Utilization of Rice Fallows for Enhancing Pulse Production in North Coastal Andhra Pradesh

Biotech KISAN Project

Acharya N G Ranga Agricultural University
Lam, Guntur, Andhra Pradesh
and
Department of Biotechnology
Ministry of Science and Technology
Government of India

सत्यमेव जयते

ANGRAU

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Message

The **Government of Andhra Pradesh** under the ***dynamic*** leadership of **Hon' ble Chief Minister Sri. Y. S. JAGAN MOHAN REDDY**, implemented many **Farmers Centric Programmes viz., YSR Rythu Bharosa, YSR zero interest credit. YSR free crop insurance, YSR polam badi, YSR jalakala, YSR Asara etc** which lead to the **Economic Sustainability** of the F**armers**. **'Agricultural Mission'** formed by under the **Leadership** of the **Hon'ble Chief Minister** is working for **Farmers Welfare round the clock**. **Dr YSR Rythu Bharosa Kendralu** established in the **Grama panchayats** are **unique & first** of their kind **Facilitation Centers** in the **Country** to **cater** to the **Needs** of the **Farmers** at the **Village level** like **Inputs, Marketing and Insurance** etc. The **government** is also *providing* **Free current** for **Nine hours** and **implementing** many more **Schemes** for **Farmers** to make **Agriculture** profitable.

Considerable extent of Rice Fallow Agriculture Land remains **Barren** during ***rabi*** **season** especially in **North Coastal Andhra Pradesh** consisting of **Srikakulam, Vizianagaram** and **Visakhapatnam districts**. **Pulses** are being **cultivated** during ***rabi*** in an **Area of 1,40,471 ha** which **constitute** only **30 per cent** of the A**rea** suitable for growing P**ulses** as R**elay crop**. In order to **improve** the N**atural Resource Management** and to **achieve** the **Goal** of **Doubling Farmers Income**, **Relay Cropping** with *short duration* **High Yielding Pulses** like **Green Gram, Black Gram** are found to be **suitable alternative**. The **Acharya N G Ranga Agricultural University** and the **Government of Andhra Pradesh** have **designed** a **programme** for U**tilization** of R**ice Fallow Area** for **growing Pulses** to bring A**dditional Income** and to improve N**utritional Standards** through **Funding** from the **Department of Biotechnology, Ministry of Science and Technology, Government of India** through **Biotech KISAN Programme**.

I am **pleased** to **know** that the **entrusted Responsibility** of **Promoting Cultivation** of **new Pulse Varieties** suitable for R**ice Fallows** in **North Coastal districts** of **Andhra Pradesh** under **Biotech-KISAN Hub project** has been *successfully* **implemented** and **I thank** the **Team** of **the scientists** for the C**ontributions** made for the **Success** of the **Project**

KURASALA KANNABABU

सत्यमेव जयते
डॉ. रेणु स्वरूप
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Message

The Department of Biotechnology lays major emphasis on generation of biotech products, processes and technologies for enhanced efficiency, productivity and cost-effectiveness in the area of agriculture, food and nutritional security, affordable health care and wellness, environmental safety, clean energy, bio-fuel, bio-manufacturing etc.

India is world's largest consumer and importer of pulses. The country is moving towards self-sufficiency in pulse production and ensuring nutritional security of common mass to achieve the projected demand a growth rate of 4.2% has to be ensured. Rice fallow pulses, a potential solution and has greater scope to be adopted in North Coastal Andhra Pradesh, is now practiced in limited area due to several constraints like improper time of sowing, management of weeds, disease management especially Yellow Mosaic Virus (YMV), terminal moisture stress etc. The University has developed many YMV tolerant/resistant varieties with technology options for greater adoption and improving productivity. The Department of Biotechnology, Ministry of Science and Technology, Government of India recognizing its importance in the nutritional economy and nutritional security, has supported the activity for popularizing the rice fallow pulses in North Coastal Andhra Pradesh under Biotech KISAN Hub at Acharya N G Ranga Agricultural University, Andhra Pradesh.

I am happy to know that the university has made lot of efforts in introduction of latest production technologies in rice fallows for growing pulses on a commercial scale with increased productivity ranging from 20% to 162% and with a net benefit of ₹ 0.49 to ₹ 2.19 per rupee invested compared to state average productivity and net incomes. Further, a large number of YMV resistant/ tolerant varieties (GBG1, LBG104 in black gram and LGG460 in green gram) are introduced, multiplied and supplied to the farmers. *Mini dal* mills has provided entrepreneurial opportunities especially women farmers with an additional advantage of increasing their income levels. Further it is also proved that rice-pulse cropping system is more remunerative than rice-rice cropping system with saving in water requirement, lowering the emission of green house gases and supply nitrogen to the succeeding crops with a recorded additional benefit of ₹ 2416/ha to ₹8231/ha in black gram and ₹14184/ha in green gram.

My best wishes to the Vice-Chancellor and his team involved in the project for their efforts to bring in new innovations in the rice fallow pulse cultivation among the farmers of North Coastal Andhra Pradesh and I hope that the efforts will be continued to make the farmers of North Coastal Zone economically sustainable with introduction of improved production technologies.

(Renu Swarup)

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Vice-Chancellor

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Foreword

India is now striving to achieve nutritional security and crop diversification with cropping pattern by introducing crops like pulses is the way. To replenish the Protein Energy Malnourished people and to maintain soil health appropriately, pulse/s must be included in the cropping system. In India, pulses are largely cultivated beneath power starved conditions, wholly on marginal and sub-marginal lands under rainfed situation with poor management practices either as sole crop or intercrop. Rice fallow pulses is another unique ecosystem where rice is grown during *kharif* season (June-October/ November) which is normally followed by a fallow during the *rabi* season (November-February).

In Andhra Pradesh the rice fallow pulses is being popular in Krishna, Guntur and Srikakulam districts. The *kharif* paddy area in these districts comprises of 11.07 lakh ha and of which 31.3% i.e., 3.47 lakh ha is being occupied by pulses (black gram and green gram) during *rabi* which signifies vast scope to expand. However, the area under rice fallow pulses is declining every year due to a variety of biotic, abiotic and socio-economic constraints prevailing in these areas. The improved high yielding pest and disease resistant varieties and production technologies developed by the Acharya N G Ranga Agricultural University has paved the way to rejuvenate the scope for sustainable cultivation of pulses in rice fallows as relay crop. Ample scope is available to expand the area of rice fallow pulses in North Coastal Districts of Andhra Pradesh, since only 28% area is being utilized. Rajmash, another pulse crop being grown by tribal farmers of Visakhapatnam district suffers with very low productivity due to lack of awareness of improved varieties and production technologies.

The Biotech KISAN project has aimed at exploring the possibility of increasing the area under rice fallow pulses in North Coastal Andhra Pradesh through introduction of improved management technologies for harvesting higher yields with low input cost. The Project Team along with the Scientists of *Krishi Vigyan Kendra*, Amadalavalasa and District Agricultural Advisory and Transfer of Technology Centre, Kondempudi have successfully implemented the project with significant impact. I would like to place on record the sincere and dedicated efforts of the project team for their tireless efforts in improving the rice fallow pulse production by the farmers and in creating awareness on post harvest management practices including value addition technologies through *mini dal* mills.

I would also sincerely thank the Department of Biotechnology, Ministry of Science and Technology, Government of India for sanctioning the project to the University.

23/06/2021.

A. Vishnu Vardhan Reddy

Executive Summary

Pulse production has remained neglected for many decades in India due to passionate promotion of wheat and rice. The research and technological interventions in pulses limited has remained as compared with wheat and rice. India is the largest producer (28.3% of global production), consumer (27% of world consumption) and importer (14% of world imports) of pulses in the world. The pulse crops grown in India on around 29.03 M ha area with production 25.6 MT during the year 2020-2021(3rd advance estimate of GoI). Andhra Pradesh (13 districts) is one of the major pulse producing states in India with an area of 12.5 lakh ha in 2020-21 which is accounted to 23.62% in total food crops area. The major pulses grown in the state are red gram, bengal gram, black gram and green gram. Red gram and bengal gram are grown in *kharif* and *rabi* seasons respectively while black gram (*Vigna mungo* L (Hepper)) and green gram (*Vigna radiata* L) are grown during both *kharif* and *rabi* seasons and as relay crop in rice fallows.

North Coastal Andhra Pradesh consisting of Srikakulam, Vizianagaram and Visakhapatnam districts growing pulses during *rabi* mainly green gram and black gram. In these three districts pulses were grown in an area of 1,40,471 ha area of which 50,648 ha green gram and 70,166 ha black gram. These crops were grown after *kharif* rice as relay crop in rice fallows. Farmers usually grow rice during the month of July or August and harvest in the month of November or December, Green gram / Black gram seed are to be broadcasted in standing rice crop 4-5 days before the harvest of paddy crop as relay crop with no tillage.

The three districts in North Coastal Zone will raise paddy in an area of 4,31,326 ha during *kharif* and hence there is a lot of scope to raise pulses during *rabi*. The farmers are not using the opportunity and potential of the pulse crop due to various constraints like,

- Delayed transplanting of *kharif* rice leading to late sowing of pulses in rice fallow during 2nd fortnight of November / December
- Lack of climate resilient technological interventions especially varieties
- Lack of knowledge on package of practices of pulses for rice fallow
- Non adoption of recommended Integrated Crop Management practices

Hence, emphasis was made to strengthen the efforts of growing green gram / black gram as relay crop in rice fallows collectively by the Department of Biotechnology, Ministry of Science and Technology, Government of India and Acharya N G Ranga Agricultural University, Lam, Guntur through Biotech KISAN Project from 2018-19. Baseline survey was conducted to identify the knowledge level of the farmers in these districts and identified the constraints. The strategies were planned for the identified constraints and implemented in the identified mandals and villages with lowest productivity. The project was executed through demonstrations, capacity building, post harvest management and establishment of value addition units. Strategies included were usage of high yielding yellow mosaic tolerant varieties like GBG1, TBG104 etc, seed treatment with insecticide, fungicide and Rhizobium, weed management with herbicides, pest and disease management and application of bio fertilisers for increased availability of P and K. The farmers have realised comparably good yields. Under this project ***fellowship farmers to demonstration farmer extension model*** was followed. The technology was demonstrated and intensive trainings were provided to fellow and demo farmers.

Increased yields were observed in both the Visakhapatnam and Srikakulam districts with adoption of improved technologies in rice fallow pulse cultivation. Further the farmers were also educated on preceding *kharif* rice cultivation also wherein advanced and low cost rice cultivation technologies viz., direct dry seeding and direct sowing with drum seeder with short to medium duration rice cultivars which resulted in timely sowing of pulse crop in rice fallows. The technology demonstrations resulted in 13% increased yields in Visakhapatanam and 4% in Srikakulam districts in rice crop. The rice fallow green gram in Visakhapatanam recorded 42.5 per cent increased yield and black gram with 40.5% increased yields i.e., significant increase over farmers practice and also mandal average yields with an additional benefit of Rs. 2.19 and Rs.1.35 per rupee invested respectively. In rajmash (*Phaseolus vularis* L) the technology demonstrations recorded 64.2% increase in yield over farmers practice. In Srikakulam district the technology demonstrations of rice fallow black gram has gave high net benefit if sown before November 15th with a per cent increase of 25% over farmers practice. The additional benefit recorded was from Rs.0.46 to Rs. 1.37 per rupee invested.

The pulses with their inherent capacity to fix atmospheric nitrogen have obviously saved the fertilizer requirement in addition to contributing nitrogen to the succeeding crops. In view of the climate resilience rice –pulse cropping system, has provided additional benefit to the cultivators in short period @ Rs. 2,416/ha to Rs.8,231/ha in black gram and Rs. 14,184/ha in green gram, with less attention and lowers GHG emissions due to lower demand for addition of synthetic fertilizers, the major driver for climate change. Further in both distrists the rice-pulse cropping system i.e. rice-black gram and rice-green gram is highly beneficial with a BC ratio of 2.40 in Srikakulam and 2.24 in Visakhapatnam with rice-black gram and 2.52 with rice-green gram as against rice-rice cropping system (1.78 & 1.58 respetively in both the districts). Moreover, the inclusion of pulses in cropping system will improve soil structure and reduces the risk of development of salinity due to monoculture of rice-rice system. In view of the above, rice-pulses cropping system is highly suitable, remunerative, climate resilient technology to be popularized in order to make farmers economically sustainable, to meet the nutrient demands of the increasing population and to reduce the damage to the soil and environmental health.

The technology was also demonstrated to the extension personnel of Department of Agriculture and all the fellow farmers and demo farmers were organised as Farmer Interest Groups and advised to follow and spread the technology to the neighboring farmers in those villages as well in the neighboring villages. It is now expected that the Department of Agriculture, Government of AP will follow systematic dissemination of this technology in other parts of the North Coastal Districts especially Srikakulam, Viziayanagaram and Visakhapatnam districts, which have sizable area to expand the relay crop of pulses in rice fallow.

CONTENTS

Acronyms & Abbreviations

ac	acres
AKPS	Annapurna Krishi Prasara Seva
ANGRAU	Acharya N G Ranga Agricultural University
Biotech	Biotechnology
DAATTC	District Agricultural Advisory and Transfer of Technology Centre
DBT	Department of Biotechnology
dist	District
GHG	Green House Gases
ha	hectares
IPM	Integrated Pest Management
IWM	Integrated Weed Management
KISAN	Krishi Innovation Scientific Application Network
KVK	Krishi Vigyan Kendra
M	Million
RARS	Regional Agricultural Research Station
T	tonnes
ToT	Transfer of Technology
v	Village
VC	Vice Chancellor
YMV	Yellow Mosaic Virus

1 Introduction

Food and Agriculture Organization (FAO), the UN designated February 10th of every year to be celebrated as International Day of Pulses and accordingly February 10th 2021, is declared as "*World Pulses Day 2021*" *with a theme of* *"Nutritious Seeds for a Sustainable Future."* On this occasion, the Union Minister for Agriculture and Farmers Welfare, Rural Development, Panchayat Raj and Food Processing Industries, Shri Narendra Singh Tomar said that India is moving towards the goal of self-sufficiency in pulses production. The country has increased its pulses production from 14.76 MT in 2007-08 to 25.43 MT in 2017-18 and he emphasized that according to an estimate, by the year 2050, about 32 MT of pulses will be required and we have to pay attention to reach the target.

Pulses occupy a unique place in India and are considered as "the poor man's meat" because of their protein profile. They are having special significance in India due to highest number of malnourished people, coupled with the country's high preference of vegetarianism. Pulses are consumed equally by India's rich and poor as it is one of the less expensive sources of protein (Mohanty and Satyasai, 2015). Around 89% of consumers eat pulses at least once a week, while the corresponding number for eating fish or chicken/meat once a week is only 35.4% (IIPS and ORC Macro, 2007). Pulses complement the staple cereals in the diets with good source of proteins and vitamins. They are gluten free, contain high quality protein responsible for growth and development and also contain high dietary fibre which is known to reduce LDL cholesterol, thus reducing the risk of coronary heart diseases. High iron content, bioactive compounds such as phytochemicals and antioxidants in pulses make them potent food for preventing iron deficiency, anemia in woman and children and anti cancerous. With high fibre content, low fat and low glycemic index pulses are suitable for diabetic patient (FAO, 2016).

India has the largest demand and market for the pulses and reported that the pulse crops were grown on 29.4 M ha area producing 25.43 MT with an average productivity of 864 kg/ha. during the year 2017-18 Among states, Madhya Pradesh, Maharashtra, Uttar Pradesh, Andhra Pradesh, Karnataka and Rajasthan are the major pulse growing states in India (75% area and production) and Madhya Pradesh has contributed 22.81% in area and 31.07% in total production followed by Rajasthan (15.33 and 11.86%), Maharashtra (13.29 and 8.56%), Karnataka (11.01 and 8.43%) and Andhra Pradesh (5.74 and 7.46%) respectively (Ministry of Agriculture and Cooperation, 2015-16). The recommended dietary allowances (RDA) for protein of an adult male and female are 1g/kg body weight/day. As a result of stagnant pulse production and continuous increase in population, the per capita availability of pulses has decreased considerably. The per capita per day availability of pulses in 1951 was 60.7 g that dwindled down to level of 35.4 g in the year 2010. However, since 2011 increasing trend of per capita per day availability is recorded. In the year 2015, provisional per capita/year availability is 16.0 kg, which is 43.8 g per capita per day (Anonymous, 2016).

Pulses can be grown in all range of soil and climatic conditions and play an important role in crop rotation, mixed and intercropping, maintaining soil fertility through nitrogen fixation, release of soil bound phosphorus, and thus contribute significantly for the sustainability of the farming systems. Its specific role in the cropping system consists of high carbon sequestration capacity, low carbon footprint, fixing atmospheric nitrogen in soils, low water footprint, hydrogen fertilization of soils and improving soil biodiversity (Adarsh *et al*., 2019). With these many advantages, even though lot of scope is identified for increase in area of pulses and production, pulse productivity is poor due to various reasons and the major being the pulses are grown in poor soils with neglected management. Several bottlenecks were identified for decline in pulse production and mainly being improper sowing time, use of low seed rate, poor management of crop and insufficient irrigation. Considering the importance of pulses in human diet and projected demand for pulses in the country, there is every need to keep efforts for targeting the new areas viz., rice fallows, and measures to increase productivity through sustainable cultivation practices. Keeping in mind the constraints, ANGRAU has responded to the call to improve the production as well as productivity of pulses with innovative and modern technologies through KISAN Hub project funded by DBT, Ministry of Science and Technology, Government of India.

2 Current Status of Rice-fallows

Rice is the predominant crop during *kharif* season in most parts of country and about 44 M ha of land is under the cultivation. Continuous cultivation of rice-rice cropping causes disturbance in the ecology of the system. Incorporation of pulses after rice improves the soil quality in terms of nutrient dynamics, soil organic carbon and biological activities. Pulses are the ideal crops that can be grown in the areas vacated after rice, because of their property to establish with the surface seeding and suitability for relay/para cropping and resistance against soil moisture and temperature stress. In India the area under rice fallow pulse is around 12.0 M ha of which 20% area has been occupied by southern states of Andhra Pradesh, Tamil Nadu and Karnataka (Subbarao *et al.,* 2001) and on an average 11.7 M ha of this area remains fallow during *rabi* season.

In AP the major pulses grown are pigeonpea, chickpea, black gram and green gram. Pigeonpea and chickpea are grown in *kharif* and *rabi* seasons respectively while black gram and green gram are grown during both *kharif* and *rabi* seasons and as relay crop in rice fallows. The rice fallow pulses is being popular in Krishna, Guntur, East and West Godavari and Srikakulam districts of AP (Chowdhury *et al,* 2020). The *kharif* paddy area in these districts comprises of 11.07 lakh ha and of which 31.3% i.e., 3.47 lakh ha is being occupied by pulses (black gram and green gram) during *rabi.* However, the area under rice fallow pulses is declining every year due to a variety of biotic, abiotic and socio-economic constraints prevailing in these areas. Management of these biotic and abiotic factors resulted in increased cost of cultivation and reduction in yields. Moreover dwindling market prices also make the pulse growing farmer to shift the crops like jowar and maize. The traditional rice fallow pulse areas in Krishna, Guntur and districts has been shifted to relay crop of jowar or maize. However, the improved high yielding disease resistant varieties, improved production technologies developed by the ANGRAU has paved the way to rejuvenate the scope for sustainable cultivation of pulses in rice fallows as relay crop.

The rice area under *kharif* in the North Coastal Districts comprises 4.31 lakh ha of which only 28% area is being utilized for growing rice fallow pulses. Hence there is ample scope to expand the area of rice fallow pulses in North Coastal Districts viz., Srikakulam, Viziayanagaram and Visakhapatnam districts. Moreover, Rajmash is another pulse crop being grown by tribal farmers of Visakhapatnam district with very low productivity due to lack of awareness of improved varieties and production technology. Pulses are mostly cultivated under as rainfed conditions either as sole or intercrop. Rice fallow pulses is another unique ecosystem where in rice is grown during *kharif* season (June-October/November) which is normally followed by a fallow during the *rabi* season (November/February) and is being utilized for growing pulses either black gram or green gram. The ANGRAU has conducted research for several years on rice fallow pulses and developed many varieties with disease tolerance and advanced technologies for improving productivity. Utilizing the opportunity, the University along with DBT, Ministry of Science and Technology, Government of India has made efforts to strengthen the pulse production especially in North Coastal Districts of AP viz., Srikakulam and Visakhapatnam through Biotech KISAN Project from 2018-2020, since there is an ample scope for improving pulse production in these districts in rice fallows and to make farmers economically sustainable.

3 Constraints limiting Pulse production in Rice fallow

The rice fallow pulse system has an immense potential towards increasing the total pulse production, achieving nutritional security and also for economic sustainability. The relay crop of pulse in rice fallows has an additional advantage of getting higher yields with low investment. Further water saving will be an additional advantage for growing pulses instead of rice followed by rice. Even though the relay crop of pulse especially black gram and green gram in rice fallows has become very popular a decade back, but the area under this cropping system is reduced year after year and is being replaced by maize and jowar due to several problems of which yellow mosaic virus is the major constraint, besides changing climatic situation and un assured market price for the pulse produce. The university developed YMV tolerant/ resistant varieties with high yield potential and advanced management techniques has shown the way forward to increasing the area of pulses in rice fallows. Further the rajmash crop grown by the tribal farmers in Visakhapatnam district is suffered with low productivity due to lack of awareness on improved varieties and production technologies which needs attention. Under these circumstances, baseline survey was conducted through the KISAN hub project to know the production, social, economic and technological constraints among the farmers for making cultivation of rice fallow pulse crop sustainable and economical for the farmers of the North Coastal Zone.

District	Farming situation	Cropping system *Kharif*	 *Rabi*
Srikakulam	Irrigated – clay loamy soils	Paddy	Black gram /green gram
	Rainfed – sandy clay loams	Paddy	Green gram
Visakhapatnam	Rainfed – clay loams	Paddy	Black gram /green gram
	Rainfed – Red sandy gravelly soils	Maize	Rajmash beans

The study conducted through the project in these farming situations of North Coastal districts viz., Srikakulam and Visakhapatanm has revealed the following production constraints,

Kharif – Rice

- Delayed sowings of paddy i.e., in the month of July or August due lack of assured irrigation facilities and rainfall dependent reservoirs
- Growing long duration varieties of rice i.e., more than 145 days duration viz., RGL-2537(Srikakulam sannalu), MTU1061 (Indra)
- Imbalanced and excess chemical fertilizer application, high N and low K and top dressing with complex fertilizers
- Non usage of biofertilisers
- Improper pest and disease management
- No management on correction of micro nutrient deficiencies

Rabi – Pulses (Black gram/ Green gram) as relay crop

- Insufficient seed rate and improper sowing (Broadcasting)
- Untimely late sowings of pulses especially black gram due to delayed harvest of paddy because of long duration of paddy varieties or late release of canal water,
- Excessive moisture during seeding stage and moisture stress at flowering stage
- Weed infestation
- Pest and disease problems like Maruca, YMV leaf curl powdery mildew
- Terminal moisture stress,
- Lack of knowledge on post harvest management

Early *rabi* – Rajmash

- Non adoption of improved varieties
- Non adoption of application of recommended fertilisers and bio fertilisers.
- Neglected management of the crop
- Improper plant protection

The base line survey results indicate that 95.0% of the farmers in Srikakulam and 88.35% of the farmers in Visakhapatnam are small farmers holding less than 5 acres. The knowledge level of the farmers in sustainable agricultural practices indicate that, Srikakulam farmers are having comparatively more knowledge about improved varieties, proper sowing time but their knowledge level on seed treatment, sowing methodology, recommended fertilisers, IWM and IPM practices is poor. The knowledge level of farmers of Visakhapatnam is relatively poor compared to Srikakulam. The adoption of sustainable cultivation practices indicate that only 4% of the farmers from Srikakulam and 3% of the farmers from Visakahpatnam are having good adoption. This clearly shows that the gap is wider in their knowledge and adoption of sustainable cultivation practices which has to be attended through affective extension programmes. The other social, economic and technological constraints identified were as follows;

Social

- Small and marginal farmers
- Lack of awareness on suitable varieties for rice fallow pulses
- Insufficient knowledge on suitable machinery for mechanical sowing not applicable

Economic

- Lack of financial assistance for rice fallow pulses from organized institutional sources
- High cost of labour towards sowing, weeding and harvesting.
- Lack of credit support.

Technological

- Unfavorable climatic conditions *viz.* fog and low temperature coincidence with flowering
- Unavailability of varieties with synchronized maturity and YMV resistance/ tolerance
- Lack of multiple resistant varieties in black gram both for YMV and powdery mildew.

4 Implementation Strategy

Based on the constraints identified through baseline survey, strategies were planned and implemented through Biotech KISAN project in two districts viz., Visakhapatnam and Srikakulam for rice-pulse cropping system and also for rajmash. The details of the demonstrations were as follows;

Crop	District		Total
	Srikakulam	Visakhapatnam	
No of mandals covered	*12 (4 Agency mandals)*	*9*	*21*
Rajmash (Rabi Crop)	-	10	10
Green gram (Relay crop)	-	24	24
Black gram (Relay crop)	49	19	65
Total	49	53	99

Strategies were planned in all the three crops viz., black gram, green gram and rajmah and the farmers were provided with required inputs as per the production strategies. The details were as follows;

Rice

- Timely sowing of the crop and also popularizing drum seeder sowing where ever feasible.
- Creating awareness on medium and short duration varieties viz., MTU1121, MTU1010, MTU1210, MTU1075, MTU1156 etc.
- Soil testing and soil test based fertilizer application
- Discouraging use of complex fertilizer as top dressing.
- Use of nitrogen, phosphatic and potash biofertilisers.

- Formation of alleyways in the crop
- Integrated pest and disease management.

Black gram

- Introduced new high yielding suitable varieties viz., PU31, TBG104, GBG 1 (tolerant to yellow mosaic).
- Proper time of sowing i.e., before November 15^{th}
- Usage of correct recommended seed rate
- Seed treatment with Imidachloprid 5ml + mancozeb 75WP @ 3g per kg seed
- Application of biofertilizers Rhizobium and PSB. No need of fertiliser application
- Weed Management- Sodium aceflorfen 16.5 + clodinafoppropargyl 8% (Iris) - 400 ml per acre
- Foliar application of 19:19:19 1.0 kg/acre 30-35DAS and 13:0:45 @1.0 kg/acre at 55-60DAS Integrated pest and disease management (Yellow and Blue sticky traps, Spraying of 0.5% neem oil and need based spraying of chemicals for the management of *Maruca* pod borer and powdery mildew.

Green gram

- Introduced new high yielding suitable varieties viz., LGG460, IPM2-14 (Yellow mosaic tolerant/ resistant varieties).
- Proper time of sowing i.e., before November 15^{th}
- Seed treatment with imidchloprid 5ml + mancozeb 75WP @ 3g per kg seed
- Application of biofertilizers viz., Rhizobium and PSB.
- Weed Management- imazethapyr 10SL per acre
- Foliar application of 19:19:19 @ 1.0 kg/acre at 30DAS and 13:0:45 @1.0 kg /acre at 45DAS Integrated pest and disease management (Yellow and Blue sticky traps, Spraying of neem kernel suspension 5% and need based spraying of chemicals for the management of *Maruca* pod borer

Rajmash

- Improved variety seed CTPL Red variety
- Seed treatment with mancozeb 75WP @3g per kg seed
- Application of biofertilizers viz., Rhizobium and PSB
- Soil test based fertiliser application
- Need based plant protection measures

Accordingly the following inputs were supplied to the farmers. The scientists and the project personnel has taken utmost care to ensure the quality of inputs and the foundation seed pertaining to the improved varieties and were obtained from Research Stations of ANGRAU and distributed to the farmers. The critical inputs distributed were as follows;

- Foundation seed of LGG460, IPM2-14 of green gram, PU31, TBG104, GBG 1 of black gram and Chinthapally red of Rajmash.
- Seed treatment chemicals Imidachloprid, Mancozeb 75WP and Rhizobium.
- Phosphorus and potash solubilizing bacteria
- Herbicides Sodium aceflorfen 16.5% + Clodinafoppropargyl 8% (Iris) and Imazethapyr 10SL
- Yellow sticky traps, blue sticky traps, Pheromone traps for *Maruca, Spodoptera,*
- Azadirachtin 1500ppm, Need based plant protection chemicals.
- Liquid fertilizers like 19:19:19 and Multi K (Potassium nitrate) for drought mitigation
- Tarpaulins for the post harvest management.
- Triple layer hermetic bags for storage.

The Farmer to farmer extension model was adopted where in fellow farmers were selected and trained thoroughly on production technologies. These farmers are also designed as ToT farmers of that district.

Glimpses of distribution of inputs to the farmers of Srikakulam and Visakhapatnam Districts

5 Yield and Economics

A large number of demonstrations were planned in farmers' fields to assess the performance of rice fallow black gram and green gram in Srikakulam and Visakhapatnam districts as relay crop and rajmah as *rabi* crop during *rabi*, 2018-19 and 2019-20. The farmers grown rice followed by green gram and black gram as relay crop. The demonstrations were conducted with improved technology and farmers practice. The results of the demonstrations were presented in Table 1.

Table 1. Performance of technology demonstrations during *rabi*, 2018-19 and 2019-20.

Crop	Yield (kg/ha)		Average yields (kg/ha)	Yield increase over check (%)	Yield increase over mandal average (%)	Gain in Benefit (Rs.)
	Demo	Control				
VISAKHAPATNAM DISTRICT						
Rice – *kharif*	4780.0	4230.0	2528.0	13.0	89.0	0.30
Green gram – Relay crop in rice fallows	702.0	492.5	550.0	42.5	27.6	2.19
Black gram – Relay crop in rice fallows	619.2	440.9	436.9	40.5	41.7	1.35
Rajmash *rabi* crop	348.0	212.0	181.0	64.2	92.2	1.35
SRIKAKULAM DISTRICT						
Rice – *kharif*	5373.0	5167.0	4088.0	4.0	31.4	0.09
Black gram – Relay crop in rice fallows (sown after November 15th)	422.1	369.8	350.0	14.2	20.6	0.46
Black gram – Relay crop in rice fallows (sown before November 15th)	718.8	575.0	556.0	25.0	29.2	1.37

Rice crop is grown in both the districts with medium to short duration varieties while in farmers practice mostly with Swarna rice variety. The improved low cost practices like direct sowing rice with gorru, drum seeder and Modified System of Rice Intensification with transplanters were attempted. This has resulted in reducing the cost of cultivation up to Rs. 3800/- per hectare on cost of raising nursery and transplanting and duration of 6-7 days was saved due to dry seeding and wet seeding with seed drill. Moreover, the yields were more when compared to farmers practice in both the districts i.e., 13.0 % increase in demo plot compared to farmers practice in Visakhapatnam district and 4.0 % in Srikakulam district. The yield increase of 89.0 per cent in Visakhapatnam district and 31.4 % in Srikakulam district was recorded when compared with mandal average yields.

In Visakhapatnam district, the green gram crop in demonstration plot gave 42.5 % increase over check i.e., 702 kg/ha in demonstration plot while 492.5 kg/ha in control plot and also recorded 27.6 % increased yield over mandal average yields (550 kg/ha), recorded all over farming situations and not only from rice fallows. An additional benefit of Rs. 2.19 was recorded with relay crop of rice fallow green gram with technology demonstrations when compared with farmers practice. Back gram as relay crop has recorded 619.2 kg/ha in demonstration plot when compared to control (440.9kg/ha) with an increase of 40.5 % improvement. Growing Rajmash with an improved variety and technology has gave 64.2 % increase in yield over control with an additional profit of Rs. 1.35 over farmers practice. When t test was conducted the increased yields are significant at 0.01level of probability both for green gram, black gram and rajmash. In Srikakulam district rice fallow black gram when grown before November 15^{th} gave higher yields when compared to delayed sowings i.e., after November 15^{th} which clearly shows that the farmers have to take care about sowing time and also variety of rice to be grown. Hence, farmers were educated about right time of sowing rice fallow pulse crop for getting higher yields. The yields recorded were significant at 0.01 level of probability (Table 2).

Table 2. Analysis on significant difference of yields.

S. No	Components	No.of Mandals	Average Yield (kg/ha)		Mean difference	't'-cal. Value
			Demo	Control		
Srikakulam						
1	Rice	n=20	5373.0	5167.0	206.0	5.69**
2	Rice fallow pulses sown after Nov 15th	n=29	422.1	369.8	52.3	2.44*
3	Rice fallow pulses sown before Nov 15th	n=20	718.75	575.0	143.75	4.68**
Visakapatnam						
1	Rice	n=20	4780.0	4230.0	550.0	7.52**
2	Green grram	n=29	702.0	492.5	209.5	6.87**
3	Black gram	n=30	619.2	440.8	178.4	6.23**

**significant at 0.01 level of probability

**0.01 't' - critical value – 2.66 (n=29)

**0.01 't' - critical value – 2.71 (n=20)

**0.01 't' - critical value – 2.66 (n=29)

**0.01 't' - critical value – 2.66 (n=30)

*significant at 0.05 level of probability

*0.05 't' -critical value - 2.00 (n=29)

*0.05 't' -critical value - 2.02 (n=20)

*0.05 't' -critical value - 2.00 (n=29)

*0.05 't' -critical value - 2.00 (n=30)

In Srikakulam district, the black gram crop when sown before November 15th, recorded 25.0 per cent increased yield over farmers practice and 29.2 per cent increased yield over mandal average yields. But yield increase was only 14.2 per cent when sown after November 15th. The average yields were low in all the crops due to the damage caused by '*Titlee*' and '*Pethai'* cyclones during 2018-19. The first cyclone was hit in October, 2018-19 and second one in December 2018-19 which has affected the average yields in pulses. However, even under cyclonic conditions, the yields recorded in technology demonstrations were higher when compared to farmers practice and also district average yields.

Table-3: Economics of Rice-Rice and Rice-Pulse cropping systems

Parameter	Rice-Rice	Rice-Pulse (Black gram)		Rice-Pulse (Green gram)	
		Demo	Farmer practice	Demo	Farmer practice
Srikakulam					
Yields (kg/ha)	10627	5373+719	5167+575		
Gross returns (Rs.)	188098	136085	124231		
Cost of cultivation (Rs.)	107500	56610	57660		
Net returns (Rs.)	80598	79475	61287		
BC ratio	1.78	2.40	2.15		
Visakhapatnam					
Yields (kg/ha)	9080	4780+619	4230+441	4780+702	4230+492
Gross returns (Rs.)	160716	119889	100008	134097	109557
Cost of cultivation (Rs.)	101700	53409	56845	53225	56033
Net returns (Rs.)	59016	66480	43163	80872	53524
BC ratio	1.58	2.24	1.75	2.52	1.96

(rice @17.70/kg; black gram @57/kg and green gram @70.50/kg)

The economics pertaining to the different cropping systems viz., rice-rice and rice – pulse were compared in Table. 3. In Srikakulam district the rice- black gram cropping system gave a net benefit of Rs.79475/ ha with a cost benefit ratio of 1:2.40 with technology demonstration as against 1:2.15 in farmers practice. The rice-rice cropping system has recorded a cost benefit ratio of 1:1.78 which indicate that rice – black gram system is highly beneficial when compared to rice – rice cropping system. In Visakhapatnam district, the rice –green gram system realised a net benefit of Rs. 80872/ha with a cost benefit ratio of 1:2.52 and rice-black gram has recorded a net benefit of Rs.66480/- with a cost benefit ratio of 1:2.24 as against rice-rice cropping system 1:1.58. This clearly indicate that in Visakhapatnam district, sowing of green gram in rice fallows as relay crop after *kharif* is highly beneficial followed by rice-black gram as against rice-rice cropping system. From the above result it is clear that the farmers are highly benefitted with technology demonstrations of rice-pluses cropping system and the cultivation cost was saved to a greater extent. ***Hence it is concluded that rice fallow pulses should be sown before November 15th with YMV tolerant/resistant varieties duly following chemical weed management with recommended practices.***

Glimpses of onfarm demonstration in Srikakulam and Visakhapatnam Districts

6 Contribution to Climate Resilience

Climate change has become a major concern for agricultural development and threatens to increase crop losses, number of people facing malnutrition and change in the development patterns of plant diseases and insect pests. Growing rice fallow pulses is one of the major opportunities utilized through the KISAN Hub project especially in backward districts in North Coastal Andhra Pradesh where in wide scope exists to mitigate climate change. We have organized 102 demonstrations in an area of 25 hectares in Srikakulam and Visakhapatnam districts in Andhra Pradesh with an yield increase of 40.5% in black gram and 42.5% in green gram in Visakhapatnam district and 14% to 25% in black gram in Srikakulam district and with an additional benefit of 2416/ha to Rs.8231/ha in black gram and Rs. 14184/ha in green gram. The technology of growing pulses in rice fallows has reduced drudgery with 60% to 70% saving in man hours and water saving to an extent of 200-400 mm during the growing period. The system also improved soil structure and reduced the problem of soil salinity with rice monoculture. Further, rice fallow pulse technology is advantageous by its resilience in climate change scenario, since pulse crops have capacity to adopt to climate and mitigating its effect with residue having CN ratio 125:1 to 40 :1 when compare with cereal crop residues 70:1 to 100:1. The emission of green house gases were minimized rice-pulse cropping system there by the rate of climate deterioration can be minimized. The inherent capacity to fix atmospheric N by pulses results in enhancement of soil fertility, improve yields and contribute food diversity. The cropping system of green gram and black gram crop in rice fallows utilizes residual moisture & nutrients from the previous crop of rice and saved 200 kg of N synthetic fertilizers and 200-400 mm water during the growing period. Besides reduction in the use of synthetic nitrogen fertilizers which releases nitrous oxide causing high global warming potential when compared with the other GHGs, the system also contributes nitrogen to the succeeding crops.

The present system of growing relay crop of green gram / black gram in rice fallows after *kharif* rice has benefitted farmers in multiple folds through reduction in drudgery, increased income and improved soil health. The technology has lot of scope for expansion in North Coastal districts of Andhra Pradesh to an extent of more than 3 lakh hectares and the Biotech KISAN project has made a beginning and created a huge dent.

7 Post-Harvest Management

Awareness was created on measures followed to combat losses through management in harvesting and post harvest. Accordingly from the project tarpaulins and triple layer hermetic bags were supplied for reducing the losses during harvest and post harvest for the pulse produce harvested by the farmers. Fifteen tarpaulin sheets and number of hermetic bags were procured and distributed to farmers of Biotech KISAN Hub villages in Srikakulam and Visakhapatnam districts so as to create awareness among farmers about management to be followed during harvest and post harvest to avoid losses. The farmers were trained on the time of harvest, threshing and drying for maintaining optimum moisture and also on storage of the produce since the majority of the produce harvested through rice fallow pulse demonstrations was used as seed for distributing to the fellow farmers in those villages since yellow mosaic tolerant/ resistant and foundation seed was supplied to the demo farmers.

Triple layer hermetic storage bags were distributed and demonstrated their usage for the farmers of KISAN Hub. Also collected data on the damage of the produce stored in hermetic bags compared with normal storage methods in gunny bags and the data revealed that the storage in hermetic bags has avoided damage due to storage pests i.e., pest incidence was not recorded even after six month of storage where as in normal storage method i.e., gunny bags in farmers practice 19% damage due to storage pest in balck gram and 21% in green gram was recorded (Table 4). The germination percentage was also above 90% in triple layer hermetic bags and 77% to 78% in normal storage method.

Tarpaulins distribution

Table 4. Performance of hermetic bags

Treatments	Pest incidence				Germination			
	Black gram (%)		Green gram(%)		Black gram (%)		Green gram (%)	
	Before	After 6 months	Before	After 6 months	Before	After 6 months	Before	After 6 months
Hermetic bags	Nil	Nil	Nil	Nil	95	91	96	92
Farmers practice	Nil	19	Nil	21	95	77	96	78

Triple layer bags for storage of the produce and the difference in damage between triple layer bags and farmers practice

8 Value addition

After successful efforts on the scope of rice fallow pulses and technology adoption on growing of rice fallow pulses cultivation, the KISAN Hub project has thought of increasing the income of the farmers so as to make them economically sustainable an initiative was made to train the farmers on value addition

Through a pilot project on establishment of *mini dal* mills at village level. Accordingly efforts were made to establish *mini dal* mills one each at Srikakulam and Visakhapatnam districts on Public Private Partnership (PPP) mode where in the units will be running by the farmers group at village level and technology, recurring expenditure by the KISAN Hub project. Guidelines were framed to run these value addition units and implemented from 2018-19 onwards simultaneously.

- These units will operate in PPP Mode by women farmers in the villages under supervision of KVKs.
- Established and designated in a well identified place with display boards depicting the name of the University, Project and KVK.
- Demo classes and trainings were given to the group who are involved in running the unit.
- Wide publicity and awareness to the farmers, included in this value addition unit by promoting farmers facilitation centre for market information & intelligence by FPO's etc.

Accordingly two *mini dal* mill units were established under Biotech KISAN Hub at two villages in Srikakulam and Visakhapatnam districts on a pilot mode as detailed below;

1. Kothapenta village, Devarapalle mandal, Vishakapatnam dist covering nine DBT villages at around 564 households. The unit are running by R.Gangunaidu, Kothapenta (v), Devarpalle (m). Vishakapatnam Dist.
2. K P.Valasa of Polaki mandal of Srikakulam district a DBT village covering 5-6 villages around with more than 400 households. The unit will be running by Alagi Chandrasekhar, a fellowship farmers under DBT and rural youth belonging to the K P valasa (v).

The cost for processing pulse produce outside is Rs 200/- per 10 kg, but from our unit we are charging Rs.10 per kg seed I.e., is Rs 100/- per 10kg . The average monthly and yearly returns from the units were presented in Table 5.

Table 5 . Economics of processing unit

District	Particulars of grain processed	Processing cost (Rs/kg) and quantity processed	Returns per month (Rs)	Maint-enance charges (Rs)	Profit (Rs)	
					Per month	Per year
Visakhapa-tanam	Black gram/ green gram	Rs.10/ kg and about 700 kgs	7000	500	6500	78000
Srikakulam	Black gram/ green gram/ redgram	Rs.10/ kg and about 500 kgs	5000	400	4500	54000

With the advent of the above intervention, the farmers are getting additional income and hence many farmers are utilizing the opportunity. Further many new farmers are showing interest in starting the *mini dal* mills. The KVKs and the DAATTCs are initiating measures to assist those farmers in facilitating the technology and also initiated efforts to include the same in State Agriculture Department subsidy programme.

9 Training & Capacity Building

As many farmers were unaware of the cultivation of pulses as relay crop in rice fallows and discouragement of the crop due to severe Yellow mosaic menace, capacity building of farmers became necessary and the project has approached various extension methods to bring awareness to the farmers on latest and sustainable cultivation practices. The programmes include trainings, Farmer Scientist interactions, method demonstrations, field visits, field days, providing literature etc. Both on campus trainings at KVK, Amadalavalasa and DAATTC, Kondempudi and also off campus i.e., in villages were conducted in both the districts. Large number of method demonstrations were conducted on seed treatment, herbicide sprayings, use of sticky traps and pheromone traps since the skill development is the main component in adoption of technologies. About 31 trainings were given in Srikakulam covering 623 farmers and 26 trainings in Visakhapatanam covering 588 farmers. The details of the various extension programmes conducted were presented in Table 6.

Table 6. Capacity building programmes

Programme	Number of Programmes		No of beneficiaries
	Srikakulam	Visakhapatnam	
Training programmes	31	26	1211
Workshops	1	2	135
Exposure visits	4	4	140
Field days	9	6	270
Method demonstrations	30	16	537
Farmer Scientist Interaction	2	2	350

Glimpses of the capacity building programmes

In order to improve the knowledge level of the farmers, a new extension strategy viz., "Knowledge on Wheels" is utilized to reach the farmers through providing access to agricultural services at their door steps. The "Knowledge on Wheels" contains audio visual units, video conferencing unit, literature related to the target crops and items for conducting demonstrations on technological gaps in the target crops and reaches the farmers at village level to facilitate capacity building and interaction with farmers at their field level.

Table 7: Number of farmers covered through Knowledge on Wheels programme

District	Programmes conducted	Farmers covered	Villages covered	Mandals covered	Improvement in their knowledge level (%)
Srikakulam	30	1550	12	5	53
Visakhapatnam	28	1240	10	5	48

Glimpses of programmes conducted with knowledge on wheels

10 Success Stories

1. Rice fallow pulse, a remunerative crop for tribal farmers

Technology in rice fallow pulse harvested good income to the tribal farmers of Visakhapatnam district in Andhra Pradesh. These tribal farmers are unaware of rice fallow pulses. Even though some farmers are cultivating pulses as rice fallow, they are unaware of the management practices. They simply broadcast the seed in paddy fields before harvesting and they don't follow any management practices and realise yields of 0.5 to 1.5 q/ac. The Biotech KISAN project has planned technology interventions and implemented in an area of about 25 ha with green gram spread across 12 mandals and 25 ha with black gram spread across 11 mandals of which tribal farmers of 60 villages were covered. The interventions were planned from *kharif* season in rice followed by pulse as relay crop in rice fallows. During *kharif* season rice varieties of medium to short duration viz., MTU-1121 were grown and seed was supplied through DAATT Centre, Visakhapatanam and the farmers were trained in management practices in rice. Later during *rabi,* pulse crop of green gram and black gram was sown in rice fallows as relay crop with the following interventions.

- o Use of improved varieties of green gram viz., LGG460, IPM2-14, WGG37 (tolerant to yellow mosaic) and black gram viz., PU31, TBG104, GBG 1 (Yellow mosaic tolerant/ resistant varieties).
- o Adopting correct time of sowing i.e., before November 15th
- o Seed treatment with imidachloprid 600 FS @ 5ml per + mancozeb 75WP @ 3g per kg seed
- o Application of biofertilizers Rhizobium and PSB.
- o Weed Management through spraying of sodium aceflorfen 16.5 + clodinafoppropargyl 8% (Iris) - 400 ml/ac
- o Foliar application of 19:19:19, 13:0:45 @1kg each per acre with a gap of 15 days for mitigation of terminal moisture stress as well as nutritional deficiencies.
- o Integrated pest and disease management (Yellow and Blue sticky traps, Spraying of neem oil 0. 5% and need based spraying of plant protection chemicals for the management of *Maruca* pod borer and powdery mildew.

Method demonstration with seed treatment with imidachloprid in tribal hamlets of Visakhapatnam dist.

Average yields obtained by the farmers who have grown rice fallow pulse crop is presented in Table 8. The data clearly shows that the cultivation of green gram/ black gram after *kharif* rice as rice fallow relay crop is highly remunerative with low risk and ease which was witnessed through 2.8 benefit cost ratio in black gram and 3.3 benefit cost ratio in green gram.

Table 8. Yield and economics of the demonstrations

S.No	Particulars	Demonstrations on Black gram			Demonstrations on Greeen gram		
		Kisan Hub Demo plot	Control plot	Differ-ence (+/-)	Kisan Hub Demo plot	Control plot	Differ-ence (+/-)
1	Yield (kg/ha)	875	680	28.68	780	620	25.81
2	Gross income (Rs.)	49875	38760	11115	54600	43400	11200
3	Cost of cultivation (Rs.)	17800	16700	(-)1100	16500	15800	(-)700
4	Net income (Rs.)	32075	22060	10015	38100	27600	10500
5	Benefit cost ratio	2.80	2.32		3.31	2.75	

*Calculated using MSP, 2019-20

The technology was well accepted and spread to an area of 150 acres of demonstrating farmers covering 120 plain and tribal farmers of 60 villages belongs to 15 mandals/blocks of Vishakhapatnam district. The farmers have harvested the improved variety seed and threshing were done carefully under the supervision of project personnel and the seed was supplied to the neighboring farmers.

Particulars	Area	Farmers	Villages	Mandals
Number covered	150 acres	150	60	15

The farmers were well trained in the technology and the technological interventions were being followed and also trained to neighboring farmers. The technological interventions spread among the farmers and being followed are;

- High yielding yellow mosaic tolerant varieties LGG460, IPM2-14, WGG37 in green gram and PU31, TBG104, GBG 1 in black gram.
- Seed treatment with imidachloprid 5ml/ kg seed of black gram or green gram to manage sucking pests at early stages.
- Application of NPK 19:19:19 , 20 days after sowing for good crop growth
- Spraying of 13:0:45 at 55 days after sowing for mitigation of drought

- Application of herbicide with - sodium aceflorfen 16.5% + clodinafoppropargyl 8% (Iris) - 400 ml per acre for effective weed management.

With the advent of technological interventions the farmers have good economic gains with minimum effort and risk resulting in horizontal spread of technology. Further the efforts of Fellow Farmers are priceless and made the technology so popular which can be witnessed from the horizontal spread (Table 9).

Table 9: Technology spread through fellowship farmers during 2019-20

Particulars	Area (ac)	Farmers (No.)	Villages (No.)	Mandals (No.)
Spread	1932	1600	50	16

2. Mr V Appa Rao, a successful rice fallow green gram farmer

Village	Mandal	District
Kothapenta	Devarapalli	Visakhapatnam

Farming Situation	Type of soil
Rice fallow	Loamy soils

Yield (Kg/ha)	Gross income (Rs.)	Cost of cultivation (Rs./ha)	Net income (Rs/ ha)
657.8	46,375	7800	38,575

It was a new experience for the farmer Sri. Appa Rao who used to cultivate rice during *kharif* and keeping fallow during *rabi*. He used to cultivate MTU7029 (Swarna) variety (150 days duration) during *kharif* season. During 2019-20, sowings were done in July first fortnight and if the farmer used same variety then sowing of pulse crop will be attempted during December first fortnight. Hence the project personnel from DAATTC, Visakhapatanm has brought awareness to the farmer and advised him to sow medium duration variety MTU1075 (135 days duration). Accordingly the farmer has raised the nursery in the first fortnight of June and transplanted during first week of July. This enabled the farmer to grow green gram crop as relay crop during October end.

He opined that the extension activities carried under this project helped me in transition for focusing on successes, learning experiences for achieving good results. Further the project personnel has procured the seed of LGG460 an improved variety in green gram and advised to me to sow the seed only after seed treatment which helped me to reduce the incidence of sucking pests and viral diseases. I have also used herbicides as per their advise for affective management of weeds which helped me in reducing my expenses on weed management since weed menace is a major problem for rice fallow pulse crop. As per their advise I also used waste decomposer which enabled me for faster decomposer of rice stubbles and added nutrients to the soil. I supplied foliar nutrition through spraying of 19:19:19 and also potassium nitrate and affectively managed pests and diseases through the advises received from the project.

He became active member of the project and due to the benefit realized he convinced with the technology and implementing the technology from there onwards.

3. Mr. Sayam Raghunath, successful rice fallow black gram farmer

Village	Mandal	District
Bangaarumetta	Buttchayyapeta	Visakhapatnam

Farming Situation	Type of soil
Rice – Pulses	Red loamy soils

Yield (Kg/ha)	Gross income (Rs.)	Cost of cultivation (Rs./ha)	Net income (Rs/ ha)
1118.9	63,777	8200	55577

A fellowship farmer under this project and helped for strengthening the capacity of farmers towards Agriculture and supported farmers by providing need based inputs in right time and helps to change the farming practices to become more sustainable. He attended several trainings, workshops, field visits, Scientist-Farmer Interaction meetings conducted under this project and is highly involved in sharing/transferring best practices to the neighboring farmers.

He used to cultivate pulse crop after rice as relay crop but with local variety "*Buttaminumu*" and is not following any sustainable cultivation practices. He used to sow the seed and harvest the crop whatever it is available. He felt that the project has brought tremendous change in my perception on cultivation of rice fallow pulse crop and followed the technology. Procured the black gram seed of yellow mosaic tolerant variety PU31 from the project and attended to seed treatment for the management of sucking pests and also for Rhizobium inoculation. Drought mitigation measures were followed by spraying with 19:19:19 soluble fertilizer twice from 60 days age of the crop with weekly interval. The project has made be aware of major pests and diseases affecting the black gram crop and affective low cost management practices to minimise the losses. Affective weed management was followed and all these improved management practices made it possible to reap higher benefits with minimum expenses.

The farmer has harvested the seed in the presence of KISAN hub project personnel and carefully processed, cleaned and dried and distributed as seed to the neighboring farmers since PU31 variety is tolerant to YMV.

4. Mr. J. Demullu, a tribal farmer succeeded with Rajmash cultivation

Village	Mandal	District
G. Madugula	G. Madugula	Visakhapatnam

Farming Situation	Type of soil
Red gravelly soils - Rainfed	Red gravelly soils

Yield (Kg/ha)	Gross income	Cost of cultivation (Rs./ha)	Net income (Rs/ ha)
1200	57600	15000	42000

Sri. Demullu, a tribal farmer from Visakhapatnam dist. has cultivated Rajmash in one hectare during late *kharif* season. Earlier he used to cultivate *desi* varieties he used to get an yield of 3.5 quintals per ha, and his gross returns and cost of cultivation were almost equal with no profits. The farmer has sown rajmash in the late *kharif* season of 2019-20 and 60 kg seed of improved variety *Jwala* was used per sowing one hectare area and line sowing was followed in podu lands to maintain the spacing of 30 cm x 10 cm. The seeds were treated with Phosphorus Solubilizing Bacteria (PSB) 5g/kg of seed followed by *Trichoderma harzianum* and *Pseudomonas fluorescens* @ 5g each per kg of seed. A basal dose of 20 kg of N, 50 kg of P_2O_5 and 40 kg of K_2o were applied as basal on the basis of soil test.

The farmer got net gross income of Rs 42,000/- and it made a big difference to his income. The benefit cost ratio was 3.84 it says cultivation of Rajmash under scientific guidance is highly profitable to farmers. The farmer could able to sell the produce immediately the day it is harvested due to quality produce with attractive shiny red colour. By seeing Demullu, the farmers of the village and other nearby areas have been enthusiastic to grow the rajmash by improved technology, that is, use of HYV seed, bio-fertilizer PSB, bio-fungicides like *Trichoderma* enriched FYM and other cultural practices.

5. Successful farmers under the project in Srikakulam dist.

P. Ramarao Labam village of Boorja rural mandal a demo farmer of the DBT Project at KVK, Amadalavalasa during 2019-20. Adopted the HYV TBG-104 , seed treatment, foliar nutrient application, and use of neem oil for pest management and got good yield 1180 kg/ha when compared to last year 775kg/ha which is 52% higher yield than control plot . By seeing the performance of the crop, other farmers with local variety also adopted the foliar nutrition and Plant protection measures and got good yield.

P.Varaha. Narasimhulu, Nakkalapeta village of Sarubujjili mandal involved in DBT project as fellowship farmer during 2018-19. Adopted the critical interventions like sowing black gram variety TBG 104 during first fortnight of November, seed treatment, application of post emergence herbicide, and timely pest management and got good yield 675kg/ha during 2018-19 and 850 kg/ha when compared to 475kg/ha during 2017-18. He was actively involved in "Knowledge on Wheel" programme designing and publicity.

Kandapu Jamuna, P.R.Raju peta village of Palakonda mandal selected as women fellowship farmer of the DBT Project. Got good yield 750 kg/ha during 2018-19 and 875kg/acre during 2019-20 when compared to 2017-18, 550 kg/ha. Adopted black gram variety TBG 104, seed treatment, application of post emergence herbicide at 20-25 DAS for weed management is the critical interventions for yield enhancement. She was also creating awareness among the other farmers and school children in the village about importance of pulses in up keeping soil health and human health.

B.Shiva Prasad, Byri village of Srikakulam rural mandal selected as fellow farmer of the DBT Project at KVK, Amadalavalasa during 2019-20. Adopted the seed treatment, foliar nutrient application, installation of sticky traps and use of neem oil for pest management and got good yield 800kg/ha when compared to previous year 525kg/ha. By seeing the performance of the crop other farmers with local variety also adopted the foliar nutrition and Plant protection measures and got good yield.

11 Awards and Recognitions

As a mark of recognition of their achievements, some of the Biotech KISAN farmers were felicitated with the awards and appreciations.

Sri. N. Varaha Narsinham of Nakkalapeta of Srikakulum dist. a fellow farmer was awarded as *'Best Farmer'* for Amadalavalasa constituency during *Rythu Dinostvam* on 08.07.2019, presented by Hon'ble Speaker, AP Assembly Sri Tammineni Seetaram Garu.

The fellow farmers of Biotech KISAN project, Srikakulam dist has won the quiz competition conducted during *Kisan mela* at Regional Agricultural Research Station, Anakapalli.

Sri. J Demullu, G.Maduga block, a tribal fellow farmer in Vishakapatnam dist has received best progressive farmer award from ANGRAU under tribal category.

12 Conclusion and Way forward

The team of Biotech KISAN Project implemented by the Acharya NG Ranga Agricultural University with financial and technical support from the Department of Biotechnology, Ministry of Science & Technology, Govt. of India has tirelessly worked for strengthening of pulse production in North Coastal Andhra Pradesh. The project team has worked in 160 villages across 45 mandals and touched more than 88,579 farmers through various extension approaches for imparting latest technical knowledge on rice fallow pulses viz., green gram and black gram. The net benefit of Rs.26,918/- was realized for growing black gram and Rs.40,882/- for growing green gram in rice fallows in Visakhapatnam and Rs.24,676/- for growing black gram in Srikakulum has shown a greater scope for adopting the technology. Further the cost economics has also revealed that rice-pulse relay cropping system is highly beneficial when compared to rice-rice cropping system. Growing of green gram / black gram in rice fallows as relay crop is an easy task for the farmer and produce assured returns at low investment. Moreover, this is a practice which protects environment due to reduction in release of GHG and soil ecology through water saving (200-400mm), grow with residual fertilizer applied for rice crop during *kharif,* balances soil nutrients, accumulates and adds soil nutrients.

Experts believe that relay crop of rice fallow pulse especially green gram and black gram has all potentials of being cultivated among remunerative crops of the state. Increased production of pulses will also solve the need of imports for pulses. Cropping system of rice-pulses in rice fallows has lot of scope to expand in North Coastal Andhra Pradesh (Till now only 28 percent of the area is being utilized in North Costal Districts), where the farmers are resource poor and marginal. The farmers have thus scope of increasing their profit margin by taking up cultivation of green gram / black gram in rice fallows primarily because of low cultivation cost of the crop. Popularization of value addition through establishment of *mini dal* mills is an additional advantage to the farmers since the processed grain will yield higher returns than raw produce. Further the seed of improved tolerant pulse varieties to Yellow Mosaic Virus was multiplied with the farmers and is being popularized across the farmers for getting higher yields. The farmers are to be educated in this cropping system intensively i.e., on raising of rice crop early and also use of medium and short duration rice varieties followed by pulses after *kharif* with zero tillage. This cropping system has provided higher profits with a benefit cost ratio of more than 5.0. Further, mechanization has to be introduced for seeding and harvesting which will make the farmers task more easy. The University has continuously involved in the development of the machinery besides high yielding and virus resistant viz.,YMV and leaf curl tolerant/resistant varieties.

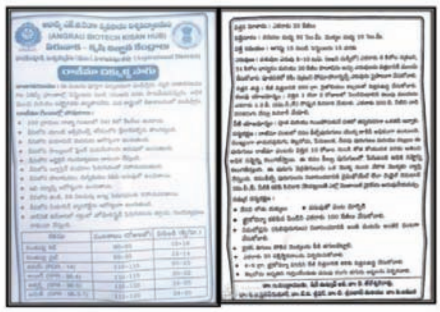
The feedback collected from farmers indicated that farmers are ready to adopt technology and have come forward to adopt cultivation of green gram / black gram in a big way especially in rice fallows. This will bring smile on the face of thousands of farmers and their family and also contribute in reducing protein malnutrition by supplementing pulse production of the state. It is now expected that the State Department of Agriculture of the Government of Andhra Pradesh will take this technology forward and spread cultivation of green gram / black gram in rice fallows as relay crop in other areas of Srikakulam, Visakhapatanam and Vizianagaram districts of the state having sizeable area under green gram / black gram so as to reduce shortage of pulses and fodder on one hand and help in substantial increase in the income of the farmers on the other.

13 Publications

As a part of the project several brochures and booklets were printed depicting the advanced technologies for getting higher productivity. More over a diary was printed and handed over to Fellow farmers for recording their day to day activities. Several copies of the booklets were printed and distributed to the farmers under the project (Table 10).

Table 10. Publications brought out

S No	Name of the publication	Number of copies	Type of publication	Printed by
1	Red gram, green gram, black gram and chickpea – Production technology for getting higher yields	1000	Booklet	Biotech KISAN project Main Hub
2	Biotech KISAN Hub Diary	1000	Booklet	Biotech KISAN project Main Hub
3	Knowledge on wheels, An innovative technology transfer programme to reach the unreached	1000	Brochure	Biotech KISAN project- Main Hub
4	Rice fallow pulses	1000	Brochure	DAATTC, Visakhapatnam dist. - Sub hub
5	Production technology for Rajmash beans	1000	Brochure	DAATTC, Visakhapatnam dist. - Sub hub
6	Production technology for rice in view of the rice fallow pulses	1000	Brochure	KVK, Srikakulum dist. – Sub Hub
7	Rice fallow pulses	1000	Brochure	KVK, Srikakulum dist. – Sub Hub
8	Post harvest management and value addition for pulses	1000	Brochure	KVK, Srikakulum dist. – Sub Hub



Publications

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Fellow farmers meet at Acharya N G Ranga Agricultural University

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