chickpea cropping system performed better with higher soybean equivalent yield of 4427 and 4307 kg ha^{-1}, respectively, compared to soybean-sorghum, soybean-safflower and soybean+pigeonpea. In addition, growing of these cropping systems on BBF or RF land configurations gave higher soybean equivalent yields (4786 and 4121 kg ha^{-1} respectively) over flat bed sowing.

Cost of Technology

The machinery cost to be incurred for configuring the land into boradbed and furrows or ridges and furrows is approximately Rs. 3500-4500 ha^{-1}.

Impact and Benefit

Adilabad district alone contributes to around 40,000 ha of soybean area in Telangana State. By adopting the BBF method of land configuration, net returns of Rs. 97,636 ha^{-1} with a B:C ratio of 2.09 can be realized. Similarly, cotton+pigeon pea (Rs. 87,395 ha^{-1}; 1.82) or soybean–chickpea (Rs.82,997 ha^{-1}; 1.98) cultivation recorded higher net returns and B:C ratio, respectively.

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3 Contour Farming Technology for Conserving Soil Moisture and Productivity Enhancement in Rainfed Crops Grown on Alfisols in Central Telangana Zone

Salient Features

Cropped area under rainfed agriculture is generally undulating, slopy and poorly bunded, thus becoming susceptible to erosion. Erosion causes loss of top fertile soil and nutrients, consequently resulting in poor productivity of rainfed crops. It also leads to moisture deficit stress in the upper reaches and excess moisture in the lower reaches of the slope. Contour bunding or contour farming is the farming practice of tilling and/or planting across a slope following its cutivation on contour lines. All the operations, *viz.*, sowing of the crop, inter-cultivation to control weeds, and irrigation, are done across the slope by following the contours. Contour farming helps in preserving natural resources besides controlling soil and water erosion and enhancing crop productivity.

Practising contour farming with greengram + pigeonpea (4:1) intercropping on Alfisols with a 3-5% slope in Central Telangana Zone conserves soil and moisture. It is more productive and profitable than greengram-pigeonpea and maize-pigeonpea intercropping systems under conventional farming (along the slope).

Greengram + pigeonpea intercropping under contour farming

Maize + pigeonpea intercropping under contour farming

Performance

Adoption of contour farming resulted in significantly higher productivity (5313 kg ha^{-1}) over conventional farming (4882 kg ha^{-1}). Further, contour farming conserved more soil moisture (11.1-16.0%) as compared to that of conventional farming (9.8-14.8%). On the otherhand, greengram+pigeonpea intercropping (4:1) with 6369 kgha^{-1} significantly outyielded maize+pigeonpea intercropping (4:1) (3826 kg ha^{-1}) in terms of maize equivalent yield. The combination of greengram+pigeonpea and contour farming recorded significantly higher maize equivalent yield (6681 kg ha^{-1}), net returns (Rs. 59641 ha^{-1}) and B:C (2.0) than that of greengram+pigeonpea under conventional farming (6057 kg ha^{-1}; Rs. 50918 ha^{-1}; 1.89, respectively), maize+pigeonpea under contour farming (3944 kg ha^{-1}; Rs. 3544 ha^{-1}; 1.05, respectively) or conventional farming (3708 kg ha^{-1}; Rs. 715 ha^{-1}; 1.01, respectively).

Cost of Technology

Additional cost of greengram+pigeonpea (4:1) intercropping under contour farming over conventional farming is: Rs. 2200 ha^{-1}

Impact and Benefit

Contour farming (across the slope farming) resulted in 8.8% improvement in total productivity over conventional farming (along with slope farming). Further, greengram+pigeonpea intercropping (4:1) gave a 66.5% yield advantage over maize + pigeonpea intercropping (4:1).

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4 Identification of Suitable Mustard Varieties for Central and Northern Telangana Zones

Experimental view of mustard varietal evaluation trial

Performance of NRCHB 101 mustard variety

Salient Features

In Telangana, mustard is generally grown during *rabi* season under irrigated dry situations/residual soil moisture. Higher productivity in mustard can only be achieved by selecting suitable cultivar and adopting improved agronomic management practices best suited for the specific agro-climatic situation. As mustard is a non-traditional crop in the Central (CTZ) and Northern Telangana Zones (NTZ), efforts were made to evaluate different mustard varieties and identify best suitable variety. Mustard varieties NRCHB-101, Pusa Mehak and Pusa Mustard-27 can be recommended for cultivation during *rabi* season under protected irrigation in Alfisols.

Performance

Among eight different mustard varieties (Pusa Mustard-25, Pusa Mustard-26, Pusa Mustard-27, Pusa Tarak, Pusa Agrani (Sej-2), Pusa Mehak, Pusa Jagannath and NRCHB-101) evaluated, NRCHB-101 recorded highest seed yield (1415 kg ha^{-1}), gross returns (Rs.61,103 ha^{-1}), net returns (Rs.31,213 ha^{-1}) and B:C (2.04) than other varieties. It was closely followed by Pusa Mehak variety (seed yield 1,375 kg ha^{-1}, gross returns Rs. 59,387 ha^{-1}, net returns Rs. 29,497 ha^{-1} and B:C 1.99).

Cost of Technology

Cost of cultivation for NRCHB-101 is Rs. 29,890 ha^{-1} (CTZ) and Rs. 18,750 ha^{-1} (NTZ).

Impact and Benefit

The variety NRCHB-101 was found suitable for both Central and North Telangana Zones with higher net returns (Rs. 31,213 ha^{-1} and Rs. 16,507 ha^{-1}). The yield improvement varied from 3-38% over other varieties.

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5 Yield Potential of Sunhemp Genotypes under Different Sowing Windows in Northern Telangana Zone

Salient Features

Telangana government imports to a greater extent the green manure crop seeds, especially *Dhaincha* and Sunhemp seed from Uttar Pradesh, Madhya Pradesh and Gujarat states due to lack of seed production and insufficient seed stocks in the state. Under these circumstances, there is a need to evaluate the released Sunhemp genotypes and identify the promising ones to know the seed production potential in Telangana State to plan for seed production in near future. SH-4 and SUIN-053 (Swastika) gentoypes and sowing during September 2nd week were found to be profitable.

Overview of the experiment

Performance

Six varieties were evaluated on three dates of sowing (September 2nd week, September 3rd week and October 2nd Week. Sowing sunhemp during September 2nd week resulted in the highest seed yield (33.6 q ha^{-1}), which was significantly superior to later sowing dates. Among the six genotypes tested *viz.*, Prankur (JRJ 610), SUIN 037 (Ankur), SUIN 053 (Swastika), SH4, K12 Yellow and Type 6), the genotypes; SH-4 (3721 kg ha^{-1}) and SUIN-053 (Swastika) (3459 kg ha^{-1}) when planted during September 2nd week recorded higher seed yield and net returns (Rs. 66,500 ha^{-1}).

Performance of SH 4 Sunhemp variety

Cost of Technology

Total cost of cultivation of sunhemp for seed production is Rs. 37,500 ha^{-1}.

Impact and Benefit

Genotypes SH-4 and SUIN-053 (Swastika) were found to be profitable when sown during September 2nd Week in Northern Telangana zone.

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6 Optimal Sowing Window and Sowing Method in Dry Direct Seeded Rice (D-DSR)

Mechanized line-sowing with tractor in Dry Direct Seeded Rice (D-DSR)

Field view of Dry Direct Seeded Rice (D-DSR)

Salient Features

Imminent water crisis, labour scarcity and climate change threaten the sustainability and profitability of traditional transplanted rice. Dry Direct Seeded Rice (D-DSR) technology envisages reduced water use, saving labour requirement, mitigating greenhouse gas emissions and improving environmental sustainability. Dry DSR is gaining acceptance by farmers due to relatively high grain yield, less water consumption, and reduced labour intensity, facilitating mechanization during crop establishment and lower greenhouse gas emissions. An optimum sowing time and sowing methods which are most suitable for dry DSR in Northern Telangana Zone were tested in this study.

Performance

The best time for sowing dry DSR is July 20th (3,507 kg grain yield ha^{-1}). Further, delayed sowing by 30-40 days resulted in drastic reduction in yield by 54.4% (1,598 kg ha^{-1}) compared to that of July 20th sowing. The best method of sowing was found to be mechanized line sowing (2,733 kg ha^{-1}) which recorded 200 kg ha^{-1} additional grain yield higher over broadcasting method (2,533 kg ha^{-1}) and 341 kg ha^{-1} higher than the manual line sowing method (2,392 kg ha^{-1}).

Cost of Technology

Cost of machine: Rs. 2 lakhs. (available on 50% subsidy from the government).

On hiring basis: Rs. 1500-2000 ha^{-1}.

Impact and Benefit

An early date of sowing with tractor drawn ferti cum seed drill in dry DSR can save Rs. 3,000 ha^{-1} as compared to manual line sowing under scarce labour conditions.

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7 Soil Test Based Fertilizer Recommendation for Targeted Yield in Sugarcane (Plant Crop)

Salient Features

Fertilizer is one of the costliest inputs in agriculture, and the use of the right amount of fertilizer is fundamental for farm profitability and environmental protection. Soil test based fertilizer prescription eliminates over or under usage of fertilizer inputs and increases the fertilizer use efficiency and yield of crops. Furthermore, soil test based application of plant nutrients helps to realize a higher response ratio and benefit-cost ratio as the nutrients are applied in proportion to the magnitude of the deficiency of a particular nutrient. In addition, correcting the nutrient imbalance in the soil helps harness the synergistic effects of balanced fertilization.

STCR equation for sugarcane plant crop for Vertisols of the Northern Telangana Zone for achieving a yield target of 110 t ha^{-1}:

$$FN = 5.40\ T - 1.42\ SN$$
$$FP_2O_5 = 1.80\ T - 4.37\ SP$$
$$FK_2O = 1.70\ T - 0.33\ SK$$

Performance

The mean increase in yield due to adoption of STCR equation (110 t ha^{-1}) was 1.0% over the blanket application of fertilizers (100% RDF), and 3.7% over farmers' practice. The fertilizer application as per yield target,i.e., 110 t ha^{-1} to sugarcane crop for validation achieved the targeted yield of ± 5%. A higher benefit-cost ratio was attained under STCR recommendations (2.30) over farmers' practice (2.18).Therefore, the fertilizer prescription equation developed for the sugarcane plant crop has achieved the target yield of 110 t ha^{-1}.

Cost of Technology

The cost of soil testing in government soil testing laboratories is nominal and ranges from Rs. 10 to 20 per sample (farmer field). This technology can be implemented with simple soil testing and using the ready-reckoner available to compute fertilizer doses.

Impact and Benefit

A net saving of P_2O_5 and K_2O fertilizers from the current recommended dose was 41 kg and 37 kg respectively and a saving of cost on fertilizers applied was Rs.2,275 ha^{-1}.

STCR experiment for targeted yield in sugarcane at tillering (Plant crop)

STCR experiment for targeted yield in sugarcane at maturity (Plant crop)

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8 Soil Test Based Fertilizer Recommendation for Targeted Yield in Sugarcane (Ratoon Crop)

STCR experiment for targeted yield in sugarcane at vegetative stage

STCR experiment for targeted yield in sugarcane at maturity stage

Salient Features

Soil testing is now accepted as a procedure for recommending fertilizer doses for various crops. However, soil testing would become a helpful tool only when it is based on an intimate knowledge of soil-crop-variety-fertilizer-climate management interaction for a given situation. In this regard, targeted yield approach is beneficial in recommending balanced fertilization considering available nutrient status in the soil and the crop needs. Adopting the target yield concept over other nutrient management practices resulted in higher yields, net benefit and optimal economic returns.

The validity of the following STCR equation developed for sugarcane ratoon crop for Vertisols of the Northern Telangana Zone was tested.

$$\mathbf{FN = 12.53T-4.66SN}$$

$$\mathbf{FP_2O_5 = 1.82T-3.24SP}$$

$$\mathbf{FK_2O = 4.48T-0.97SK}$$

Performance

The mean yield obtained in soil test based targeted yield for 90 t ha^{-1} was similar to that of farmer practice of fertilizer recommendations (88 t ha^{-1}). It showed that the per cent achievement of the targeted yield was within ± 5% variation, proving the validity of the equations for prescribing fertilizer doses for the sugarcane ratoon crop. Economics of fertilizer application based on targeted concept gave a benefit-cost ratio of 2.47. The corresponding value for farmers' fertilizer practice and RDF is 2.35 and 2.40, respectively.

Cost of Technology

The cost of soil testing in government soil testing laboratories is nominal and ranges from Rs 10 to Rs 20 per sample (farmer field). This technology can be implemented with simple soil testing and interpretation of results.

Impact and Benefit

A net saving of N, P_2O_5 and K_2O fertilizers from the current recommended dose was 62, 31and 29 kg, respectively and saving of cost on fertilizers applied per hectare was Rs. 3,247 ha^{-1}.

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9 Soil Test-Based Fertilizer Prescription Equations for Targeted Yield of *Bt* Cotton in Alfisols

Salient Features

In Southern Telangana Zone, *Bt* cotton is predominantly grown on red soils (Alfisols), which vary significantly in physico-chemical properties and fertility. Hence, recommending uniform doses for all cotton-growing farmers may result in imbalanced nutrition and low productivity. Soil Test Crop Respone (STCR) fertilizer recommendation provides soil test-based balanced fertilizer recommendations considering the yield targets.

Performance

Targeted yield equation for achieving 20 q ha^{-1} seed cotton yield in Alfisols is

FN=6.98T-0.29SN-0.16VCN

FP=2.58T-0.92SP-0.28VCP

FK=5.08T-0.32SK-0.18VCK

To achieve yield target of 20 q ha^{-1} in *Bt*-cotton with the available nutrient status of N, P and K of 175, 25 and 175 kg ha^{-1}, the fertilizer requirement of N, P_2O_5 and K_2O is 89, 29 and 46 kg ha^{-1} under Soil Test Crop Respone- Intergrated Plant Nutrient Supply System (STCR-IPNS) (NPK + vermicompost at 5.0 t ha^{-1}). The established equation requires a relatively low dose of fertilizers compared to farmers practice (125:70:40 kg ha^{-1}) and zonal reommendation of fertilizers (120:60:60 kg ha^{-1}).

Under the field validation study, the highest kapas yield of 18.05 q ha^{-1} was obtained at target yield of 20 q ha^{-1} with STCR-IPNS followed by application of STCR chemical fertilizers alone (17.68 q ha^{-1}), zonal recommendation of fertilizers (17.29 q ha^{-1}) and farmers practice (16.52 q ha^{-1}).

Cost of Technology

Generally, the cost of soil testing in government soil testing laboratories is nominal and ranges from Rs. 10 to 20 per sample (farmer field). This technology can be implemented with soil testing and interpretation of results.

Impact and Benefit

With the adoption of soil test-based fertilizer application, an additional net benefit of Rs 3,243 ha^{-1} can be realized over the recommended dose of fertilizers in *Bt* cotton. The Soil Test Crop Response Based Integrated Plant Nutrition System (STCR-IPNS) ensures sustainable crop production and reduce the cost of production.

Overview of the field experiment

STCR experiment for targeted yield in cotton - 2X gradient (Alfisol)

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10 Soil Test Based Prescription Equations for Balanced Fertilizer Use and Targeted Yield of *Bt* Cotton in Vertisols

STCR experiment for targeted yield in *Bt* Cotton (Vertisol) at vegetative stage

STCR experiment for targeted yield in *Bt* cotton (Vertisol) at maturity stage

Salient Features

Among the different agricultural inputs, fertilizers are the most important for increasing crop production, and have become one of the costliest agricultural inputs. Because of increasing input costs and decreasing commodity prices, new ways to increase efficiency with reduced costs have to be adopted. The targeted yield approach recommends balanced fertilization considering available nutrient status in the soil and the crop needs.

Performance

Soil test-based fertilizer prescription equations for the targeted yield of *Bt* Cotton was developed in black soils for situations *viz.*, only Chemical fertilizers and IPNS (inclusion of vermicompost).

Fertilizer prescription equations for a target yield of 2.5 t ha^{-1} or 3.0 t ha^{-1} cotton yield.

Only with chemical fertilizers	*With Chemical fertilizers + Vermicompost @ 5t/ha*
FN=8.66T-0.47SN (for nitrogen)	FN=8.66T-0.47SN-0.09VCN (for nitrogen)
FP=1.69T-0.80SP (for phosphorus)	FP=1.69T-0.80SP-0.19SK (for phosphorus)
FK=4.72T-0.28SK (for potassium)	FK=4.72T-0.28SK-0.94VCK (for potassium)

When soil test values were 161 kg N, 26 kg P and 293 kg K ha^{-1}, by using the above equation, the application of 141 kg nitrogen, 21 kg P_2O_5 and 36 kg K_2O ha^{-1} was estimated as needed to attain a target yield of 2.5 t ha^{-1} ha with chemical fertilizers; whereas 139 kg N, 20 kg P_2O_5 and 31 kg K_2O are necessary along with 2.5 t ha^{-1} vermicompost to attain this target yield in *Bt* Cotton. The deviation in fertilizer use by employing soil test-based prescription equations in comparison with that of general RDF (120-60-60kg NPK/ha) was (+) 21 kg N, (-) 39 kg phosphorus and (-) 24 kg potassium in Vertisols (black soils) for the above fertility status of the soil. The achievement of yield was 87-88% of the 2.5 t ha^{-1} yield target with chemical fertilizers and including vermicompost under field conditions.

Cost of Technology

Generally, the cost of soil testing in government soil testing laboratories is nominal and ranges from Rs. 10 to 20 per sample (farmer field). This technology can be implemented with soil testing and interpretation of results.

Impact and Benefit

Balanced fertilizers improve soil health, prevent the indiscriminate use of chemical fertilizers and help in best input use efficiency. In this process, input use costs can be regulated, and maximum net returns can be achieved. This fertilizer prescription targeted yield equations can be recommended for the Vertisols of the Southern Telangana zone.

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11 Sulphur and Boron Fertilization for Yield Maximisation of Groundnut Grown on Alfisols

Salient Features

The deficiency of sulphur (S) and boron (B) has also become widespread apart from (N) deficiency in groundnut growing soils in Southern Telangana Zone. The sulphur requirement for oilseed crops is relatively high and it is critical for metabolic and enzymatic processes, including photosynthesis, respiration and legume-rhizobium symbiotic nitrogen fixation. Boron is essential to improve pollen grain germination, pollen tube growth and viability of pollen grains. The synergistic effect of sulphur and boron has been observed in enhancing the groundnut yields in Alfisols of Telangana.

Performance

The pooled pod yield of groundnut was significantly higher (2256 kg ha^{-1}) with the application of 6 kg boron and 625 kg gypsum ha^{-1} in addition to recommended dose of fertilizers (40:40:50 NPK) and was on par with the yield obtained from other treatments receiving boron 4 kg ha^{-1} along with 500 kg gypsum ha^{-1} (2301 kg ha^{-1}). Higher net returns and B:C ratio (Rs. 43,542 ha^{-1} and 2.60) obtained with the application of boron@4 kg ha-^{1} along with a recommended dose of gypsum @ 500 kg ha^{-1}, compared to the 100% RDF (40:40:50 NPK+ gypsum @ 500 kg ha^{-1}) as Rs. 33,619 ha^{-1} and 2.19.

Cost of Technology

The additional cost of boron and sulphur fertilization is Rs.1500 ha^{-1}.

Impact and Benefit

Combining boron (4 kg ha^{-1}) and gypsum (500 kg ha^{-1}) in addition to recommended dose of fertilizers will enhance the yields of *rabi* groundnut upto 15-20% in Alfisols of Telangana State.

Field view of groundnut crop at pod forming stage with boron and sulphur fertilizers

Performance of groundnut crop with boron and sulphur fertilization

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12 Integrated Plant Nutrient Supply System in Greengram-Sorghum Sequential Cropping System under Rainfed Conditions

Rabi sorghum crop under INM

Rabi sorghum (60 kg N per ha) after *kharif* greengram (5 ton FYM+20 kg N per ha)

Salient Features

The fertilizer needs of a succeeding crop in a sequence cropping system is strongly influenced by the preceding crop(s) and the amount of fertilizers applied to them. Cereal crops like sorghum demand effective nutrient management for achieving productivity targets and sustaining soil fertility. An integrated supply of FYM with chemical fertilizers in *kharif* crops minimized the use of chemical fertilizers to a greater extent without affecting the *rabi* crop yield. Therefore, for efficient nutrient management in greengram-sorghum cropping system, a quantitative evaluation of the role of preceding crop and the residual effect of nutrients applied assumes great importance.

Performance

Application of FYM @ 5.0 t ha^{-1} and N (0, 10 and 20 kg N ha^{-1}) levels to *kharif* greengram did not influence the growth and grain yield of *rabi* sorghum. However, greengram biomass (5.18 t ha^{-1}), straw yield (3,412 kg ha^{-1}), sorghum equivalent yield (4,475 kg ha^{-1}) and economics were significantly higher with FYM @ 5 t ha^{-1} + 20 kg N ha^{-1}. For *rabi* sorghum, application of 60 kg ha^{-1} nitrogen recorded significantly higher grain yield (1950 kg ha^{-1}), fodder yield (3,663 kg ha^{-1}) and sorghum yield (4,586 kg ha^{-1}). The highest gross returns (Rs.61,570 ha^{-1}), net returns (Rs.37,870 ha^{-1}) and B-C ratio (1.60) were recorded with the application of 60 kg N ha^{-1}.

Cost of Technology

The cost of growing *kharif* greengram with the application of FYM @ 5 t ha^{-1} + 20 kg N ha^{-1} and application of nitrogen @ 60 kg ha^{-1} to *rabi* sorghum is Rs. 24,100 ha^{-1}.

Impact and Benefit

Higher sorghum equivalent yield and profits can be realized by growing *kharif* greengram with FYM @ 5 t ha^{-1} + 20 kg N ha^{-1} followed by applying 60 kg N ha^{-1} to *rabi* sorghum.

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13 Enhancing Production Potential of Pigeonpea through Foliar Nutrition

Salient Features

Yield of pigeonpea remains low due to excessive vegetative growth, indeterminate growth habit, non-adoption of timely nutrient management, drought and poor source-sink relationship. Further, nutrient deficiency, especially under moisture stress, causes an imbalance in the physiological and metabolic processes in the plant. Foliar nutrition helps in the absorption of nutrients efficiently through the leaves. Further, it reduces the nutrient dose, application loss and cost, thus economizing the crop production. Foliar spray of 2% urea or 1% Pulse magic or 0.5 % 19:19:19 at 50 % flowering stage and RDF (20-50-0 kg N, P_2O_5, K_2O ha^{-1}) in pigeonpea will help meet nutritional needs during moisture stress and enhance productivity.

Pigeonpea crop with RDF + 1% pulse magic foliar spray

Performance

Foliar spray of 2% urea or 1% Pulse magic (10% of nitrogen, 40% of phosphorus, 3% of micronutrients and 20 ppm plant growth regulators) or 0.5 % 19:19:19 at 50% flowering along with RDF (20-50-0 kg N, P_2O_5, K_2O ha^{-1}) resulted in higher pigeonpea yield (1703, 1679 and 1629 kg ha^{-1}, respectively) and B:C (3.33, 3.19 and 3.17, respectively) than the application of RDF alone (1261 kgha^{-1} and B:C of 2.30).

Pigeonpea crop with RDF + 2% urea foliar spray

Cost of Technology

An additional cost of Rs. 1000-1200 ha^{-1} is required for foliar spray of 2% urea or 1% Pulse magic or 0.5% 19: 19: 19.

Impact and Benefit

Foliar application of 2% urea or 1% Pulse magic or 0.5 % 19:19:19 at 50 % flowering stage along with the basal application of RDF have resulted in a 15% yield advantage in pigeonpea compared to RDF alone.

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14 Nitrogen Management in Dry Converted Wet Rice System

Dry converted wet rice with 140 kg N ha^{-1} at tillering stage

Field view of Dry converted wet rice with 140 kg N ha^{-1}

Salient Features

In recent years, onset of monsoon is getting delayed leading to the late release of water under canal commands. Further, dwindling groundwater resources and expensive irrigation water under upcoming irrigation projects demand research on dry converted wet rice systems to overcome delayed transplanting and optimize N dose and schedule for rice cultivation under such circumstances.

Performance

Among different N levels tested (120, 140 and 160 kg N ha^{-1}), application of N @ 140 kg ha^{-1} has given the highest grain yield (6827 kg ha^{-1}). Among different N schedules tested, N application in three splits @ 28 kg N ha^{-1} (1/5th part) each time at basal, 25 and 50 DAS and 56 kg N ha^{-1} (2/5th part) at 80 DAS resulted in significantly higher grain yield (6984 kg ha^{-1}).

Cost of Technology

The cost of cultivating rice with the application of nitrogen (140 kg ha^{-1}) is Rs. 45,813 ha^{-1}. The price of an additional 20 kg N is Rs. 217.

Impact and Benefit

Application of 20 kg N ha^{-1} in addition to the recommended dose *i.e.,* 120 kg N ha^{-1} with optimum scheduling could enhance the dry converted wet rice yield by 15% with an additional net returns of Rs. 13,179 ha^{-1} .

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15 Optimizing Nitrogen and Potassium Application for *Rabi* Sunflower through Fertigation

Salient Features

Sunflower is a short duration (90-100 days), photo insensitive and day neutral crop which can be grown throughout the year. In Telangana, sunflower is mainly grown in the *rabi* season under surface flood irrigation and conventional fertilizer application.

Growing *rabi* sunflower by irrigating the crop at 1.0 Epan (10-12 days interval) and supply of 100% nitrogen and potassic fertilizers (75 kg N+30 kg K_2O ha^{-1}) through fertigation resulted in higher yield, B:C and higher input use efficiency.

Fertigation schedule: 3.75 kg N ha^{-1} during germination and establishment, 15 kg N+7.5 kg K_2O ha^{-1} during the vegetative stage, 26 kg N+7.5 kg K_2O ha^{-1} during buttoning stage, 22.5 kg N +7.5 kg K_2O ha^{-1} during flowering and fertilization and 7.5 kg N+7.5 kg K_2O ha^{-1} during seed development.

Fertigation in *rabi* sunflower with 100% N & K at 1.0 Epan

Performance

Significantly higher seed yield of *rabi* sunflower was recorded in 100% N & K fertigation treatment (1584 kg ha^{-1} with 75 kg N and 30 kg K_2O ha^{-1}) at 1.0 Epan which was on par with 120 % N & K fertigation (1,561 kg ha^{-1}) and 80 % N & K fertigation (1549 kg ha^{-1}). Water productivity was higher in 100% N & K fertigation (0.43 kg ha^{-1} mm^{-3}) and 0.8 Epan (0.5 kg ha^{-1} mm^{-3}). Further, drip irrigation @ 1.0 Epan (Rs. 87,271 ha^{-1}, Rs. 50,160 ha^{-1} and 2.35) and fertigation levels, 100% N & K (Rs. 89663 ha^{-1}, Rs. 52,740 ha^{-1} and 2.43) recorded higher gross returns, net returns and B:C respectively.

Experimental view of sunflower fertigation

Cost of Technology

Cost of cultivation for drip irrigation at 1.0 Epan is Rs. 37,111 ha^{-1} and fertigation @ 100% N & K is Rs. 36,922 ha^{-1}.

Impact and Benefit

Adoption of drip irrigation at 1.0 Epan enhanced 3-6 % yield and 6-12% monetary returns over 0.8 Epan and 1.2 Epan. Fertigation level @ 100% N & K in sunflower improved seed yield by 19.8% over 60% N & K. Drip irrigation at 1.0 Epan saved 15 % water over 1.2 Epan.

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16 Drip Irrigation Regimes and Fertigation Schedules in *Rabi* Cauliflower

Fertigation of cauliflower with 50 % RD N & K at 1.0 Epan

Fertigation of cauliflower with 100 % RD N & K at 0.6 Epan

Salient Features

In vegetable cultivation, especially in cauliflower, irrational water and nutrient management system causes unnecessary wastage of water and fertilizer resources and leads to environmental pollution. But on the other hand, the economical use of water and nutrients is crucial as they are limited in nature and becoming costlier daily. Therefore, it is the need of the hour to use drip irrigation and fertigation to utilize water and fertilizer judiciously and efficiently to enhance the input use efficiency on a sustainable basis.

Performance

Drip irrigation at 1.0 Epan and fertigation of 80:100 N-K_2O kg ha^{-1} in 15 splits once in four days is recommended to maximize yield and net returns in cauliflower during *rabi* season. Drip irrigation at 1.0 Epan recorded higher curd yield (19.2 t ha^{-1}), net returns (Rs 1,85,004 ha^{-1}) and B-C ratio (1.9). Fertigation at 100% recommended dose i.e 80:100 N- K_2O kg ha^{-1} registered higher curd yield (24.5 t ha^{-1}), net returns (Rs 2,69,814 ha^{-1}) and B-C ratio (2.2).

Cost of Technology

Installation of drip system costs around Rs 1,00,000 to 1,25,000 ha^{-1}. Due to high initial investment the government is providing 80-100% subsidy to farmers. If a drip facility is available, the cost of technology is Rs 53,791 (Including costs of fertilizer and irrigation water).

Impact and Benefit

Drip irrigation is the most efficient method, which offers the judicious use of irrigation water through frequent irrigation with the volume of applied water approximating the consumptive use there by minimizing conveyance, deep percolation and application losses. In addition, an increase in yield and product quality is achieved through fertigation. Drip irrigation saves 77% of irrigation water and achieves 58% increase in curd yield over furrow irrigation.

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17 Water Budgeting of Irrigated Lowland Rice using Drum Culture Technique

Salient Features

Seasonal water requirement for rice ranges between 750 to 2500 mm for different rice cultivation systems, with an average value of 1,250 mm. The worldwide estimate of evapotranspiration (ET) of rice ranges between 450 and 700 mm season^{-1}, depending on the climate and growing season. In tail end regions of any command area, only 35-40% of their water requirement is released due to percolation losses/overuse of water in the head and middle reaches. Accurate prediction of water balance components in rice helps in precise water budgeting for efficient water management by reducing water losses (percolation and runoff) and diverting water to the needy areas for increasing cropped area under irrigation.

Field view of water budgeting study in transplanted rice

Performance

The total quantity of water applied was 1,276.5 mm. The water balance components were measured using the drum culture technique in low land rice and found that ET as 402.86 mm, percolation 452.13 mm and effective rainfall 310.0 mm, while ineffective rainfall was 111.5 mm. A grain yield of 4,783 kg ha^{-1} was recorded with irrigation water use efficiency of 3.92 kg ha^{-1}mm^{-1} and field water use efficiency of 3.83 kg ha^{-1}mm^{-1} in loamy soils of Northern Telangana Zone.

Water budgeting using drum culture technique in transplanted rice

Cost of Technology

Cost for installing drums is Rs. 2,500 ha^{-1}.

Impact and Benefit

Based on the results, it was noticed that 36 % of the water applied to paddy was subjected to percolation losses. Therefore, if measures are taken to reduce these percolation losses, the equivalent irrigated area can be increased.

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18 Water budgeting of Alternate Wetting and Drying Rice (AWD) with Drum Culture Technique

Field view of water budgeting study in rice under AWD

Water budgeting in rice under AWD

Salient Features

The AWD technology is the proven technology that saves the irrigation requirement by 30-40% without decline in yield. Hence, water budgeting and scientific irrigation scheduling in the AWD method helps to quantify the water balance parameters (ET, percolation, runoff and seepage). Subsequently, it helps to reduce percolation losses and enhances the water productivity.

Performance

In comparison with conventional water management, AWD method saved 37.7% water applied and also reduced 56.6% deep percolation losses. Further, the effective rainfall was 130% higher in the AWD method than conventional water management, indicating that rainfall is effectively utilized in AWD method.

The total field water applied was 844 mm. The water balance components measured by using Drum Culture Technique under AWD in rice crop were ET (351.2 mm), percolation (289.3 mm), effective rainfall (543.4 mm) and ineffective rainfall (19.9 mm) and seepage losses (57.9 mm). A grain yield of 5149 kg ha^{-1} was obtained with irrigation water use efficiency of 13 kg ha^{-1} mm^{-1} and field water use efficiency of 6.01 kg ha^{-1} mm^{-1} in loam soils in Northern Telangana Zone.

Cost of Technology

The cost involved in installing drums and AWD is Rs 3500 ha^{-1}.

Impact and Benefit

Nearly 56% reduction in percolation losses was observed in AWD method. If all the rice growing farmers of NTZ (≈5 lakh ha) adopt AWD technology, it helps to save 110 TMC of water which can be used to increase the equivalent area under irrigation.

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19 Weed Management in Rice - Maize Cropping System under Conservation Agriculture

Salient Features

Conservation agriculture (CA) is a system designed to achieve agricultural sustainability by improving the biological functions of the agroecosystem with limited mechanical practices and judicious use of chemical inputs. Weeds are one of the biggest constraints in conservation agriculture due to minimum soil disturbance by mechanical tillage. However, the recent development of post-emergence broad-spectrum herbicides provides an opportunity to control weeds in conservation agriculture.

Chemical weed management in rice- zero till maize cropping system under CA

Application of bensulfuron methyl (0.6%) + pretilachlor (6%) 6.6% GR (ready mix) at 10.0 kg ha^{-1} as pre-emergence at 3-5 days after transplanting (DAT) followed by (*fb*) bispyribac sodium at 250 ml ha^{-1} as post-emergence at 20 -25 DAT (2-4 leaf stage of the weed) in *kharif* rice and atrazine 50% WP 2.5 kg/ha + paraquat 24 % SL (tank mix) 2500 ml ha^{-1} pre-emergence *fb* tembotrione 33.6% SC @ 287.5 ml ha^{-1}at 20-25 DAS (2-4 leaf stage of the weed) as post-emergence in *rabi* maize (zero tilled or conventional) was the effective option for weed control.

Integrated weed management in rice- zero till maize cropping system under CA

Bispyribac sodium 10% SC 250 ml ha^{-1}as early post-emergence at 15 DAT (2-3 leaf stage of weed) *fb* hand weeding at 40-45 DAT in *kharif* transplanted rice and application of atrazine 2.5 kg ha^{-1}+ paraquat (tank mix) 2.5 L ha^{-1} as pre-emergence *fb* hand weeding at 40 DAS for *rabi* zero-till maize resulted in higher weed control efficiency.

Performance

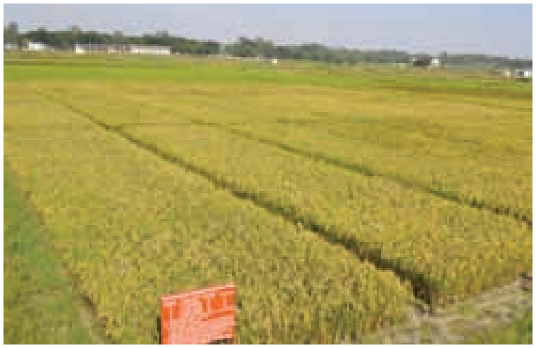
- Higher system productivity, gross returns, net returns and B:C ratio were obtained with rice-zero till maize(10,625 kg ha^{-1}, Rs.1,92,845, Rs.1,15,098 and 2.48), respectively, followed by rice -conventionally tilled maize (10,425 kg ha^{-1}, Rs.1,89,214, Rs.1,11,467 and 2.43).
- Adopting IWM resulted in higher system productivity, gross returns, net returns and B:C ratio (9,514 kg ha^{-1}, Rs.1,72,679, Rs 96,192 and 2.26) followed by chemical methods (8,722 kg ha^{-1}, Rs.1,58,304, Rs. 85,784 and 2.18, respectively).

Cost of Technology

- IWM in transplanted rice: Rs.11,000 ha^{-1}
- IWM in zero-till maize: Rs.13,375 ha^{-1}
- Chemical weed management in maize: Rs.8,375 ha^{-1}
- Chemical weed management in transplanted rice: Rs.5,650 ha^{-1}

Impact and Benefit

- Cultivation of transplanted rice during *kharif* season followed by zero till maize during *rabi* with the chemical weed management or IWM can be adopted for realizing higher yields and profits.
- Adopting total chemical weed control has resulted in significant savings in the form of 22-25 man days and cost of cultivation by Rs. 10,000-11,000 ha^{-1} in the rice maize cropping system compared to IWM.



Experimental view of rice in rice-maize cropping system under CA

Chemical weed management in *rabi* ZT maize

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20 Non-Chemical Weed Management in Okra-Carrot Organic Cropping System

Poly film mulch in *kharif* okra

Rice straw mulch in *rabi* carrot

Salient Feature

Organic farmers struggle to control the weeds effectively and economically. Weed management should reduce competition from current and future weeds by preventing the production of weed seeds and perennial propagules. Consistent weed management can reduce weed control costs and contribute to an economic crop production system. Organic weed management practices in the okra-carrot organic cropping system will aid in mitigating the losses caused by weeds and enhance productivity.

Weed management in okra (*kharif*)

Inter-row poly-film (30 micro-metres thickness) followed by intra-row hand weeding at 30 DAS or inter-row rice straw mulch (5 tha^{-1}) *fb* intra-row weeding at 30 DAS or mechanical weeding in inter-rows at 20 & 40 DAS *fb* intra-row manual weeding provided efficient weed control and higher yield in okra.

Weed management in carrot (*rabi*)

Rice straw mulch 5 tons ha^{-1} (inter-row) fb intra-row weeding at 30 DAS or rice husk mulch (3 t ha^{-1}) followed by intra-row weeding at 30 DAS resulted in efficient weed control and higher root yield of carrot.

Performance

The highest okra fruit yield was recorded in poly film mulch (3,875 kg ha^{-1}), followed by mechanical weeding twice (2,912 kg ha^{-1}). However, among the non-human weed management interventions, poly film mulch and rice straw mulch (1,928 kg ha^{-1}) were better options. In carrot, highest carrot root yield (13.64 t ha^{-1}) was recorded with straw mulch, followed by mechanical weeding (11.79 t ha^{-1}) and rice husk mulch (11.11 t ha^{-1}) which were at par with each other.

The system productivity (okra equivalent yield) was highest (9,500 kg ha^{-1}) in poly-film mulch treatment, followed by mechanical weeding treatment (8811 kg ha^{-1}) and rice straw much (8749 kg ha^{-1}).

Cost of Technology

- Poly film mulch: Rs. 37,000 ha^{-1}
- Rice straw (5 t ha^{-1}) mulching followed by intra-row hand weeding: Rs. 8,750 ha^{-1}
- Rice husk (3 t ha^{-1}) mulch followed intra-row hand weeding: Rs.7,000 ha^{-1}
- Mechanical weeding (20 & 40 DAS) followed by intra-row hand weeding: Rs. 8,640 ha^{-1}

Impact and Benefit

The overall highest system net returns and B:C were recorded in rice straw mulch treatment (Rs. 3,90,438 ha^{-1}; 3.90), followed by mechanical weeding treatment (Rs. 3,86,547 ha^{-1}; 3.72).

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21 Agronomic Package for Selective Mechanisation in Cotton on Rainfed Alfisols

Salient Features

Cotton production is plagued with a scarcity of manual labour and high costs involved in hiring, especially during sowing, weeding and picking, thus, increasing the production cost. Therefore, maximizing cotton production and productivity, while minimizing the cost of cultivation remains a significant challenge. Hence, complete or selective mechanization in cotton involving various improved tools and machinery helps to reduce drudgery, achieve timeliness and high labour efficiency, efficient utilization of resources, reduce the cost of cultivation and increase productivity which is the need of the hour.

Selective mechanization practices (SMPs) in cotton include sowing with seed cum ferti drill, intercultivation with tractor-drawn cultivator/rotavator in the initial stages (45-50 days after sowing) and power tiller (7 HP) in the later stage (beyond 50 days after sowing), line weeding with handheld weed scraper, spraying with a motorized power sprayer, stem application with stem applicator and picking with battery operated cotton picking machine and stubble incorporation with multi crop shredder.

Intercultivation in cotton with tractor drawn cultivator

Cotton crop under selective mechanization

Performance

Adopting the SMPs resulted in a significantly higher number of sympodial branches, bolls per plant and higher seed cotton yield (1,898 kg ha^{-1}) over conventional practices (CPs) (1,723 kg ha^{-1}). Further, SMPs could save 35 man-days and 71.2 hours' time ha^{-1} accruing higher net returns and B:C (Rs. 51,380 ha^{-1} and 1.89) over CPs (Rs. 34,164 ha^{-1} and 1.53).

Cost of Technology

The cost of cultivation under selective mechanization was Rs.56,970 ha^{-1} and conventional practices were Rs.64,064 ha^{-1}.

Impact and Benefit

Selective mechanization practices in rainfed cotton could reduce the cost of cultivation by Rs.7,095 ha^{-1}, improve the seed cotton yield by 10% (175 kg ha^{-1}), and increase the gross returns by Rs.10,122 ha^{-1}, net returns by Rs.17,216 ha^{-1}over conventional practices.

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22 Agronomic Package for Complete Mechanisation in Pigeonpea on Rainfed Alfisols

Intercultivation in pigeonpea with tractor drawn implement

Mechanical harvesting of pigeonpea with paddy combine harvester

Salient Features

Pigeonpea is the most important legume crop grown under rainfed situations in Telangana state. Scarcity of labour coupled with higher labour hiring costs and production costs necessitates mechanization in pigeonpea. Mechanization minimizes the use of human labour through the utilization of various user-friendly tools and farm machinery to perform various agronomic operations starting from pre-sowing to post harvest operations. It helps in the timely completion of operations, enhancing labour efficiency, reducing the cost of cultivation and increasing productivity and net income.

Mechanization practices in pigeonpea include sowing with seed cum ferti drill, intercultivation with tractor drawn cultivator/ rotavator in the initial stages (upto 60 days after sowing) and power tiller (7 HP) in the later stage (beyond 60 days after sowing), line weeding with hand held weed scraper, spraying with a motorized power sprayer and harvesting with paddy combiner and stubble incorporation with rotavator.

Performance

Adoption of the mechanized interventions recorded significantly more number of pods per plant (284.1) and higher seed yield (1,362 kg ha^{-1}) than conventional practices (261.8; 1,176 kg ha^{-1}, respectively).

Mechanization in pigeonpea could save 40 man-days and 67.5 hours ha^{-1}, thus, recording higher net returns (Rs. 33,836 ha^{-1}) and B:C (1.75) over conventional practices (Rs. 16,316 ha^{-1}; 1.35, respectively).

Cost of Technology

The cost of cultivation of rainfed pigeonpea under mechanization was Rs. 46,528 ha^{-1} as against conventional practices of Rs.52,978 ha^{-1}.

Impact and Benefit

Adoption of mechanization practices in rainfed pigeonpea reduced the cost of cultivation by Rs. 6,450 ha^{-1}, improved the seed yield by 15.8% (186 kg ha^{-1}) and increased the gross returns by Rs. 11,070 ha^{-1}, net returns by Rs. 17,520 ha^{-1} over conventional practices.

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23 Selective Mechanisation for Safflower Growers' Profitability

Salient Features

The level of mechanization in rainfed crops like safflower at present is meagre. But, because of labour shortage and increase in labour wages and thus, the cost of cultivation, it is imperative to introduce mechanization in safflower cultivation. Moreover, the thorniness of safflower deters the farm labour from participating in cultural operations, including harvesting. A comparative study with mechanized sowing and harvesting against manual sowing and harvesting (conventional method) was conducted to evaluate the efficacy and economics. Mechanised harvesting requires 10 hours ha^{-1} compared to 150 hours ha^{-1} for manual harvesting.

Broad Bed and Furrows for safflower sowing

Performance

Adoption of selective mechanization resulted in significantly higher plant height (123.1 cm), more primary branches (9.17), capitula per plant (20.4), filled seeds per capitula (26.2), 100 seed weight (6.27 g), as well as higher seed weight per plant (19.4 g) thus, significantly higher seed yield by 30% over conventional method. Further, higher energy output (21,802 MJ ha^{-1}), net energy returns (16,372 MJ ha^{-1}) and energy use efficiency (4.02) were observed with selective mechanization as compared to the conventional method. The total field losses observed with machine harvesting was 3.75% compared to 1.07% in manual harvesting.

Pesticide spraying with drone in safflower

Cost of Technology

Selective mechanization in safflower reduced the cost of cultivation by Rs. 4,921 ha^{-1} and increased the net returns by Rs.17,494 ha^{-1} over the conventional method.

Safflower harvesting using paddy combine harvester

Impact and Benefit

Farm mechanization is an efficient system for safflower in terms of time, labour use, net monetary returns and moisture conservation under *rabi* rainfed conditions. Selective mechanization could save 38 man days ha^{-1} and 54 hrs time compared to the conventional method. Further, selective mechanization treatment positively influences the growth, yield and economics of safflower under rainfed conditions.

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24 Machine Transplanting and Direct Seeding of Rice are the Best Options Over Conventional Transplanting in Puddled Soils

Evaluation of different crop establishment methods in rice

Machine transplanting of rice

Salient Features

Rice is the most important food crop of Telangana state, cultivated over 21.3 lakh ha in *kharif* and 20.2 lakh ha in *rabi,* respectively. The favourable soil and climatic conditions and water availability during the second season (*rabi*) drive almost the same rice area as the first season (*kharif*). Conventional rice demands 25-30 man days for transplanting one hectare. However, the short transplanting window (December 20- January 10) and labour shortage necessitate diversion towards alternate establishment methods, which require minimum labour without declining the yields. Machine planting and direct seeding are such options.

Performance

Establishing rice through machine transplanting with a spacing of 30 cm x 12 cm recorded significantly higher grain yield (6,058 kg ha^{-1}) which was followed by the broadcasting seed @50 kg ha^{-1} followed by (*fb*) line forming with power weeder at 15-20 DAS (5,238 kg ha^{-1}) and was at par with the direct seeding with drum seeder (4,901 kg ha^{-1}) compared to conventional transplanting (4,783 kg ha^{-1}). The highest net returns (Rs.68, 571 ha^{-1}) and B:C (2.16) were realised when rice was established through machine transplanting followed by drum seeding (Rs.51,911 ha^{-1} and 2.00, respectively) and broadcasting seed *fb* line forming with a power weeder (Rs.51,452 ha^{-1} and 1.88, respectively).

Cost of Technology

Cost of transplanting with machine transplanting, drum seeding and broadcasting seed followed by line forming with a power weeder is 37.5%, 75% and 69% less than the cost of conventional transplanting of rice (Rs.10,000 ha^{-1}).

Impact and Benefit

Machine transplanting and direct seeding in puddled soil are alternative methods of rice cultivation over conventional manual transplanting, particularly under the conditions of acute labour shortage.With these techniques, large areas can be sown within a short period besides higher yields and net returns.

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25 Quick Cooking Redgram Dhal - A Convenience Product

Salient Features

The cooking quality of redgram dhal is primarily assessed by its cooking time. With increased urbanization and more women joining the workforce, there is a need to develop products that need less preparation time in households. Since pigeonpea requires considerable cooking time, there is a need to have quick cooking red gram dhal (QCD). Foods like QCD will also be suitable as convenience foods, Ready to Cook food and operational pack rations of armed forces because of their light weight, easy cooking characteristics and long shelf life. Such convenience products are also gaining popularity and greater demand in the market. The quick cooking redgram dhal has an appreciable decrease in cooking time and had no significant loss of nutritional value, indicating that treatments like soaking, autoclaving, freezing and dehydration effectively reduce the cooking time of redgram dhal.

Performance

Cooking time of the dhal decreased to 12-16 minutes from 70-82 minutes in all three cultivars (TDRG-4, RGT-1 and WRG-122) due to various pretreatments like soaking followed by autoclaving, freezing and dehydration. The TDRG-4 dhal (raw and QCD) had an excellent aroma, which lasted long while cooking. Further, it preserved low free fatty acids and peroxide values during storage indicating good keeping quality compared to the RGT-1 and WRG-122.

Cost of Technology

Purchase and installation of processing equipment like autoclaves, individual quick freezing machines, driers, packaging machines, weighing balances and accessories require Rs.16 lakhs and Rs.3.6 lakhs for production of 1000 to 2000 kg quick cooking dhal per month.

Impact and Benefit

All the three varieties of PJTSAU *viz.*, TDRG - 4, RGT-1 and WRGE-122 are suitable for preparation of quick cooking dhal, a convenience product. TDRG-4 is the best in terms of nutritional composition, functional properties and storage stability. Therefore, quick cooking dhal is suitable for commercial marketing with additional features like addition of dehydrated green leafy vegetables, seasoning, etc.

Quick cooking redgram dhal

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26 Management of Stem Borer in Rice with Novel Insecticides

Efficacy of novel insecticide schedule-I

Efficacy of novel insecticide schedule-II

Salient Features

Yellow stem borer (YSB), *Scirpophaga incertulas* (Walker) is the most important and devastating insect pest in rice ecosystem at vegetative and reproductive stages causing yield losses upto 27-34%. Therefore, timely application of suitable insecticides to control stem borer is most important. Chlorantraniliprole belonging to the "diamide group of insecticides" acts on Ryanodine receptors in insect muscles, causing immediate feeding cessation thus preventing crop damage.

Performance

Among different insecticide schedules tested, highest yield (7,213 kg ha^{-1}) and B:C ratio (3.87) was recorded in chlorantraniliprole 0.4 GR @ 10 kg ha^{-1} at 15-20 DAT + spray application of cartap hydrochloride 50 SP @ 1 kg ha^{-1} at 50-60 DAT followed by the schedule with spray application of cartap hydrochloride 50 SP @ 1 kg ha^{-1} at 15-20 DAT + spray of chlorantraniliprole 18.5 SC @ 150 ml ha^{-1} at 50-60 DAT with yield (7063 kg ha^{-1}) and B:C ratio (3.30).

Cost of technology

- Cost of insecticidal schedule I (Granular application of chlorantraniliprole 0.4 GR @ 10 kg ha^{-1} at 15-20 DAT + foliar spray of cartap hydrochloride 50 SP @ 1 kg ha^{-1} at 50-60 DAT) - Rs. 5,125.00 ha^{-1}
- Cost of insecticidal schedule II (Spraying cartap hydrochloride 50 SP @ 1 kg ha^{-1} at 15-20 DAT + chlorantraniliprole 18.5 SC @ 150 ml ha^{-1} at 50-60 DAT) - Rs. 5,245 ha^{-1}

Impact and benefit

Combination schedule involving chlorantraniliprole 0.4 GR @ 10 kg ha^{-1} at 15-20 DAT + cartap hydrochloride 50 SP @ 1.0 kg ha^{-1} at 50-60 DAT increased yield by 27.57% compared to control with B:C ratio of 3.87 and is well suited as a tool in insect resistance management programme.

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27 Novel Insecticide Combinations for the Control of Sucking Pests and Pink Bollworm in Cotton

Salient Features

Among pests that infest cotton, the severity of damage caused by sucking pests and pink bollworm is increasing year by year in Central and South India, causing significant reduction in cotton production, productivity and quality. Insecticides are an integral part of pest management strategies to keep pest populations below ETL and minimize yield losses. Rotating insecticides with different modes of action aids in preventing the emergence of insecticide resistance. Hence, there is an imminent need to evaluate novel insecticide combinations.

View of the experimental field

Performance

Bioefficacy of 10 combination insecticides was compared against sucking pests and results revealed that pests *viz.*, leaf hoppers and thrips were low in the treatment wherein fipronil + imidacloprid @100 g ha^{-1} was sprayed two times at fifteen days interval from 50 DAS. Lambda cyhalothrin + chlorantraniliprole @ 200 ml ha^{-1} was sprayed two times at fifteen days interval from 80 DAS and found to be effective against Pink Bollworm.

Efficacy of fipronil + imidachloprid against sucking pests & PBW

Cost of Technology

- Cost of combination insecticide (fipronil + imidacloprid) @100 g ha^{-1} for the management of sucking pest in cotton is Rs 2,480/-
- Cost of combination insecticide (lambda cyhalothrin + chlorantraniliprole) @ 200 ml ha^{-1} for the management of PBW is Rs 3,692/-.

Impact and Benefit

Farmers can save Rs.3,750 - 4,000 ha^{-1} using combination insecticides.

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28 Novel Fungicide Molecules to Manage Anthracnose Disease in Soybean

Efficacy of carbendazim + mancozeb at vegetative stage

Efficacy of carbendazim + mancozeb at pod development stage

Salient Features

Soybean (*Glycine max* L. Merrill), the most important oilseed crop is cultivated in 1.61 lakh ha in Telangana during *kharif* season. Anthracnose caused by *Colletotrichum truncatum* is an important seed borne disease that appears late in the season on the stem, pods and seeds causing 30-50% yield loss. Managing anthracnose disease through timely application with an effective fungicide i.e mancozeb 63% + carbendazim 12WP mitigates the losses and enhances productivity.

Performance

Six combination fungicides were evaluated to manage anthracnose disease. Foliar application of mancozeb 63% + carbendazim 12WP (2.5 gL^{-1}) twice at vegetative and pod formation stage recorded mimimum per cent disease index (24.09) and highest seed yield of 2,219 kg ha^{-1} followed by captan + hexaconazole with PDI 33.33 and 1,945 kg ha^{-1} yield compared to untreated control with PDI (65.84) and yield (1,448 kg ha^{-1}).

Cost of Technology

- The total cost of technology is Rs 3,601 ha^{-1}.
- The cost of chemical is Rs 838/- and the labour charges for spraying of chemical is Rs 1,925/-.

Impact and Benefit

Spraying of mancozeb 63% + carbendazim 12WP @ 2.5 gL^{-1} at vegetative and pod formation stages resulted in seed yield of 2,219 kg ha^{-1} and B:C ratio of 2.85 with additional net returns of Rs. 12,146 ha^{-1}.

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29 Use of Nuclear Polyhedrosis Virus (*S*NPV) and Bird Perches to Reduce Insect Pests in Bhendi

Salient Features

Birds are voracious feeders on various crop pests and are important bio-agents as they are a natural check on insect pest population growth. Such predatory birds are beneficial to the crop and thereby to the farmers. A total of 86 beneficial birds feeding on several insects and their life stages at the time of ploughing, vegetative stage and seed formation stage in crops have been identified. Birds also act as dispersal agents of various viruses.

Performance

Fixing of bird perches @ 50 ha^{-1} one foot above the crop canopy height increased the efficiency of predatory birds in controlling various crop pests by 68%. Along with bird perches, foliar spray of *S* Nuclear Polyhedrosis Virus (*S*NPV) @ 250 LE ha^{-1} increased insect mortality by 45-73%.

Bird perches arranged in field to reduce insect pest damage

Cost of Technology

The farmers can use locally available sticks for installing bird perches. Labour cost for the installation of sticks per hectare is approximately Rs.800 and *S*NPV costs Rs.250 ha^{-1}. The total cost of the technology is Rs.1,050 ha^{-1} approximately.

Impact and Benefit

The technology is eco-friendly, cost-effective and reduces insect pests, thereby cost of plant protection decreases by 15-23% and enhances yield by 25-48% compared to control.

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30 Seed Treatment with Copper Oxychloride / Azadirachtin to Reduce Bird Damage at Sowing Stage in Maize and Sunflower

Salient Features

Nearly 28 species of birds cause considerable damage during sowing and seedling stage in various crops *viz.*, cereals (15-20%), pulses (0.2-3%) and oilseeds (0.5-36%). Among various crops, maize, groundnut, safflower and soybean are the most affected by birds. Use of seed treatment with copper oxychloride (COC) and azadirachtin proved to be effective in reducing the bird damage during sowing and seedling stages.

Effect of COC/azadirachtin seed treatment against bird damage

Performance

Seed treatment with copper oxychloride @ 3g kg^{-1} or azadirachtin 300 ppm @ 25 ml kg^{-1} followed by soaking the treated seed in water overnight one day prior to sowing was found to have better absorption. Use of COC or azadirachtin proved to be effective in reducing bird damage by 70-80% at sowing and seedling stages.

Cost of Technology

The cost of seed treatment including labour wages is approximately Rs. 625 ha^{-1} for COC and Rs.1,250 ha^{-1} for azadirachtin.

Impact and Benefit

It is a cost- effective and eco-friendly technology that reduces bird damage by 70-80% and enhances germination by 95%.

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31 Planting Barrier Crops to Reduce Bird Damage in Maize crop

Salient Features

In maize, birds like rose ringed parakeet (*Psittacula krameri*), house crow (*Corvus splendens*), jungle crow (*Corvus macrorhynchos*) and common myna (*Acridotheres tristis*) cause significant damage during dough stage of the crop. The extent of damage during ripening stage ranges between 6-39% and in isolated areas it goes upto 65%. Predominantly, patterns of damage by birds are restricted to peripheral rows. Use of high density planting of maize (or) sorghum fodder around the main crop (maize) can minimize bird damage.

Performance

The technique reduced damage besides giving better yield and additional income in the form of fodder to the farmer. Planting fodder maize (or) fodder sorghum in four rows around the main crop (maize) at 30 cm x 15 cm spacing minimized bird damage by 80-90%.

Cost of Technology

- Additional cost of growing fodder maize is Rs.2,900 ha^{-1}.
- Additional cost of growing fodder sorghum is Rs.2,625 ha^{-1}.

Impact and Benefit

This technology is eco-friendly and environmentally safe. It reduces crop damage by an extent of 93.87% with a yield increase of 56.83% in fodder maize border crop. Similarly, it reduces crop damage by 89.19% with yield increase of 38.23% in sorghum fodder border crop in comparison with control. B:C ratio is 13.6 in fodder maize and 10.2 in fodder sorghum.

Barrier crops in maize to reduce bird damage

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32 Integrated Bird Management in Maize Using Reflective Ribbons and Wrapping Method

Use of reflective ribbon to protect maize cobs from bird damage

Wrapping 3 - 4 leaves around maize cobs to protect from bird damage

Salient Features

Ten species of birds were recorded to feed on maize, of which the rose ringed parakeet is the most important in all states of the country.

Performance

Integrating two methods *viz.*, reflective ribbons and wrapping leaves around the cob was found to be effective in reducing bird damage significantly. Fixing of 25 reflective ribbons ha^{-1} in north-south direction at 0.5 m height above the crop and at 5-10 m intervals using bamboo poles along with covering maize cobs all along the peripheral four rows by wrapping adjacent green leaves around them during the milky stage reduced damage caused by parakeet and crows to a negligible level.

Cost of Technology

Cost involved in fixing reflective ribbons is Rs.3,625 ha^{-1} (Rs.1,625 for 25 ribbons and Rs.2,000 for labour charges towards wrapping)

Impact and Benefit

This ecofriendly technology reduces bird damage by 76% and results in 59% increase in yield over control.

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33 Block Plantation, Reflective ribbons and Whole Egg Solution Spray in Sunflower and Bajra to Reduce Bird Damage

Salient Features

In sunflower and bajra crops, rose ringed parakeet, house crow and munia are predominant depredatory birds and cause more than 10 - 40% damage. In isolated areas, the extent of damage reaches 100%, drastically declining cropped area across the country. Integrating several techniques suitable to the location and based on the availability of resources provides an effective control strategy to reduce bird damage.


Block plantation of bajra

Performance

A minimum block size of 21 acres of sunflower and bajra crops reduced parakeet damage. In addition, fixing reflective ribbons at the rate of 25 ha^{-1} in north - south direction at 0.5 m height above the crop at 5-10 m intervals using bamboo poles followed by spraying of whole egg solution @ 25 ml L^{-1} water during milky stage significantly reduced bird damage.


Damage by rose ringed parakeet in sunflower

Cost of Technology

Cost for fixing the reflective ribbons is Rs.3,625 ha^{-1} (Rs.1,625 for 25 ribbons and 2000 for labour) and for spraying of egg solution is Rs. 5,000 ha^{-1} (Rs.3,000 for eggs and Rs.2,000 for labour).

Impact and Benefit

This technology is ecologically safe and reduces bird damage by 55-60% in sunflower with 10-15% yield increase over control. In bajra, it reduces bird damage by 65-75% with 15-20% yield increase over control.

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34 Management of *Macrophomina phaseolina* Stem and Root Rot of Sesame

View of field experiment

Efficacy of trifloxystrobin + tebuconazole against stem and root rot in sesame

Salient Features

The stem and root rot of sesame caused by *M. phaseolina* is one of the major diseases causing 25-30% yield loss annually especially in turmeric fallows of Northern Telangana Zone. The disease occurs at any stage of crop growth and is favoured by dry weather and moisture stress. Secondary infection by sclerotia is the major concern causing substantial yield losses. Foliar application of trifloxystrobin + tebuconazole @ 0.5 g L^{-1} was found to be effective in managing the disease under field conditions.

Performance

Seven fungicides were evaluated for the management of stem and root rot disease. Minimum root rot incidence (16.2%) was recorded by foliar spray of trifloxystrobin + tebuconazole @ 0.5 g L^{-1} at capsule initiation and second spray at 15 days after first spraying with highest yield (651.6 kg ha^{-1}) followed by azoxystrobin @ 1 ml L^{-1} at same spray schedule which recorded 17.3% disease incidence and 610.3 kg ha^{-1} yield compared to highest root rot incidence (34.7%) and low yield (333.6 kg ha^{-1}) in untreated check.

Cost of Technology

- Cost of application of trifloxystrobin + tebuconazole is Rs.7,800 ha^{-1} (Two applications of trifloxystrobin + tebuconazole @ 0.5 g L^{-1} is Rs.5,000 ha^{-1} and labour charges Rs.2,800 ha^{-1}.)
- Cost of application of azoxystrobin is Rs.7,550 ha^{-1} (Two applications of azoxystrobin @ 1 ml L^{-1} is Rs. 4,750 ha^{-1} and labour charges Rs.2,800 ha^{-1}).

Impact and Benefit

Two foliar sprays with trifloxystrobin + tebuconazole @ 0.5 g L^{-1} at capsule initiation and at 15 days interval resulted in low root rot incidence and highest yield in sesame. However, B:C ratio recorded was highest in trifloxystrobin + tebuconazole (1.8) followed by azoxystrobin (1.7).

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35 Soybean Storage Technology: Impact on Quality and Health of Treated Seeds

Salient Features

Maintenance of seed viability from harvesting to the next planting season is a significant constraint in soybean seed production. As a regular practice, most soybean producers store their seed in gunny bags which are moisture pervious and alter the seed moisture content during extended storage leading to the invasion of storage mycoflora resulting in loss of seed viability. Therefore, an attempt was made to find cost effective pre storage seed treatment and storage container. In soybean, the pre storage seed treatment with carboxin 37.5% + thiram 37.5% @ 3 g kg^{-1} followed by storage of treated seeds in polylined gunny bags resulted in high seedling vigour, good germination and nil seed infection.

Germination of treated seed stored in gunny bag

Performance

In soybean, the pre storage seed treatment with carboxin 37.5% + thiram 37.5% @ 3 g kg^{-1} followed by storage of treated seeds in polylined gunny bags gave complete protection to seed with nil seed infection, better germination (77.17%) and seedling vigour (1871) compared to untreated seeds stored in gunny bags with increased seed infections (19.17%), reduced germination (51.50%) and less seedling vigour (1059) after eight months of storage.

Germination of treated seed stored in polylined gunny bag

Cost of Technology

The cost of seed treatment with carboxin+thiram @ 3 g kg^{-1} is Rs.375 ha^{-1}, and storage container (polylined gunny bag) is Rs.100.00 ha^{-1}. The total cost of technology is Rs 475 ha^{-1}.

Impact and Benefit

Pre-storage seed treatment with carboxin 37.5%+thiram 37.5% @ 3 g kg^{-1} followed by storage of treated seeds in polylined gunny bag was found to be the effective storage technology for soybean seed producers to curb the loss of viability.

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ANNEXURE

Agro Technologies 2020-21		
S. No.	**Technology**	**Research Station and Scientists Contributed**
1	*Rabi* sunflower based cropping systems in Telangana for climate resilience and profitability	**ARS, Tornala** Dr. D. Swetha, Dr. N. Sainath, Dr. A.V. Ramanjaneyulu, Smt. D. Sravanthi
2	Profitable cropping systems with broad-bed & furrow and ridge-furrow land configuration for Vertisols	**ARS, Adilabad** Dr. Sreedhar Chauhan, Dr. D. Mohan Das
3	Contour farming technology for conserving soil moisture and productivity enhancement in rainfed crops grown on Alfisols in Central Telangana Zone	**ARS, Tornala** Dr. A.V. Ramanjaneyulu, Dr. D. Swetha, Dr. N. Sainath, Smt. D. Sravanthi, Dr. M.Venkata Ramana
4	Identification of suitable mustard varieties for Central and Northern Telangana Zones	**ARS, Tornala** Dr. D. Swetha, Dr. A.V. Ramanjaneyulu, Dr. E. Uma Rani **RARS, Jagtial** Sri P. Madhukar Rao, Dr. D. Padmaja, Ms. N. Navatha, Dr. P. Madhukar, Smt B. Madhavi, Dr. R. Uma Reddy, Dr. P. Jagan Mohan Rao
5	Yield potential of sunhemp genotypes under different sowing windows in Northern Telangana Zone	**ARS, Kunaram** Sri.D. Anil, Dr. Sreedhar Siddi
6	Optimal sowing window and sowing method in Dry Direct Seeded Rice (D-DSR)	**RARS, Jagtial** Dr. P. Revathi, Dr. A. Krishna Chaitanya, Dr. S. Ompraksh, Mr. M. Rajendra Prasad
7	Soil test based fertilizer recommendation for targeted yield in sugarcane (Plant Crop)	**RS & RRS, Rudrur** Dr. T. Prabhakar Reddy, Dr. T. Srijaya Dr. A. Madhavi, Mr. S. Ravindhar
8	Soil test based fertilizer recommendation for targeted yield in sugarcane (Ratoon Crop)	**RS & RRS, Rudrur** Dr. T. Prabhakar Reddy, Dr. T.Srijaya Dr. A. Madhavi, Mr. S. Ravindhar
9	Soil test based fertilizer prescription equations for targeted yield of *Bt* cotton in Alfisols	**RARS, Palem** Dr. Kasthuri Rajamani, Dr. A. Madhavi, Dr. T. Srijaya, Dr. D. Vijaya Lakshmi
10	Soil test based prescription equations for balanced fertilizer use and targeted yield of *Bt* cotton in Vertisols	**AICRP-Soil Test Crop Response, ARI, Rajendranagar** Dr. T. Srijaya, Dr. A. Madhavi

Agro Technologies 2020-21		
S. No.	**Technology**	**Research Station and Scientists Contributed**
11	Sulphur and boron fertilization for yield maximisation of groundnut grown on Alfisols	**RARS, Palem** Dr. Kasthuri Rajamani, Dr. P. Surendra Babu, Dr. D.Vijaya Lakshmi
12	Integrated plant nutrient supply system in greengram-sorghum sequential cropping system under rainfed conditions	**ARS, Tandur,** Dr. K. Sandhya Rani, Dr. C. Sudhakar, Dr. C. Sudharani
13	Enhancing production potential of pigeonpea through foliar nutrition	**RARS, Warangal** Dr. M. Madhu, Dr. Ch. Pallavi, Dr. N. Sandhya Kishore, Dr. G. Padmaja, Dr. D. Veeranna, Dr. P. Jagan Mohan Rao, Dr. R. Uma Reddy
14	Nitrogen management in dry converted wet rice system	**RARS, Jagtial** Dr. P. Revathi, Dr. K. Chandra Shekar, Dr. M. Venkata Ramana
15	Optimizing nitrogen and potassium application for *rabi* sunflower through fertigation	**ARS, Tornala** Dr. D. Swetha, Dr. A.V. Ramanjaneyulu, Dr. N.Sainath
16	Drip irrigation regimes and fertigation schedules in *rabi* cauliflower	**AICRP on Water Technology Centre, Rajendranagar** Md. Latheef Pasha, G. Sidhartha, Dr. K. Avil Kumar, Dr. M. Umadevi, Dr. V. Ramulu, Dr. K. Chaitanya
17	Water budgeting of irrigated lowland rice using drum culture technique	**RARS, Jagtial** Dr. P. Revathi, Dr. K. Chandra Shekhar Dr. K.B. Suneetha Devi
18	Water budgeting of Alternate Wetting and Drying rice (AWD) with drum culture technique	**RARS, Jagtial** Dr. P. Revathi, Dr. K.B. Suneetha Devi Dr. Krishna Chaitanya
19	Weed management in rice - maize cropping system under conservation agriculture	**AICRP on Weed Management, Rajendranagar** Dr. M. Madhavi, Dr. T. Ram Prakash, Dr. M. Yakadri, Dr. P. Leela Rani, Dr. S. Sudha Rani
20	Non-chemical weed management in okra-carrot organic cropping system	**AICRP on Weed Management, Rajendranagar** Dr. M. Madhavi, Dr. T. Ram Prakash
21	Agronomic package for selective mechanisation in cotton on rainfed Alfisols	**ARS, Tornala** Dr. A.V. Ramanjaneyulu, Dr. N. Sainath, Dr. D. Swetha, Dr. D. Sravanthi, Dr. A. Sudarshanam, Dr. P. Sudhakar Reddy
22	Agronomic package for complete mechanisation in pigeonpea on rainfed Alfisols	**ARS, Tornala** Dr. A.V. Ramanjaneyulu, Dr. D. Sravanthi, Dr. D. Swetha, Dr. N. Sainath
23	Selective mechanisation for safflower growers' profitability	**AICRP on Oilseeds (Safflower), ARS, Tandur** Dr. C. Sudhakar, Dr. C. Sudharani

Agro Technologies 2020-21		
S. No.	**Technology**	**Research Station and Scientists Contributed**
24	Machine transplanting and direct seeding are the best options over conventional transplanting in puddled soils	**RRC, Rajendranagar** Dr. M. Venkata Ramana, Dr. P. Raghu Rami Reddy, Dr. P. Spandana Bhatt
25	Quick cooking redgram dhal- A convenience product	**MFPI - Quality Control Lab, Rajendranagar** Dr. Aparna Kuna, Dr. K. Lakshmiprasanna, Dr. T. Kamalaja, Dr. R. Neela Rani
26	Management of stem borer in rice with novel insecticides	**RARS, Jagtial** Dr. S. Omprakash, Dr. S. Srinivasa Reddy
27	Novel insecticide combinations for the control of sucking pests and pink bollworm in cotton	**ARS, Adilabad** Dr. K. Rajashekar
28	Novel fungicide molecules to manage anthracnose disease in soybean	**RARS, Jagtial** Dr. N. Balram, Sri. M. Rajendra Prasad Dr. T. Kiran Babu, Dr. S. Srinivasa Reddy
29	Use of nuclear polyhedrosis virus (*S*NPV) and bird perches to reduce insect pests in bhendi	**All India Network Project on Vertebrate Pest Management (AINP VPM), Rajendranagar** Dr. V. Vasudevarao, Dr. V. Sunitha, Dr. V. Ravinder Reddy, Dr. I. Aruna Sri
30	Seed treatment with copper oxychloride/ azadirachtin to reduce bird damage at sowing stage in maize and sunflower	**All India Network Project on Vertebrate Pest Management (AINP VPM), Rajendranagar** Dr. V. Vasudevarao, Dr. V. Sunitha, Dr. V. Ravinder Reddy, Dr. I. Aruna Sri
31	Planting barrier crops to reduce bird damage in maize crop	**All India Network Project on Vertebrate Pest Management (AINP VPM), Rajendranagar** Dr. V. Vasudevarao, Dr. V. Sunitha, Dr. V. Ravinder Reddy, Dr. I. Aruna Sri
32	Integrated bird management in maize using reflective ribbons and wrapping method	**All India Network Project on Vertebrate Pest Management (AINP VPM), Rajendranagar** Dr. V. Vasudevarao, Dr. V. Sunitha, Dr. V. Ravinder Reddy, Dr. I. Aruna Sri
33	Block plantation, reflective ribbons and whole egg solution spray in sunflower and bajra to reduce bird damage	**All India Network Project on Vertebrate Pest Management (AINP VPM), Rajendranagar** Dr. V. Vasudevarao, Dr. V. Sunitha, Dr. V. Ravinder Reddy, Dr. I. Aruna Sri
34	Management of *Macrophomina phaseolina* stem and root rot of sesame	**RARS, Jagtial** Sri. M. Rajendra Prasad, Dr. N. Balram, Dr. D. Padmaja
35	Soybean storage technology: Impact on quality and health of treated seeds	**Seed Research and Technology Centre, Rajendranagar** Dr. M. Madhavi, Dr. B. Pushpavathi, Dr. V. Bharathi, Dr. T. Pradeep and Dr. M.V. Nagesh Kumar

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