AGRO TECHNOLOGIES

2019-20

**Natural Resource Management & Crop Production,
Crop Protection and Farm Mechanization**

Professor Jayashankar Telangana State Agricultural University

Rajendranagar, Hyderabad - 500030, Telangana State, India.
www. pjtsau.edu.in

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CONTENTS

CONTENTS

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FOREWORD

The Agricultural sector of Telangana stands as a testimony to inception and implementation of unprecedented and enabling farmer centric proactive measures, which has catapulted the state to a position of most happening agrarian ecosystem of the country. Focused mechanization, streaming irrigation waters to newer agro niches through engineering excellence, science based approaches to counter the field constraints, creation of formidable agri-extension machinery, installing modern processing capabilities and viable back end linkages to potential markets were the growth engines behind this transformation. Such an integrated approach has raised the productivity levels of major crops manifold in a short period of time. Subsistence, non-remunerative farming has been seamlessly transformed into a commercial and profitable venture.

Such an improvement could not have happened but for the generation and adoption of resilient, cost effective, time tested technologies rolled out by Professor Jayashankar Telangana State Agricultural University. Research areas in mandate crops which needed immediate attention were prioritized and time bound objectives were set to tackle most crippling field constraints. Multi-disciplinary teams of scientists were deployed on a mission mode to fabricate competitive technology modules amenable for easy adoption. Robust crop improvement schemes have brought out superior cultivars, which have spread not only in the native state but also have become popular in neighbouring states. All the new varieties thus developed are designed to be input efficient, eco friendly stocks delivering desirable produce quality. Such designer cultures are ably supported by carefully designed package of practices including crop husbandry, crop protection and natural resource management. Sustainable development goals have been the driving force for the agro technologies being rolled out by the University to ensure idealistic growth pattern 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.

University believes in maintaining the momentum of an optimum 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 2019-20**" would be of immense practical value to all the stake holders in resolving the nagging 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.

(V. PRAVEEN RAO)

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PREFACE

Indefinite production constraints encountered in regular field experience by the farming community of the state had been the inspiration for technological solutions offered by the research scientists of the university. These innovations have bearing on the successful agrarian journey. The State is witnessing currently justifying the cause of 'Research with Societal Relevance'. Manifestation of these solutions has been realized 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 to lead further on a strong platform with confidence and certainty.

Field implementation of such farm technologies has propelled the state's performance figures in terms of crop productivity vis-a-vis resource utilization 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 water, fertilizers and crop protection chemicals use efficiency leading to sustainability.

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.

This compendium "**Agro – Technologies 2019-20"** 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. 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 Herbicide application to control nutsedge in *kharif* maize

Salient Features

Weed management in maize crop during rainy season has become a serious problem due to continuous moisture in the field coupled with labour shortage during peak period of agricultural operations. Due to non removal of weeds in time, crop yields are reduced drastically. *Cyperus rotundus* commonly called as nutsedge is a major menace in maize. To overcome this, a selective post-emergence herbicide halosulfuron methyl 75% WG @ 90 g/ha tank mixed with atrazine 50% WP @ 1000 g/ha (to control grasses and broad leaved weeds) can be used at 2-4 leaf stage of weeds. Together these herbicides effectively control nutsedge in addition to grasses and broad leaf weeds.

Halosulfuron methyl 90g + Atrazine 1000g/ha

Control

Performance

Sedges, grasses and broad leaved weeds in maize cause 30-50% yield loss. Continuous use of selective herbicide such as atrazine for both pre and post emergence weed management may result in development of resistance in weeds to herbicides and also may result in species shifts. New herbicide molecules like tembotrione or topramezone offer better control of only grasses and broad leaved weeds and do not control sedges. When there is severe infestation of nutsedge, halosulfuron methyl @ 90g/ha in combination with atrazine 50% WP @ 1000 g/ha as post-emergence herbicide at 2-4 leaf stage of weeds resulted in excellent control of nutsedge and recorded higher yield (15-20%) compared to application of atrazine as pre-emergence followed by 2,4 –D as post-emergence herbicides.

Cost of technology

Cost of herbicide is Rs. 5000/ha (halosulfuron methyl 75% WG @ 90 g /ha + atrazine 50% WP @ 1000 g/ha)

Impact and benefit

The herbicide halosulfuron methyl in combination with atrazine has the potential to provide effective post emergence control of sedges and broad leaf weeds in maize, which is not possible with other selective herbicides. Further, chemical weed management saves time and labour for weeding especially nutsedge which is an obnoxious weed. Its application avoids loss of nutrients and reduces cost of weeding by Rs. 5000- 6000/- per ha. Maize yields are increased by 15-20% due to timely weed control.

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2 Efficacy of diuron with sequential application of herbicides for cotton weed control

Salient Features

Cotton crop is prone to severe weed competition due to wider spacing and slow initial growth. Weed infestation is one of the most serious constraints in cotton production. The degree of damage is related to the weed species composition, weed density and duration of competition. Yield losses in cotton can be 50-80% due to weeds. Farmers are resorting to herbicide use to control weeds due to ever increasing labour cost and their non-availability in time. In rainfed cotton, pre-emergence application of diuron 80% WP (400 g/ha in red soil and 300 g/ha in black soil) followed by post-emergence application of a combination of pyrithiobac sodium (625 ml/ha) and quizalofop ethyl (1000ml/ha) at 2-3 leaf stage of weeds effectively controlled broad spectrum of weeds and resulted in higher seed cotton yield comparable to mechanical weeding.

Diuron (Pre-emergence) followed by combination of Pyrithiobac sodium and Quizalofop ethyl (Post-emergence)

Control

Performance

Pre-emergence application of diuron followed by post-emergence application of a combination of pyrithiobac sodium and quizalofop ethyl at 2-3 leaf stage of weeds resulted in efficient and timely weed control on par with that of mechanical weeding done at 20, 40 and 60 DAS. The overall net returns with the adoption of these herbicides application in cotton is Rs. 36,350/- per ha in red soil with B:C ratio of 1.97 and Rs. 47,150/- per ha with B:C ratio of 2.27 in black soils.

Cost of technology

Cost of herbicide is Rs. 6,050/- per ha (diuron 80% WP @ 400 g/ha in red soil and 300 g/ha in black soil as PE) with sequential application of pyrithiobac sodium 10% EC @ 625 ml + quizalofop ethyl 50% EC @ 1000ml/ha.

Impact and benefit

Combination of herbicides with broad spectrum action provides superior weed control compared to single application of either pre or post-emergence herbicides with a narrow spectrum weed control. This technology lowers the weed competition from the beginning and reduces loss of nutrients to cotton crop. The saving in weed control cost is Rs. 6,250/- per ha compared to mechanical weeding.

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3 Yield response of *rabi* maize to bio-fertigation with microbial consortium

Salient Features

Maize is the second major cultivated crop in the state of Telangana. Drip fertigation has proved its superiority over conventional fertilizer application in providing judicious amounts of water and nutrients to plants to increase the productivity. Biofertigation is application of liquid biofertilizers or microbial consortium along with drip irrigation to precisely deliver the bio-inoculants in the root zone. Such use of drip biofertigation has been proved to reduce the use of chemical fertilizers and sustain soil health.

Performance

A common dose of 80kg P_2O_5 / ha was applied to soil as basal. Drip bio-fertigation was adopted with recommended dose of nitrogen and potassium fertilizers (240kg N and 80kg K_2O/ha) along with a microbial consortium containing nitrogen fixing bacteria, phosphorus solubilizing bacteria, potassium releasing bacteria and zinc solubilizing bacteria (microbial population maintained $1x10^9$ cfu/ml liquid formulation). The effects of application of full dose of this combination three times at an interval of 10 days was compared with five times application at a reduced dose (by 25%) of this combination on seed yield of maize (DHM 117). The bio-fertigation of microbial consortia along with drip fertigation at reduced dose (by 25%) realized higher net returns (Rs. 52,227/- per ha) and B: C ratio (1.74). The soil application of bio-fertilizers alone increased the grain yield by six percent while addition of microbial consortium to 75% NPK (at 25% reduced dose) has enhanced grain yields by 16 percent.

Response of *rabi* maize to bio-fertigation of microbial consortium

Cost of technology

The cost of drip bio-fertigation technology is Rs. 70,656/ha (includes cost of fertilizers, microbial consortium, water and their application).

Impact and benefit

Drip bio-fertigation with 75% fertilizer dose along with microbial consortium for five times at 10 days interval from 10DAS resulted in achieving optimum grain yield (7489 kg/ha) and net returns (Rs. 52,227/- per ha) in *rabi* maize crop.

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4 Response of Sesame to drip irrigation regimes and fertigation during summer season

Response of summer sesamum to drip fertigation

Salient Features

Sesame is an important summer oil seed crop grown after turmeric, groundnut or cowpea in *kharif* rice fallows. Drip fertigation is an approach for water and nutrient management as the nutrients and water are applied directly into the soil. Drip fertigation is the fast growing micro irrigation method in Telangana State. It is adopted on a wide variety of crops as farmers are facing increasing shortage of water.

Performance

Summer sesame (var. Swetha) was grown under drip irrigation scheduled at 0.8 E pan. Recommended fertilizer dose N (60kg/ha) and K (40kg K_2O/ha) applied in differential dosages of 1.5, 4.5 & 3 kg N/ha and 0.9, 1.8 & 3.0 kg K_2O/ha during 10 to 30 DAS, 30 to 50 DAS and 50 to 70 DAS recorded significantly higher seed yield (1011 kg/ha) and water productivity (0.238 kg/m^3) with a common dose of 60 kg P_2O_5 applied to soil as basal.

Cost of technology

The cost of technology is Rs. 32,752/- per ha (includes cost of fertilizers, water and their application).

Impact and benefit

This technology resulted in achieving optimum grain yield (1011 kg/ha) and net returns (Rs. 53,604/- per ha) of summer sesamum crop under drip fertigation with full dose of recommended N&K along with 425 mm of water and B:C ratio of 2.95.

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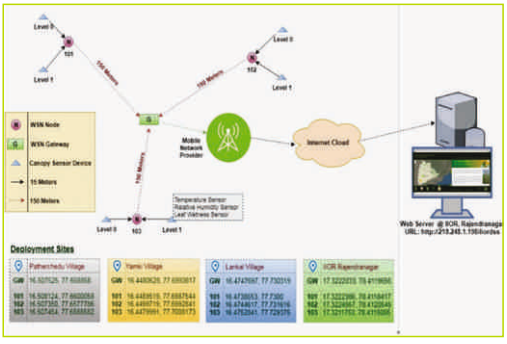
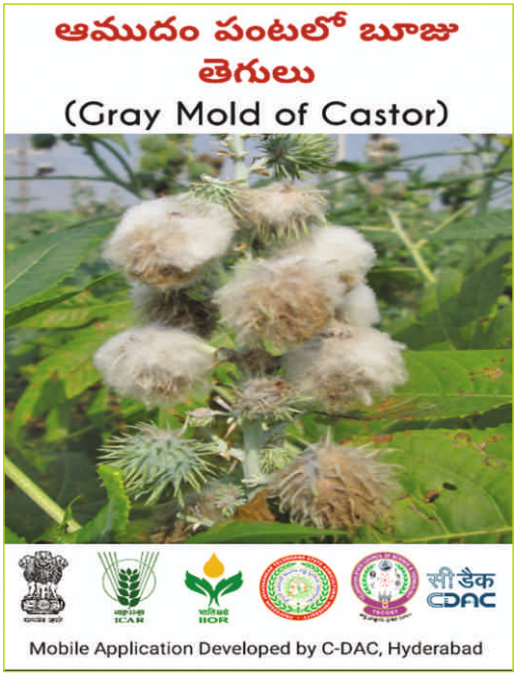
5 Monitoring and Forewarning System for Castor Gray Mold

Salient Features

Monitoring and forewarning system for management of Castor gray mold disease was developed. The system comprises of disease monitoring through Wireless Sensor Network (WSN) installed in field, linked to centralized server and computer which processes the data using gray mold disease prediction model. One unit comprises of 4 sets of 3 sensors (temperature, rainfall and leaf surface wetness) and one gate way. Based on the congenial to the famers conditions for the disease sensed through WSN, alert message is sent through castor gray mold mobile App along with the control measures. One unit of sensor network system is capable of covering around 2500 hectares.





Performance

Wireless Sensor Network systems were deployed in farmer's fields covering 7 villages in six mandals of Mahabubnagar district from 2017 to 2019 evaluated under DST funded project . The results indicated that, the farmers who used the WSN expert system could manage gray mold disease effectively, reducing disease severity by 84% resulting in 72% yield increase over general practice.

Cost of technology

Each WSN unit costs Rs. 3.2 lakh for covering 2500 hectares (Rs. 128/- per ha). The unit has to be linked to the centralized server which is already available at ICAR-IIOR, Rajendranagar, Hyderabad.

Impact and benefit

Monitoring and early detection of congenial conditions for gray mold disease incidence through WSN system and dissemination of alerts using Castor gray mold mobile App which helped about 4000 farmers in taking up prophylactic measures against gray mold disease realizing an additional income of Rs. 51600/- per hectare over farmers practice.

(https://play.google.com/store/apps/details?id=com.cdac.mlearn.castor)

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6 Performance of High-yielding mid-early and medium duration Pigeon Pea Varieties Under Rainfed Conditions

Salient Features

Pigeon pea is a drought resistant crop, needs less water and nutrients to give reasonably good yields even under unfavourable agro-ecological conditions in rainfed agriculture. The changing climatic conditions have a major impact on rainfed crops including pigeonpea. Cultivation of traditional low-yielding varieties susceptible to abiotic and biotic stress is one of the main reasons for low productivity. Hence, there is a dire need to replace them with location specific high-yielding varieties to enhance the productivity under rainfed conditions.

WRGE-96

WRGE-97

Performance

Among the different mid-early (140-160 days maturing) entries tested, WRGE-96 recorded more pods/plant (226) and seed yield (1336 kg/ha) besides higher gross, net returns and benefit cost ratio (Rs. 766680/- per ha, Rs. 45913/- per ha and 2.49, respectively). Another mid-early variety WRGE-97 and medium maturity variety WRG-27 also showed similar high yields (1271 and 1237 kg/ha) and B:C ratio (2.39 and 2.32). The traditional pigeon pea varieties *viz.,* Durga, PRG 176, Maruthi and Asha produced lower pods (132 to 202) and seed yield (691 to 1182kg/ha) with B:C ratio of 1.43 to 2.23. Hence, cultivation of mid-early and medium duration cultivars of pigeonpea will give higher yields and net profits on rainfed Alfisols of erstwhile Medak district.

Cost of technology

The cost of cultivation for high yielding mid-early and medium duration pigeon pea varieties ranged from Rs. 30350 to Rs. 30755/- per ha.

Impact and benefit

Cultivation of location specific high yielding pigeon pea varieties like WRGE-96, WRGE-97 (mid-early 140-160 days) and WRG-27 (medium maturity 160-180 days) could enhance the productivity by 23% and realise higher net returns by 44% over existing old varieties in alfisols under rainfed conditions.

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7 Re-scheduling of N-fertilizer application rate in dry seeded paddy

Salient Features

In Telangana paddy is cultivated predominantly in puddle condition in command areas under tanks and bore wells. Due to deficit rainfall and low availability of canal water farmers have begun to switch over to dry seeded paddy cultivation. In dry seeded paddy cultivation, the nutrient uptake is limited due to shallow depth of root penetration compared to transplanted paddy under puddle situation and hence there is a need to reschedule N- fertilizer rates in dry seeded paddy situation.

Tillering stage - 150% N (180 kg N/ha)

Farmers practice (120 kg/ha) (FP)

Performance

Different N fertilizer levels (120,150,180 and 210 kg N/ha) were tested in dry seeded paddy. Application of 180 kg N/ha in 3 splits recorded the highest number of filled grains per panicle (193) and test weight (15.6 g) over the farmers practice (169 filled grains/panicle and test weight of 14.1 g). Application of 180 kg N/ha realized higher grain and straw yields (4952 and 6652 kg/ha, respectively), 18-27% superior over the farmers practice (grain yield 3901 and straw yield 5619 kg/ha, respectively). As a result higher gross and net returns and benefit cost ratio was obtained in direct seeded paddy. The extra net income amounted to Rs. 13415/ha. The benefit cost ratio increased from 0.9 (farmers practice) to 1.7 at 180 kg N/ha application in dry seeded paddy.

Cost of technology

Though there is marginal increase in the cost of fertilizer N used compared to the farmer practice (Rs.727/ha), there was benefit of 27% yield increase over farmers practice.

Impact and benefit

The potential area for cultivation of dry seeded paddy in Telangana State is about 0.42 lakh hectares. By introducing 180 kg N/ha in dry seeded method, productivity of the area can be increased by 27%, more economically than current farmers practice.

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8 Performance of minor millets under different sowing methods in rice fallows

Salient Features

In Telangana, cultivation of paddy during *kharif* (vanakalam) and maize during *rabi* (yasangi) under rice fallow situation is practiced by some farmers. However, with limited availability of irrigation water the yasangi maize crop experiences terminal stress due to high temperatures. Moreover, during yasangi most of the paddy area remains fallow. Therefore, there is a need to adopt to grow drought tolerant and short duration minor millets to increase farmer's income instead of keeping field as fallow. Establishment methods (broadcasting and dibbling) of different minor millets were tested under rice fallow situation.

Broadcasted Ragi

Dibbled Ragi

Performance

Among minor millets (Ragi, Korra, Oodalu and Varigalu), highest grain yield and rice equivalent yield were recorded with ragi @ 3.5 kg/ha sown by broadcasting (2002 and 3074 kg/ha, respectively) compared to dibbling @ 3.2 kg/ha (1755 and 2771 kg/ha, respectively) followed by korra (1658 and 2673 kg/ha, respectively) and oodalu (1631 and 2341 kg/ha, respectively) sown by broadcasting method. Broadcast sown ragi gave the highest gross and net returns and B:C ratio (Rs.58922/-, Rs.36469/- per ha and 1.6, respectively).

Cost of technology

Cost of cultivation of broadcast seeded ragi in rice fallows saves Rs. 2,212/- per ha compared to dibble seeded ragi.

Impact and benefit

The potential area for sowing millets in rice fallows in Telangana is 1.54 lakh hectares. Broadcast seeding of millets enhances the yields by 8 to 16.4% than dibbled seeded millets in rice fallows. Adoption of broadcast seeding of millets in rice fallows not only improves the income of the farmers in rainfed areas but also aids in increasing millet production of Telangana State.

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9 Nutrient management to increase productivity of yellow Jowar in rice fallows

Salient Features

In low lands, rice is grown during *kharif* (vanakalam) and then fields remain fallow during *rabi* (yasangi) due to lack of irrigation, cultivation of long-duration varieties of rice, early withdrawal of monsoon rains leading to soil moisture stress at planting time of winter crops. In such situations, growing sorghum under residual moisture in rice fallows is gaining attention. Nutrient management of sorghum in rice fallows assumes importance.

125% RDF (125:75:50 NPK kg/ha) + PSB

Farmers practice (95:92:17 NPK kg/ha)

Performance

Three fertilizer levels 75% RDF (75:45:30 NPK kg/ha), 100% RDF (100:60:40 NPK kg/ha) & 125% RDF (125:75:50 NPK kg/ha) along with seed treatment of phosphorous solubilising bacteria (PSB @ 25 g/kg seed) tested for rice fallow sorghum indicated that application of 125% RDF (125:75:50 NPK kg/ha) + PSB has realized higher sorghum grain yield (1658 kg/ha) with higher test weight of 33.2g which is 17.1% superior over the farmers practice (1416 kg/ha).

Cost of technology

In rice fallow sorghum additional cost for fertilizer with 125% RDF (125:75:50 NPK kg/ha) + PSB is Rs. 1181/ha over farmers practice (95:92:17 NPK kg/ha).

Impact and benefit

Farmer can earn additional income of Rs. 18205/ha by cultivating yellow jowar in rice fallows by application of 125% RDF + PSB, instead of keeping as fallow.

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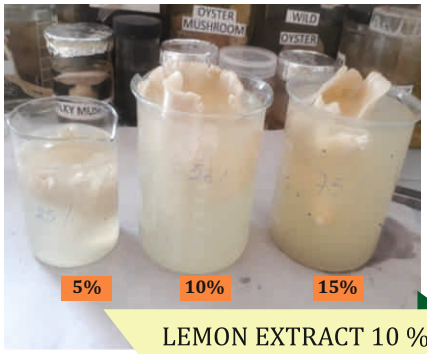
10 Improving the Shelf-life of Oyster mushrooms and enriching with Vitamin C using lemon extract

Salient Features

Mushrooms are highly perishable in nature and deteriorate within a day after harvest due to their high respiration rate and delicate epidermal structure. Consequently, the shelf-life of freshly harvested mushrooms is limited to 1-3 days under ambient conditions. Farmers are currently using NaCl (common salt) to enhance the shelf-life. The Mushrooms ready to market are dipped in 100 ml of lemon extract/ litre of water for 10 min and then removed to dry and packed. By using lemon extract, farmers can enhance the Vitamin C content and shelf-life to fetch better market price.

SODIUM CHLORIDE 2%

ASCORBIC ACID 0.1%



LEMON EXTRACT 10 %

Performance

Studies revealed that treating with NaCl (common salt) @20 g/l, Ascorbic acid @ 1g/l and lemon extract @ 100 ml/l could improve the shelf-life of oyster mushrooms by 12, 7 and 6 days, respectively without any browning under refrigerated conditions. However, by using lemon extract, vitamin C content in mushrooms enhanced by 55 g/ kg of mushrooms.

Cost of technology

Using lemon extract instead of NaCl, the mushroom growers incur an additional expenditure of Rs. 160/100 kg.

Impact and benefit

Using lemon extract to enrich mushrooms with vitamin C and storing upto 6 days, farmer can market mushrooms at an increased price of Rs. 25/kg and get an additional income of Rs. 2500/100 kg.

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11 Optimization of seed rate under improved sowing method in soybean

Salient Features

Soybean is one of the most important oilseed cum pulse crop grown widely in Northern Telangana region of Telangana state during *kharif* season as rainfed crop. As general practice, soybean is cultivated in traditional method on flat beds by sowing behind the plough or seed drilling with bullock drawn or tractor drawn seed drills by adopting a seed rate of 60-75 kg/ha. However, by adopting proper sowing methods like broad bed furrow (BBF) or ridge and furrow seed drills, seed rate, sowing time and sowing cost can be saved significantly over the traditional method of cultivation.

SEED RATE OF @ 70 kg/ha

SEED RATE OF @ 60 kg/ha

Performance

During 2018 and 2019, adoption of reduced seed rate of 60 kg/ha recorded at par soybean yields (2259 kg/ha) with recommended seed rate of 70 kg/ha (2443 kg/ha). Soybean sown on ridge and furrow method of sowing at 45 cm row distance recorded higher yield (2418 kg/ha) as compared to the flat bed method of sowing (2146 kg/ha).

Cost of technology

No additional sowing cost is required to adopt ridge and furrow seed drills to sow the soybean crop instead of the traditional methods like sowing behind the plough or seed drilling with bullock drawn or tractor drawn seed drills. Sowing time can also be saved up to 2.5-3.5 hours over the farmer's practice (sowing behind the cattle pair) as well as 12.5-15 kg/ha seed rate as against the traditional method with saving of Rs. 500-600/- per ha on seed cost.

Impact and benefit

By adopting 60 kg/ha seed rate in soybean sown at a spacing of 45x10 cm on ridge and furrow in black cotton soils, higher yield can be realized. It may be possible to increase benefits further by adopting high yielding variety.

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12 Evaluation of pre released rice cultures under different N levels in Northern Telangana Zone

Salient Features

The actual yield advantage in rice production depends on the development of potential cultivars and improved agronomic management practices. Identification and use of high yielding cultivars with appropriate nitrogen fertilizer application is a major concern with regards to economic viability of rice crop production.

VALUATION AT DIFFERENT N LEVELS

Performance

Four pre released rice cultures of Northern Telangana Zone *viz.,* KNM 733, KNM 1638, JGL 24423 and JGLH 1 along with one check variety MTU 1010 were evaluated with four levels of nitrogen (150, 120, 108 and 90kg/ha) through neem coated urea as N source during *kharif* and *rabi* seasons. KNM 1638 rice recorded highest yield (9951 kg/ha) during *kharif* where as JGL 24423 (5802 kg/ha) during *rabi* season over other varieties. Two season's data indicated that application of 120 kg N/ha recorded highest yield in KNM 1638 during *kharif,* JGL 24423 (120 or 150 kg N/ha in *rabi* season but realized on par yields with 108kg N/ha, with respect to these varieties.

Cost of technology

Cost of 108 kg N/ha can be reduced from the recommended dose of nitrogen (120 kg N/ha) to rice crop with saving of Rs.1328/- per ha to obtain optimum yields.

Impact and benefit

To realize higher yield potential under optimum nitrogen dose with identification of suitable location specific cultivars *viz.,* KNM 1638 and JGL 24423 for *kharif* and *rabi* seasons for Northern Telangana Zone are essential for increasing the productivity of rice. Ninety percent of recommended dose of nitrogen (@ 108kg N/ha) when applied as neem coated urea is enough to obtain high yields in rice crop which saves 10% of nitrogen when compared to normal recommended dose of nitrogen.

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13 Yield Potential of KNM rice genotypes under different sowing windows

Salient Features

Performance of a genotype entirely depends upon the time of sowing. The medium slender, KNM 1638 and short slender KNM 733 (Kunaram Rice-1) rice varieties developed are evaluated for their yield performance with best checks by sowing on different dates in *kharif* and *rabi*.

Rice cultures transplanted at different dates

Performance

In *kharif,* among the genotypes KNM 1638 recorded the highest grain yield (7455 kg/ha) when sown on 5th July and next best was sown on 20th June. In *rabi,* KNM 733 recorded the highest grain yield (8301 kg/ha) when sown on 20th November and next best was 5th December. Cultivation of KNM 1638 in *kharif* registered higher gross (Rs.1,35,308/- per ha) and net (Rs. 75,308/- per ha) returns to farmers (B:C ratio 2.25). Adopting the cultivation of KNM 733 in *rabi* season registered higher gross (Rs.1,50,663/- per ha) and net returns (Rs. 90,663/- per ha) to farmers (B:C ratio 2.51).

Cost of technology

No additional cost is involved with sowing on different dates although total cost of cultivation is Rs. 60,000/ha.

Impact and benefit

Selection of KNM 1638 (medium slender grain) and KNM 733 (short slender grain) with early duration when sown at 5th July in *kharif* and 20th November in *rabi* season, respectively produces higher yield in rice.

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14 Effect of Plant Growth Regulator "Cholorocholine Chloride(CCC)" on Growth, Yield and Economics of *Rabi* Sorghum under rainfed conditions

Salient Features

The reduction of plant growth and size of the panicles through chemicals is a common practice to make a plant more compact and commercially more acceptable. Cycocel (Chlorocholine Chloride - CCC) is taken up mainly through green parts of the plant and diverts energy to modify plant habit and reduces or stunts plant growth. The modern *rabi* sorghum genotypes are typically characterized by the plants with thin culm girth and heavy panicle size, which make them more susceptible to lodging at maturity. Hence, use of plant growth inhibitor Cycocel enhances the source to sink ratio by inhibiting the vegetative growth besides increasing grain yield and imparting resistance to lodging.

CYCOCEL TREATED
RABI SORGHUM

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Performance

Two foliar sprays with Cycocel @ 1000 ppm at knee high stage (45 DAS) and booting stage (65 DAS) recorded significantly high reduction in plant height, led to highest panicle width and grain yield of *rabi* sorghum when compared to crop left unsprayed (control). The gross monetary returns (Rs.73868/- per ha), net returns (Rs.48868/- per ha) and B:C ratio (1.94) were also significantly high with Cycocel spray @ 1000 ppm at knee high stage (45 DAS) & booting stage (65 DAS).

Cost of technology

Cost of Cycocel is Rs.600/500 ml/hectare.

Impact and benefit

Application of Cycocel spray @ 1000 ppm at knee high stage (45 DAS) and booting stage (65 DAS) reduces the lodging of yasangi sorghum due to reduced plant height and improves the grain yield by 34%.

15 A Farmer Friendly Technology of Raising Rice Mat Nursery for Machine Transplanting

Salient Features

Raising of rice mat nursery on polythene sheet is an efficient method to replace existing tray method. In this method 60 micron thickness white polythene sheet is spread on the puddled and well settled soil. The puddled soil from the same field is filled on the polythene sheet to a maximum depth of 2 cm in wooden frames with 8 partitions, each partition size of 58 cm length, 28 cm width, 2.5 cm thickness and pre-germinated seed of 120-160g is evenly distributed in each portion of the frame, covered with a thin layer of vermicompost/ FYM (40g). For 3-4 days cover the nursery with paddy straw of the same variety/ gunny bags. Keep the soil moist till seedlings germinate. After one leaf stage (7 DAS), nursery can be irrigated upto 1 cm water level. Spray fertilizer NPK 19:19:19 or DAP @ 10 g/l of water between 7 and 10 days after sowing. An additional spray of the same may be given at 15 days after sowing during yasangi (*rabi*) season. Drain out water a day before removing the seedling mats for transplanting. A total of 80-100 mats are required to transplant one acre.

Performance

Appropriate shoot length (20 cm) was recorded in sheet method of nursery at 16 DAS during vanakalam and 22 DAS during yasangi by raising mat nursery on polythene sheet,

Cost of technology

The cost of raising rice nursery on polythene sheet is around Rs. 1100/- per acre compared to tray nursery (Rs. 3800/ac) using dry soil mixture.

Impact and benefit

There is a cost benefit of Rs. 2700/- per acre in the polythene sheet method compared to tray method of nursery raising. Large area can be machine planted with this mat nursery within a short span of time, particularly under the conditions of acute labour shortage, delayed monsoon, late release of canal water etc.

Raising of Rice Mat Nursery on Polythene Sheet

Machine transplanting of rice with mat nursery raised on polythene sheet

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16 Sensor based nitrogen management in maize

Salient Features

Maize hybrids are very responsive to external supply of nutrients. Generally, farmers tend to apply higher rates of N fertilizer than recommended to ensure high harvests which often results in unused N moving to ground and surface water in the form of nitrate and result in sizeable fertilizer N losses that not only reduces grower profits but can also lead to environmental contamination.

The Green seeker optical sensor works on reflection of light from the chlorophyll, use visible and near-infrared (NIR) spectral radiation from plant canopies to detect N stress and crop vigour (NDVI) values, which gives and opportunity to adjust N requirement according to crop demand.

Performance

Seven different green seeker based N treatments applied at knee high and tasseling stage were compared with RDF (NPK @ 200-60-50 kg/ha), soil test crop response (NPK @ 246-54-60 kg/ha), nutrient expert (NPK @ 141-48-90 kg/ha) and the N-rich strip (NPK @ 300-60-40 kg/ha) treatments in rainfed maize.

Among green seeker based N-application treatments, the application of 35% N (66 kg N/ha) at basal, 35% at 25 DAS (66 kg N/ha) and green seeker based N at tasseling stage (35 kg N/ha) with a total application of 167 kg N/ha has realized the high maize grain yield of 8.1 t/ha and on par with RDF (8 t/ha) in three splits (33% at basal, knee high and tasseling stages) and saved 33 kg N/ha.

Cost of technology

The cost of the instrument is Rs. 75,000/-.

Impact and benefit

Adoption of green seeker optical sensor as decision support tool for N could save 33kg N/ha, without any yield reduction. By using this tool may be about 10,000 ha N fertilizer worth Rs. 45 lakhs would be saved. Further, it can be used for identification of nutrient use efficient maize genotypes.

DIFFERENT N MANAGEMENT STRATEGIES IN MAIZE

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17 Enhancing Lucerne seed production through foliar application of plant growth regulators

Salient Features

Lucerne *(Medicago sativa L.)* popularly known as alfalfa occupies third position among forage crops in India. Seed setting in lucerne is a major problem due to higher flower drop which affects the seed yield. Two plant growth regulators *viz.,* brassinolide that can improve seed setting and mepiquat chloride that can suppress excessive vegetative growth and reduce flower drop were identified to improve lucerne seed production.

SEED PRODUCTION OF LUCERNE USING PLANT GROWTH REGULATORS

Performance

Foliar application of plant growth regulators, **brassinolide** @ 100 ppm (first spray at 50% flowering followed by second spray after 10 days) recorded high seed yield 201 kg/ha, with a net returns of Rs. 78,959/- per ha, and BC ratio of 1:2.22. Another plant growth regulator **mepiquat chloride** @ 500 ppm (first spray at 50% flowering and second at 10 days later) produced seed yield of 186 kg /ha, net returns of Rs. 68,239/- per ha and benefit cost ratio of 1:1.97 over control.

Cost of technology

Cost for spraying of brassinolide @ 100 ppm was Rs. 1900/- per ha and mepiquat chloride @ 500 ppm was Rs. 2190/- per ha .

Impact and benefit

Spraying of brassinolide @ 100 ppm and spraying of mepiquat chloride @ 500 ppm have improved the seed setting in lucerne resulting in 34.5% and 24.7% higher seed yield and 50% and 30% higher net returns than untreated control.

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17

18 Perennial grass based cropping systems for year-round supply of fodder for milch animals

Salient Features

Well planned year-round economical forage crop production is lacking among the small and marginal dairy farmers in India. Long term economical milk production along with the maintenance of better health and fertility of the dairy animals can only be achieved through feeding of quality green fodder. The association of cereal and legume forages not only maintains similar level of herbage yield but also nearly doubles the crude protein production round the year within the farm.

CROPPING SYSTEM FOR SUPPLY OF FODDER TO MILCH ANIMALS

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Performance

Among the grasses, bajra-napier hybrid (*Pennisetum glaucum x Pennisetum purpureum*) recorded significantly higher green fodder (1342 q/ha), dry matter (317 q/ha) and crude protein yield of 20 q/ha when compared with guinea grass (755, 240, and 14 q/ha in green fodder, dry matter and crude protein yields, respectively). Among the leguminous inter crops tested, Agati (*Sesbania grandiflora*) recorded higher green fodder (349 q/ha), dry matter (76 q/ha) and crude protein yield (12 q/ha) than Lucerne and Hedge Lucerne. In a system mode, the inter-cropping of hybrid bajra-napier and Agati with 2:1 ratio has recorded the highest green fodder (1577 q), dry matter (348 q) and crude protein (29 q) yield per hectare which can sustain 7-8 milch animals throughout the year.

Cost of technology

Cost of technology (Bajra-Napier hybrid and Agati in 2:1 ratio) was Rs 64,419/- per ha which was followed by Bajra-Napier sole crop (Rs. 61,394/- per ha).

Impact and benefit

Bajra-Napier hybrid + Agati (2:1) inter cropping system has proved to be the best perennial fodder system for year round production of fodder with higher net returns (Rs. 1,95,878/- per ha) and B:C ratio (1:4.03) followed by Bajra-Napier hybrid pure crop with net returns of Rs.131800/- per ha and BC ratio of 1:3.24).

19 Novel Insecticides for the management of Fall army worm in Maize

Salient Features

Fall army worm (FAW) *Spodoptera frugiperda* (JE Smith) is new invasive pest that was first reported on maize crop in India during 2018. About 40-70% of maize fields are known to be infested by FAW with damage intensity of 10 to 62% and yield losses of 34%. Chlorantraniliprole acts on calcium chloride channels after insects chew or ingest leading to paralysis or death. Spinetoram is a fermented product of *Saccharopolyspora spinosa* and acts through a novel site receptor in nerve cells to lead to a cascade of events, terminating in death of insects. The new insecticides identified aid in an effective FAW management in maize crop and prevent loss in yield.

FIELD VIEW

UNTREATED CONTROL PLOT

SPINETORAM TREATED PLOT

CHLORANTRANILIPROLE TREATED PLOT

Performance

Among the nine insecticides tested against FAW during *rabi* 2018-19 and *kharif* 2019, three sprays of chlorantraniliprole 18.5 SC @ 0.4 ml or spinetoram @ 0.5 g/l of water, starting from 15 DAS at 10 days interval reduced leaf damage by 94-98%. Spinetoram recorded the highest yield increase by 44%, while chlorantraniliprole increased yield by 39% compared to untreated control.

Cost of technology

Cost of three foliar sprays for the control of FAW in maize for Spinetoram is Rs. 3067/- per ha, for Chlorantraniliprole 18.5% SC is Rs. 2492/- per ha.

Impact and benefit

Spinetoram and Chlorantraniliprole spray against FAW resulted in net profit of Rs. 30,816 and Rs. 24,480/- per ha, respectively. Benefit cost ratio was higher for spinetoram (3.09:1) than for chlorantraniliprole (2.89:1). Using these insecticides in about 25,000 ha, an additional income of Rs. 62 to 77 crores, can be generated by farmers through sale of increased yield of maize crop.

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20 A novel combination fungicide (Metiram 55 % + Pyraclostrobin 5% WG) for the management of Alternaria leaf spot of Pigeonpea

Salient Features

Alternaria leaf spot has become one of the serious fungal diseases of pigeonpea. The disease is found to be more severe, when flowering stage of the crop coincides with congenial conditions like rains or cyclones coupled with high relative humidity, causing yield losses upto 20-80 per cent. Combination fungicide of Metiram 55 % + Pyraclostrobin 5% WG has been identified as an alternative to mancozeb which has been banned from May 2020.

Incidence of Alternaria leaf spot in control

Performance

Spraying of Metiram 55 % + Pyraclostrobin 5% WG @ 400g/acre, twice at 15 days interval during flowering period reduced alternaria leaf spot incidence by 64% over untreated control and significantly superior over Chlorthalonil (53.6%).

Best treatment Metiram 55% + Pyraclostrobin 5% WG

Cost of technology

The cost of two sprays with Metiram 55% + Pyraclostrobin 5% WG is Rs. 4134/- per ha.

Impact and benefit

Use of Metiram 55 % + Pyraclostrobin 5% WG realized 51% additional yield over untreated control. Metiram 55 % + Pyraclostrobin 5% WG accrued net returns of Rs.54, 686/- per ha and BC ratio of 1.31.

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21 Insecticides for the Management of Major Insect Pests of Soybean

Salient Features

Continuous cultivation of soybean with simultaneous increase in area has led to increased incidence of insect pests, causing 20 to 25 percent yield losses. Use of insecticides in insect pest management is very important under farmer field conditions, to manage the pests below economic injury level. In view of number of insecticides available in the market, cost effective chemicals identified against major insect pests of soybean through this study are effective against defoliators and whiteflies.

Emamectin benzoate treated plot

Control plot

Chlorantraniliprole treated plot

Control plot

Performance

Among the nine insecticides evaluated (two sprays @ 10 and 45 days after germination), emamectin benzoate 5% SG @ 0.4 g/l was found effective against defoliators (*Spodoptera litura* and *Chrysodeixis acuta*) recording 0.71 larvae/metre row length (76% reduction in larval incidence). chlorantraniliprole 18.5% SC @ 0.3 ml/l treated plot showed 1.45 larvae/metre row length (50% reduction in larval incidence) over untreated control (2.9 larvae /metre row length). Against whiteflies, thiamethoxam + lambda cyhalothrin @ 0.5 ml/l performed better recording least whiteflies/plant (0.41) with reduction of 83% whitefly incidence triazophos 40% EC applied @2 ml/l (0.94 whiteflies/plant) reduced whiteflies by 62% against untreated control (2.45 whiteflies/plant).

Cost of technology

Cost of two foliar sprays with emamectin benzoate, chlorantraniliprole and thiamethoxam + lambda cyhalothrin, is Rs. 1526, Rs. 3600 and Rs. 726/- per ha, respectively.

Impact and benefit

Against defoliators, emamectin benzoate 5% SG @ 0.4 g/l and chlorantraniliprole 18.5 % SC @ 0.3 ml/l were highly effective with 56-59 % higher yield and benefit cost ratio of 2.32 and 2.21, respectively. Thiamethoxam + lambda cyhalothrin @ 0.5 ml/l was effective against whiteflies with an yield increase of 45.32% and BC ratio of 1.75. Depending on observed insects, suitable selection of insecticide may help to reduce overall cost.

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22 Management of Soil borne Diseases in Safflower through Seed Biopriming

Salient Features

Biopriming employs a biological inoculation of seed with benign micro-organisms to guard seeds and regulate seed hydration for management of biotic or abiotic stress and improve seed germination. It is a novel technique for managing major seed and soil borne diseases effectively than seed treatment practice in vogue.

Seed Biopriming with *Trichoderma harzianum*

Untreated Control

Performance

Biopriming of safflower seed was made by soaking 1 kg seed in *Trichoderma harzianum* (Th4d WP- IIOR) solution (10g/l water) for 12 hours. *Bioprimed* seed grown safflower plants exhibited reduction of Fusarium wilt (68.37%) and *Macrophomina* root rot (81.30%) incidence over untreated control.

Cost of technology

The cost for seed biopriming with *Trichoderma harzianum* (Th4d WP–IIOR) is Rs. 30/- per ha at seed rate of 10 kg/ha.

Impact and benefit

Biopriming of safflower seed with *Trichoderma harzianum* (Th4d WP- IIOR) solution (10g/l/kg) for 12 hours reduced the incidence of soil borne diseases (*Fusarium* wilt and *Macrophomina* root rot) and recorded highest seed yield (878 kg/ha) with B:C ratio of 1.79.

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23 Development and Evaluation of Mini Tractor Operated Trencher

Salient Features

At present, self propelled and tractor operated trenchers are commercially available in the market to make trenches of varying width and depth depending upon the requirement of the end users. Due to high initial cost they are in limited use only and entrepreneurs are sharing them on custom hiring basis. Hence, a need was felt to develop a mini tractor operated trencher for making small trenches which can be used by farmers for laying pipes for irrigation and for other similar works. The trenching mechanism consists of a frame, digging chain with blades, drive shaft and driven shaft, chain and sprockets, and soil delivery auger. To transfer the power from mini tractor power take of shaft to digging boom assembly a gear box was arranged from the gearbox to the digging boom assembly. On the other end of the mini tractor power take of shaft gear box flange, soil delivery auger was fixed to throw the soil into to sideways. The digging boom assembly consists of digging chain with blades, crumber arm and sprockets.

Performance

This newly developed trencher was evaluated in the field at 15% moisture level in vertisols at a forward speed of 0.08 m/sec with digging blade speed of 105 rpm. During the field trials, it was observed that the length of trench covered per hour was 28 m, with a width and depth of 165 mm and 445 mm, respectively. The fuel consumption observed was 2.5 l/h and the capacity of the auger was 27.24 m^3/h.

Field operation of prototype mini tractor operated trencher

Cost of technology

The cost of the technology is Rs. 50,000/-

Impact and benefit

The developed trencher will excavate approximately 16 cubic meters of soil per day while manually, one labour can excavate only 2 to 2.5 cubic meters of soil. The cost of operation of trencher was Rs. 445/- per hour (for excavating 2 cubic meters of soil) compared to Rs.1000/- per hour by manual labour with a net saving of Rs. 555/- per hour with the developed trencher over traditional method. Additionally with developed trencher there is a 73% reduction in labour and time over conventional trenching method.

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ANNEXURE

List of Technologies Developed from Southern Telangana Zone		
S.No	Technologies	Research Station and Scientist Contributed
1.	Herbicide Application to Control nutsedge in *Kharif* Maize	**AICRP on Weed Management,** Rajendranagar Dr. M. Madhavi and T. Ram Prakash
2.	Efficacy of Diuron with Sequential Application of Herbicides for Cotton Weed Control	**AICRP on Weed Management,** Rajendranagar Dr. M. Madhavi and Dr.T. Ram Prakash
3.	Yield Response of Rabi Maize to Bio-Fertigation with Microbial Consortium	**Water Technology Centre,** Rajendranagar Dr. K. Avil Kumar, Dr. S.Triveni, Mr. A. Sai Kiran, Dr. M. Uma Devi and Dr. V. Ramulu
4.	Response of Sesame to Drip Irrigation Regimes and Fertigation During Summer Season	**Water Technology Centre,** Rajendranagar Dr. K. Avil Kumar, Dr. T L Neelima, Dr. M. Uma Devi, and Sr. Dr. V. Ramulu
5.	Monitoring and Forewarning System for Castor Gray Mold	**Agro Climatic Research Centre,** (ACRC) Rajendranagar Dr.B.Balaji Naik, Dr. G.Sreenivas, and Dr.R.Durga Prasad
6.	Improving the Shelf-Life of Oyster Mushrooms and Enriching with Vitamin C Using Lemon Extract	**Mushroom Cultivation Scheme,** Dept. of plant Pathology, College of Agriculture, Rajendranagar Dr. M. Prameela, and Dr .G. Uma Devi

ANNEXURE

List of Technologies Developed from Southern Telangana Zone		
S.No	Technologies	Research Station and Scientist Contributed
7.	A Novel Combination Fungicide (Metiram 55 % + Pyraclostrobin 5% WG) for the Management of Alternaria Leaf Spot of Pigeonpea	**ARS, Tandur** Sri. T.Rajeshwar Reddy, Dr. C. Sudhakar, Dr. S. Sandeep, and Dr. C. Sudha Rani
8.	Management of Soil Borne Diseases in Safflower through Seed Biopriming	**ARS, Tandur** T.Rajeshwar Reddy, Dr. C. Sudhakar, Smt. C. Manikya Minnie and Dr. C. Sudha Rani
9.	Effect of Plant Growth Regulator "Cholorocholine Chloride(CCC)" on Growth, Yield and Economics of *Rabi* Sorghum under rainfed conditions	**ARS, Tandur** Smt. K. Sandhya Rani Dr. C. Sudhakar and Dr. C. Sudha Rani
10.	Development and Evaluation of Mini Tractor Operated Trencher	**AICRP on FIM, Rajendranagar** Er. P. Sudhakar Reddy, Dr. P. Rajaiah, Er. Ch. Sravan Kumar Er. B. Laxman and Dr. B. Vennela
11.	A Farmer Friendly Technology of Raising Rice Mat Nursery for Machine Transplanting	**RRC, Rajendranagar** Dr. P. Spandana Bhatt, Dr. M. Venkata Ramana, Dr. U. Nagabhushanam, Mrs. Firdoz Sahana, Dr. P. Revathi, D. Anil and J.K. Revanth Nathan
12.	Sensor Based Nitrogen Management in Maize	**MRC, Rajendranagar** Dr. D. Sreelatha, Dr.G.Anuradha, Dr.M.Lava Kumar Reddy, Dr.B.Mallaiah, Dr.A.Madhavi and Dr.T.Srijaya

ANNEXURE

List of Technologies Developed from Southern Telangana Zone		
S.No	Technologies	Research Station and Scientist Contributed
13.	Enhancing Lucerne Seed Production Through Foliar Application of Plant Growth Regulators	**AICRP on Forage Crops, Rajendranagar** B.Murali, T.Shashikala and K.Shailaja
14.	Perennial grass based cropping systems for year-round supply of fodder for milch animals	**AICRP on Forage Crops Rajendranagar** B.Murali, R.Susheela, M. Shanthi T.Shashikala and K.Shailaja
List of Technologies Developed from Central Telangana Zone		
1.	Performance of High-Yielding Mid-Early and Medium Duration Pigeon Pea Varieties Under Rainfed Conditions	**ARS, Tornala** Mrs. D. Sravanthi, Dr. R. Susheela Dr. A.V. Ramanjaneyulu Dr. Y. Shivalakshmi, Ms. D. Swetha and Dr. M. Vijaya Sai Reddy
2.	Re-Scheduling of N-Fertilizer Application Rate in Dry Seeded Paddy	**ARS, Madhira** Dr. S. Srinivasa Rao Dr. J. Hemanth Kumar and Dr. R. Srinivasa Rao
3.	Performance of Minor Millets under Different Sowing Methods in Rice Fallows	**ARS, Madhira** Dr. S. Srinivasa Rao Dr. V. Sridhar and Dr. M. Vijaya sai Reddy
4.	Nutrient Management to Increase Productivity of Yellow Jowar in Rice Fallows	**ARS, Madhira** Dr. S. Srinivasa Rao Dr. G. Venugopal Dr. V. Sridhar Dr. M. Vijaya sai Reddy and Sri. A. Sriram

ANNEXURE

List of Technologies Developed from Northern Telangana Zone		
S.No	Technologies	Research Station and Scientist Contributed
1.	Novel Insecticides for the Management of Fall Army Worm in Maize	**RARS, Jagtial** S. Omprakash, and Dr. S. Srinivasa Reddy
2.	Optimization of Seed Rate under Improved Sowing Method In Soybean	**ARS, Adilabad** Dr. Sreedhar Chauhan, and Dr. M. Rajendar Reddy
3.	Evaluation of Pre Released Rice Cultures under Different N Levels in Northern Telangana Zone	**RARS, Jagtial** Dr. P. Revathi, Dr. B. Srinivas and Dr. B. Raju
4.	Yield Potential of KNM Rice Genotypes Under Different Sowing Windows	**ARS, Kunaram** D. Anil, and Dr. Sreedhar Siddi
5.	Insecticides for the Management of Major Insect Pests of Soybean	**RS & RRS, Rudrur** Dr. M. Venkataiah, Y. Swathi, Dr. RVT Balazzii Naaiik, Dr. T. Prabhakar Reddy and P. Jalender Naik

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