GREAT MILLET(*SORGHUM BICOLOR* L.) CULTIVATION IN RICE FALLOWS UNDER ZERO TILLAGEIS THE BEST BOON FORFARMERS OFCOASTAL ANDHRA PRADESH

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Recieved March5,2018and Accepted Apri15,2018

ABSTARCT: Great millet(Sorghum bicolor L. Moench) is the fifth most important cereal crop worldwide after wheat, rice, maize and barley (FAO, 2004) and staple crop for millions of farmers in the semi-arid tropics. In spite of its multiple uses as food, feed, fodder and bio-fuel, the area under grain sorghum in India has declined from 18.61 million ha in 1969-70 to 6.32 million ha in 2014 (FAO 2014). Part of the sorghum crop area has now been replaced by soybean, cotton and maize and presently it is being grown on marginal lands. However, new opportunities and areas for sorghum cultivation are emerging. Sorghum in rice-fallows in coastal Andhra Pradesh, especially in Guntur, Krishna and Prakasham districts is gaining popularity among the farmers (Mishra et al.2011 and Subbarayudu& Reddy.2018). Usually farmers grow pulses (green-gram and black-gram) in rice-fallows in the Krishna-Godavari zone of Andhra Pradesh as utera cropping which means broadcasting of seeds as a relay crop in rice field under zero tillage. However, in recent times, the area under pulses has declined due to late planting of rice and severe attack of viral diseases and parasitic weed Cuscuta. Keeping this in view the efforts were made to promote great millet cultivation in rice-fallows of Krishna basin of Andhra Pradesh.Conducted large scale field trails through various acivties viz.; free distribution of seeds of improved cultivars, mechanized methods, distribution of soil health cards, farmers interaction meetings and exposure visits on millets cultivation, production and their utilization in several villages of Guntur district of Andhra Pradesh to disseminate improved production and protection technologies. Soil samples collected from 500 farmers and those were analysed at Soil Testing Laboratory, Department of Agriculture, Bapatla, Andhra Pradesh.Issued soil health cards to them by recommending fertilizer doses. Overall complete cost effective interventions were helped to the sorghum growers in a big way. Further, in this investigation recommendations have been given which could be useful to sorghum seed producers, farmers, entrepreneurs, scientists and policy makers particularly in Andhra Pradesh and Telangana states and in general to remaining regions of India. Millets processing equipment comprising of Grader, Aspirator, De-stoner, Dehuller and Millet Roaster were installed at Bapatla Pharmacy college, Bapatla. Organized two national seminars viz.; Entrepreneurship development for Millet Products and Future challenges in agriculture, value addition in millets/ food crops and their nutrcetical function at Bapatla to inculcate a 'Start Up' culture among local graduates, post graduates, local entrepreneurs and farmers of project implemented villages. The present project experimental findings are encouraging the farmers to grow sorghum and other millets and their utilization by adopting all interventions and also to enhance their farm income.Overall, the above interventions resulted in enhancement of sorghum grain yield from 2 tonnes/ ha to 5 tonnes/ha and their knowledge and skill development on sorghum and other millets cultivation, production and their utilization was also increased.Therefore, in Krishna basin of Andhra Pradesh in zero tillage situation, farmers got bumper grain yields to the tune of 5 times more against the national (India) average of one tonne/ha, thereby they got the farm profit of Rs.70,000/ ha by investment of Rs.35000/ha (C: B = 1 : 2).

Key words : Great millet, sorghum, zero tillage, soil health cards and skill development

Great millet (*Sorghum bicolor* L. Moench) is the fifth most important cereal crop worldwide after wheat, rice, maize, and barley (FAO, 2004) and staple crop for millions of farmers in the semi-arid tropics. In spite of its multiple uses as food, feed, fodder and bio-fuel, the area under grain sorghum in India has declined from 18.61 million ha in 1969-70 to 6.32 million ha in 2014 (FAO,2014). Part of the sorghum crop area has now been replaced by soybean, cotton and maize and presently it is being grown on marginal lands. However, new opportunities and areas for sorghum cultivation are emerging. Sorghum in rice-fallows in coastal Andhra Pradesh, especially in Guntur and adjoining Krishna and Prakasham districts is gaining popularity among the farmers (Mishra *et al*. 2011 and Subbarayudu *et al.*2011). Usually farmers grow pulses (green-gram and black-gram) in rice-fallows in the Krishna-Godavari zone of Andhra Pradesh as *utera* cropping which means broadcasting of seeds as a relay crop in rice field under zero tillage. However, in recent times, the area under pulses has declined due to late planting of rice and severe attack of viral diseases and parasitic weed *Cuscuta*. Farmers of this region are now growing maize in assured irrigated areas and sorghum in the areas where only two irrigations are available during the crop season in rice-fallows as second crop replacing pulses. During 2004-05, sorghum in Guntur district occupied over an

area of 1000 ha in rice-fallows under zero-tillage with an average productivity of 6.5 tons/ ha, the area 5000 ha in 2010 -11 summer season. Sorghum after rice gave the highest output energy of $59.1x10^3$ MJ/ha as compared to rice (*Oryza sativa* L.)-pigeon pea (*Cajanus cajan* L) and rice-safflower (*Carthamus tinctorius* L) (Mahendra Kumar 1997). Sorghum with its ability to survive in water-limiting conditions (sorghum needs 322 kgs of water to accmulate one kg of dry matter safely called as environment friendly) provides an alternative for marginal farmers after harvest of rice.

The development and release of new sorghum varieties as well as hybrids those respond to fertilizer inputs helped in breaking the stagnant yield levels in India. Sorghum hybrids grain yield potential of 5-6 tons/ha under the high residual fertility situation in coastal districts of Andhra Pradesh in Krishna basin as compared to local cultivars to the tune of 2.5 – 3.0 tons/ ha, has been achieved. The sorghum growers of this region are misconceived with reference to use of high doses of fertilizers and insecticides for the management from seedling to harvest stage. Hence, a projects were designed to optimize the use of fertilizers and insecticides to obtain higher returns by adoption of cost effective management technologies in rice –fallows of Krishna basin of Andhra Pradesh by Indian Institute of Millets Research, Hyderabad in collaboration with National Bank for Agriculture and Rural Development (NABARD). These studies also address critical analysis of location specific farming situations, technology evaluation and refinement, and development of relevant and acceptable integrated crop management technologies with the following objectives :

1) To popularize the high yielding cultivars contributing to productivity improvement from 2.5MT/ha to 5-6MT/ha
2) To reduce the cost of cultivation due to adopting of mechanized farming mainly through seed drills and soil health card based nutrition management
3) To provide training and exposure on "Sorghum grain and fodder based value added products" to young farmers and help them in setting up new / supplementary enterprises

MATERIAL AND METHODS

Shortlisted the villages viz.; Attota, Nelapadu and Siripuram of Guntur district, Andhra Pradesh where rice – sorghum sequence adopting during May 2016. The survey was made through the extension officials of State Department of Agriculture, Andhra Pradesh. Preparatory workshops were organised for the teams across Departments and Institutes to inculcate the essence of the project that operated in a participatory mode, discussed the action plans, time lines, roles and their responsibilities duringvillage visits to benchmark local constraints in terms of socio-economic, natural resources and infrastructure. Group meetings organised with selected farm families across the villages to understand their concerns and problems with special reference to rice-sorghum sequence farming, yield gap assessment, soil health related issues etc were studied.Identified the expectations of the farm families in participatory mode and also found the farm related location specific problems. Discussedwithfarmers aboutthe budget options in implementation of the experiments and finalized the selected farm family's involvement Seeds Distribution to farmers on free of cost in Attota, Siripuram, Nelapadu and in 30 villages of Guntur District, Andhra Pradesh **:** Presowing campaigns were organized in Attota village of Guntur district, Andhra Pradesh on high yielding hybrid seeds of sorghum distributed to farmers in 33 villages of Guntur district, A.P. in three phases viz.; 15-16 under sorghum rose to in carrying out the plan of action in two consequtive years of 2016 -17 and 2017-18. The improved seeds ofhigh yielding seeds of sorghum given to 500 farmers and also given the seed to seed packages.At the time of harvest grain yield/ha data recorded in the project implemented area.Trained the farmer's children on sorghum grain processing technologies and identified the opportunities for starting an enterpriseby organising National seminaron entraprenurship development for millet products at Bapatla Engineering College on 17th March 2018 and also another national seminar entitled on Future challanges in Agriculture, Value addition to Millets/Food crops and their Nutraceutical function, held at Bapatla Pharmacy college, Bapatla on 17th December 2018. Motivated the farmers and youth on entrepreneurial skills and marketing strategies so as to educate the consumer with reference to health foods and strengthened a producer-processor-consumer linkage model.

RESULTS AND DISCUSSION

1. Seed based module :

November, 2017; 25-28 November, 2017 and 5-6 December, 2017to motivate the farmers about the improved methods of sorghum cultivation, production, productivity and utilization and also to spread high yielding dual purpose sorghum hybrids viz.: CSH 14, 16, 25 and 30. The farmers appraised about the soil health cards, advantages of

mechanization and entrepreneurship development for millet products. The farmer response was very good in terms of adopting the Indian Institute of Millets Research developed sorghum hybrids. All farmers were sown sorghum seeds duringrabi 2017. They were followed all the package of practices to rise the crop successfully. Grain yield data collected from the farmers (500) and based on average it has been observed that 4.98 tonnes of grain/ha obtained by the farmers in the project implemented area (Figs. 1 and 2).

on 15-11-2017 at Attota, Guntur.

NABARD, DDM, Guntur Shri Karthik distributed the sorghum hybrid seeds of CSH 14, CSH 16, CSH 25 and CSH 30 to farmers. The farmer acceptance was very good in terms of adopting the developed sorghum hybrids and technologies (Figs.1 & 2).

2. **Mechanized based Module :**

Mechanized method of sowing with Seed Dibbler under zero tillage situation: Demonstrated the mechanized sorghum sowing with Seed Dibbler under zero tillage situation in Athota, Nandivelugu and Nelapadu villages during 25-28 November, 2017. This Seed Dibbler is very useful in sowing of the seeds to small farmers andalso where the farmers are carried out the re-sowing (Fig.3.).

3. **Soil Health cards based Module** :

Soil health cards based optimal fertilizer recommendation:

Fig. 4. *World soil day celebrations carried out at Tenali on 05-Dec.2017.*

Fig.3.*Dr B.Subbarayudu scientist demonstrating the mechanical sowing of the sorghum seeds with Seed Dibbler.*

Fig. 2. *NABARD, DDM, Guntur distributing* ***the*** *sorghum seeds to farmers*

The soil samples were collected from Athota, Siripuram, Nelapadu, Kolakaluru and Nandivelugu villages of Guntur district, Andhra Pradesh during rabi 2016-17 from 500 farmers and those samples were analyzed from soil testing laboratory, Agricultural college, Bapatla. Based on the soil health cards data, scientists advised the farmers about crop specific recommendations in terms of quantity and type of fertilizers to be applied to crops cultivated(Fig.4.). Soil health Cards were distributed to the farmers. Similarly, soil samples were collected from during rabi 2017 and after analysissoil health cards were distributed to farmers (Table 1).

Fig 5. *Awareness programme at Nelapadu village****Fig.1.*** *NABARD, DDM, Gunturdistributing the sorghum seeds to farmers*

Table- 1: Soil samples and their N-P-K availability during 2017under zero tillage in Athota and surrounding villages of Guntur district, A.P.

Villages	P^H	E.C	O.C.	N	P	K
Athota	7.83	0.72	0.09	211.46	17.82	356.64
Siripuram	8.05	0.57	0.67	308.89	29.01	492.66
Nelapadu	8.38	0.83	1.34	265.13	27.62	441.34
Kolakaluru	8.32	0.75	0.55	273.13	9.51	502.86
Nandivelugu	8.36	0.68	0.67	263.32	19.74	418.60

4. Entreprenuership based module for Sorghum and other millets:

4.a) Capacity building of the sorghum farmers: Interactions with the farmers during the awareness programmes carried out in the NABARD Project on15 November, 2017 at Attota village of Guntur district.Organized farmers' awareness programme on cultivation of millets cultivation, production and utilization in Nelapadu village on 15 March, 2018 (Fig 5).The above events were published in all local newspapers and telecasted in Etv *Telugu* channel.

4.b)National Crop Seminar on "Entrepreneurship

Fig.8*. Exposure visit on 2 April 18 (5.00 pm) at Manchala village*

Development For Millet Products" was organized on 17March 2018 at Bapatla Engineering College. The seminar was hosted by the Bapatla College of Pharmacy. The major thrust being an awareness creation activity in the NABARD sponsored Project, was an attempt to inculcate a 'Start Up' culture among local graduates, post graduates, local entrepreneurs and farmers. Three technical sessions and one exhibition organized during the day.Exposed the students, local entrepreneurs and farmers to various millets, nutritional benefits, production / value added technologies, millet based ready to eat and ready to cook products and 'start up' secrets. In this event about 400 delegates participated and made the event grand success.Speakers from various institutions included ICAR-Indian Institute of Millets Research, Hyderabad, Home Science College, ANGRAgriculturalUniversity, AP, Bapatla Engineering College, Food Science and Technology College, ANGRAU; MSME Development Institute, Health Sutra, Department of Agriculture, Andhra Pradesh and Sheep Breeding Farm. The graduate and post graduate students mainly were from Pharmacy College, Agricultural College, Bapatla, Agricultural Engineering college, Bapatla and Food Science and Technology, ANGRAU, Bapatla. Two technical sessions mainly covered topics related to Millet crops

Fig 7*. Eenadu Press coverage about the national crop seminar on "Entrepreneurship development for millet products" organized on 17-03-2018 at Bapatla, Guntur.*

their nutritional value and production systems, while one session was dedicated to Entrepreneurial development and start up related initiatives. Millet food products were displayed in exhibition session (Figs 6 & 7).**4.c)**

Exposure Visits: Exposure visits for key Farmers were organized at Nanduru and Manchala villages of Guntur district on 2nd April, 2018sorghum cultivation in rice fallows of Krishna Basin of Andhra Pradesh. High yielding dual purpose cultivars, namely, CSH 14, CSH 16, CSH 25 and CSH 30 were recommended to the farmers. Farmers preferred to cultivate yellow sorghum cultivars and showed
a lot of interest to Indian Institute of Millets Research Institute, Hyderabad due to the seed quality and grain

Fig.9*. IIMR Scientist addressing the farmers about the millets cultivation on 2 April18 (11.00 am) at Nanduru village*

yield and earlier Front Line Demonstrations, yield potentials of sorghum and entrepreneurship development for millet products. were participated and made the event grand success (Figs 8 & 9).
B.Subbarayudu suggested the Integrated Pest Management methods to control insect pests of

Fig 6*. Delegates participation during national crop seminar on "Entrepreneurship development for millet products" on 17-03-2018 at Bapatla.*

sorghum and thereby to obtain the high grain and fodder yields. He also addressed the importance of sorghum its nutritional value and the need for soil analysis of farmers fields,the value addition thereby to double the farmer's income. The said information was published in the daily newspapers viz.*; Eenadu, Vaartha and Andhra Jyothi* on 03 April,2018. In this event the food products of sorghum grain, namely, sorghum biscuits, multigrain Atta, flakes, Kichidi rawa, flour, rawa, pasta, vermicelli etc. were popularized and displayed.*Dwakra Mahila* groups are interested to start entrepreneurships/ Start Ups in both the villages. It has been observed that farmers are interested to cultivate sorghum cultivars with short or medium height cultivars with high grain yield potential in rice fallows under zero tillage situation. They also said to the scientists that they need high yielding seeds of sorghum in the coming years in a big way (Fig.10)..

చిరుధాన్యాల సాగు వైపు దృష్టి పెట్టాలి

శాస్త్రవేత్త సుబ్బారాయుడు

Fig 10: *Exposure visits for key farmers exposure meeting organized at Nanduru village of Guntur District published on 03-04-2018 in Andhra Jyothi daily news Paper.*

4.d) Promoting house hold level of consumption by setting up decentralized processing facilities:
Jowar Roti Making Machine (Portable) given to the Dwakra Mahila group on 22 April, 2018 at Nanduru village of Ponnur taluka, Guntur Dist., by Indian Institute of Millets Research, Hyderabad to implement for nourishing with nutri-rich millets by mitigating hidden hunger of villagers thereby improving their health and selling excess value-added products through marketing. This machine also ultimately helps in doubling farmer's income (Fig.11).

Figure 11. Jowar Roti making machine given to Dwakra Mahila Group at Nanduru village on 22 April 18.

4.e)Launching of millets processing centre:
Millets processing equipment comprising of Grader, Aspirator, De-stoner, dehuller and Millet Roaster were installed at Bapatla Pharmacy college, Bapatla, Guntur district of Andhra Pradesh on 17th December 2018. Sorghum and millet growers of Guntur district are acquintted with thisprocessing unit and utilising this centre.

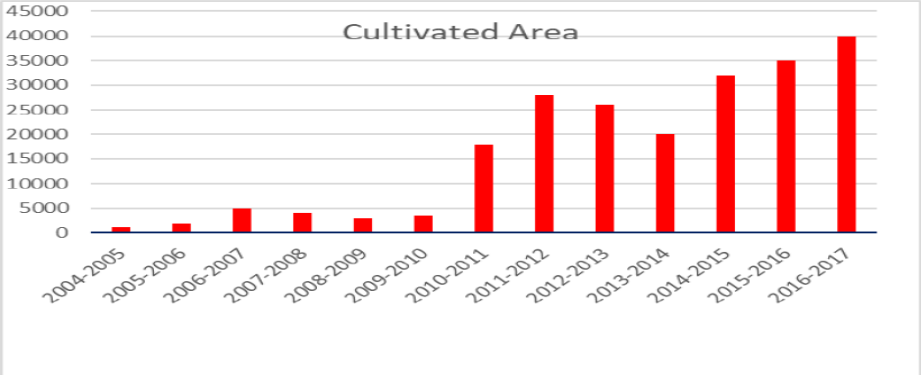

Fig.12.Area of Sorghum in rice-fallows of Guntur Dt., Andhra Pradesh

In the present investigation findings on cultivation of high yielding dual purpose great millet cultivars farmers obtained grian yields in rice fallows under zero tillage situation in Guntur district, Krishna basin of Andhra Pradesh was 5 tonnes/ha are in confirmity with that of Mishra et al. 2011 and Subbarayudu et al. 2011.Overall, the above interventions resulted in enhancement of sorghum grain yield from 2 tonnes/ ha to 5 tonnes/ha and their knowledge and skill development on sorghum and other millets cultivation, production and their utilization was also increased. The sorghum cultivation in rice fallows was 1000 ha (2004) and increased to 40000 ha (2017) in Guntur district of Andhra Pradesh (Fig.12) (Source : Depatment of Agriculture, Andhra Pradesh State Government).Therefore,in Krishna basin of Andhra Pradesh in zero tillage situation, farmers got bumper grain yields to the tune of 5 times more against the national (India) average of one tonne/ha, thereby they got the farm profit of Rs.70,000/ ha by investment of Rs.35000/ha (C: B = 1 : 2).

Acknowledgements: The Author is thankful to Dr Vilas A Tonapi, Directorand Dr S Ravi Kumar,ICAR-Indian Institute of Millets Research, Hyderabad. Thanks are also to NABARD for providing the funds and support to implement the project interventions.Thanks to ANGRAU, Department of Agriculture, Andhra Pradesh, NGOs, farmers, Bapatla Education Society, press and media of Guntur dist. associated in popularisng sorghum cultivation thereby causing profit to farmers in rice fallows in zero tillage situation, etc.

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