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ADVANCES IN RICE IPM - INDIAN SCENARIO

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India has the largest area under rice in the world and is grown in extremely diverse environments. Of the 42 million ha of rice area, about 42% is under irrigated ecosystem, 35.5% rain fed lowland, 16.8% rainfed upland and 5.7% is flood-prone/ deep water ecosystem. Rice was grown in an area of 42.6 million hectares with a production of 104.80 million tonnes during 2014-15 (Directorate of Economics and statistics, DAC, GOI - http://eands.dacnet.nic.in/). In order to meet the growing demand of the ever increasing population, we need to produce 156 million tonnes of rice by 2030. But the rice production is limited by both abiotic and biotic stresses of which insect pests alone cause about 25% losses amounting to Rs. 2,40,138 (Two lakhs forty thousand and one hundred and thirty eight million rupees) (Dhaliwal *et al.* 2010). Over 100 species of insects have been reported to attack and feed rice crop from nursery to maturity and also in storage. The tropical warm and humid climate prevalent in the country particularly in the rice ecosystem is highly favourable for their multiplication. The insect pests of rice in India are categorized into 3 major groups as follows:

1) Insect pests of National significance - include major pests like planthoppers, stem borers, gall midge, leaf folder and gundhi bug.
2) Insect pests of Regional significance - include significant pests confined to some regions like rice hispa, caseworm, thrips, mealybug, cutworm and swarming caterpillar.
3) Emerging pests - include pests that are gaining momentum and have the potential to become major pests under favourable conditions. They are black bug, blue beetle and panicle mite.

Insect pest scenario in rice – present status

Since the green revolution period, consistent rice cultivation and its intensification has provided constant niches for pest multiplication and non-judicious use of insecticides that resulted in pest resistance to insecticides, resurgence of pests and secondary pest out breaks.

The most dramatic effects of these modern cultural practices was seen in the case of planthoppers which were relegated to minor pest status in early 80's after the development of tolerant varieties. But in the last two decades, the pest has regained the major status and outbreaks of brown planthopper and whitebacked planthopper have caused widespread impact in many parts of India. They have become a serious concern spreading to non-traditional areas in Northern part of India viz., Punjab, Haryana and parts of Uttar Pradesh. Imbalanced nutrient management and development of insecticide resistance have led to frequent upsurge in South Indian States like Karnataka, Andhra Pradesh and Telangana.

Yellow stem borer is widespread and dominant across the rice ecosystems. In the last two decades, multilocation monitoring studies under AICRIP have revealed geographical variation in its species composition with occurrence of five species viz., yellow stem borer, pink stem borer, white stem borer, dark headed borer, and striped stem borer across the country. Pink stem borer and white stem borer species have made inroads in hill regions, parts of Punjab and Haryana in northern India and Kerala in southern region (DRR progress reports 2005–2014).

Despite the development of resistant varieties, rice gall midge has displayed a broad range of genetic variability resulting in variable reaction of certain cultivars in different geographic areas. It is now a wide-spread pest with six biotypes, causing serious losses in new areas like Bihar and North Eastern state of Manipur in addition to traditional areas of Orissa, Andhra Pradesh, Madhya Pradesh and Kerala (Bentur *et al.* 2003).

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Leaf folder is another pest hitherto of minor significance but which has now assumed major pest status in the entire country particularly in areas of high fertilizer input use. This pest has three species reported so far viz., *Cnaphalocrocis medinalis Guenee, Marasmia patnalis Bradley and Brachmia arotraea, of which C. medinalis* is dominant and wide spread (DRR progress report, 2009-2013; Padmavathi *et al.* 2015).

There are also other pests of regional significance and emerging pests that are causing significant yield losses at various locations.

Multilocation studies on insect monitoring under AICRIP revealed that the number of insect pests considered important has risen from 3 to 19 during 1965 to 2015 with planthoppers becoming a serious concern across the country (Fig.1).

economically unacceptable damage or loss (FAO). It is an ecologically based strategy that focuses on long term solution of pests through a combination of techniques such as use of resistant varieties, biological control, modification of agronomic practices and habitat manipulation (Fig. 2). Pesticides are carefully selected and applied to minimize the risks to the human health, beneficial and non target organisms and environment.

In the present context, the old school of thought of treating IPM as a separate entity is now being replaced by the new paradigm of it being an integral component of Integrated Crop Management (ICM). ICM is based on a good understanding of the interactions between biology, environment and land management systems. Also, holistically speaking, ICM is subsumed into the broader concept of farming

Fig. 1. Changing insect pest scenario in rice

IPM AND ITS COMPONENTS

IPM is defined as a decision support system for the selection and use of pest control tactics, singly or harmoniously coordinated into a management strategy, based on cost/benefit analyses that take into account the interests of and impacts on producers, society, and the environment (Kogan, 1998). Integrated Pest Management is a system that, in the context of the associated environment and the population dynamics of the pest species, utilizes all suitable techniques and methods in as compatible a manner as possible and maintains the pest populations at levels below those causing

system management (Fig.3). Focusing on IPM itself, it is not only about managing 'pests' but also pesticides, parasitoids, predators, pathogens and most important of all people directly linked to decision making in farming.

Concerted efforts have been made in the last two decades to develop and implement location specific integrated pest management strategies across the diverse ecosystems in rice (Pasalu *et al.*, 2004; Gururaj Katti et al, 2010). The effectiveness of IPM in rice has been proved beyond doubt, however, the latest motive trend is to maximize the use of eco-friendly components within the framework of IPM and

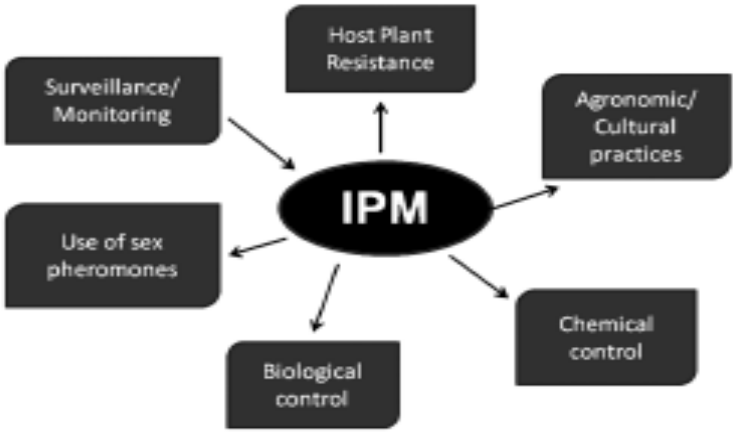

Fig. 2. Major components of IPM

minimize or if possible, eliminate the use of toxic chemicals, for long lasting economic, ecological and social benefits to farmers. Concomitantly, recent developments in scientific research related to biotechnology and other fields, technological innovations and new pesticide delivery systems as well as changes in markets and the policy environment offer new opportunities for reducing dependency on chemical pesticides and evolution of a holistic IPM for sustainable rice production.

Rice plant is able to compensate low levels of pest damage without inflicting economic loss. Only when the infestation reaches certain level, it results in economic yield losses. Thresholds vary with the pest and stage of the crop and must be closely monitored by the producer (Table 1).

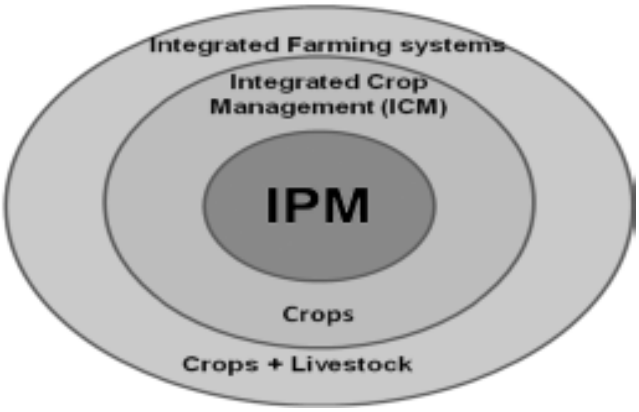

Fig. 3. Relationship between IPM and ICM

Table 1. Economic threshold levels of major insect pests

Insect Pest	Economic thresholds
Yellow stem borer	10% DH (or) 1 egg mass or 1 moth/m^2 (or) 30-35 adult male moths/pheromone trap/week
Gall midge	5% SS (at active tillering stage)
Brown planthopper & Whitebacked planthopper	10 insects per hill at vegetative stage and 20 insects/hill at later stages
Green leaf hopper	2 insects/hill in tungro endemic areas; 20 – 30 insects/ hill in other areas
Leaffolder	3 damaged leaves /hill (post active tillering stage)
Gundhi bug	1 nymph/adult per hill

In rice IPM, more emphasis is given for preventive measures and also crop production methods so as to avoid the occurrence of pest damage/ incidence (Table 2). Important among them are given in table below:

Table 2. Recommended IPM practices to avoid pest occurrence in rice

S.No	Strategy	Practice	Pest (s) affected
1.	Avoidance of pest incidence by making the crop unavailable to pest in space and time	Alteration of time of planting or harvesting based on knowledge about pest biology and behavior	Incidence of planthoppers, stem borers, gall midge can be avoided by early and synchronous planting or growing short duration varieties will reduce plant hopper incidence. By synchronous harvesting, diapausing larvae/ pupae of stem borers could be destroyed.
2.	Pest monitoring	Pheromone traps with 5 mg lure @ 8 traps acre $^{-1}$ can be used for monitoring of yellow stem borer (Krishnaiah *et al.* 2004).	Yellow stem borer
3.	Alter the crops susceptibility to pests	Development of pest resistant or tolerant varieties (Shobha Rani *et al.* 2008)	List is given in Table 5
4.	Preventing the carryover of pests from nursery to main field	Cutting the tips of leaf blades after removing seedlings from nursery for transplanting in the main field.	Egg masses of stem borer, hispa and leaf folder, if any, on the leaf tips will get removed.
5.	Field sanitation/ Clean cultivation	Removal of weeds which act as alternative hosts for major pests.	Gall midge, leaf folders, hispa and thrips
6.	Application of green manures/ organic materials	Application of vermicompost, neem cake and poultry manure lowered the pest incidence (Gururaj Katti *et al.* 2006). These also help in maintaining soil health and soil fertility.	Application of high level of organic matter leads to higher populations of detrivorous and plankton feeders and also higher populations of predators - both below and above the water.
7.	Water management	Maintenance of water in the field at saturation level and not flooding or draining excess water.	Draining field or maintaining water at saturation reduces the incidence of plant hoppers and case worm.
8.	Provide perching sites	Installation of bamboo perches of 2-3 ft height in the field @ 15 to 20 per acre at vegetative stage serve as resting/ landing sites for birds	Birds land/ rest on the perches provided and feed on the larvae that are found in the field/ in the soil before they could cause economic damage (Settle *et al.* 1996)

The following are some of the curative methods that are usually recommended after the incidence of the pest to reduce their further multiplication and spread (Table 3).

Table 3. IPM strategies to reduce further spread & multiplication of the rice pests

S.No	Strategy/ practice
1.	*Inundative release of egg parasitoids*: Release of *Trichogramma japonicum* adults against yellow stem borer and *Trichogramm chilonis* against leaffolder. Releases are made five to six times @ 1,00,000 ha^{-1} starting from 15 days after transplanting. Tricho cards containing 1000 parasitised eggs are stapled to the underside of leaves at 100 points uniformly distributed across 1 hectare area. These releases help in the supplementation of already existing natural populations of these parasitoids and thus increases the per cent parasitism. (Bentur *et al.* 1994; Gururaj Katti *et al.* 2001).
2.	*Mating disruption* - A hand applied controlled release formulation, Selibate YSB® with a blend of pheromone components in 1:3 ratio at an application rate of 40 g AI per hectare per season @ 20 traps was used for mating disruption of yellow stem borer (Cork *et al.* 2003). Yellow stem borer damage was greatly reduced due to the continuous release of pheromone for about 100 days that gave protection for the whole crop growth period.
3.	*Use of plant origin chemicals like neem* - Neem formulations (both commercial and farm made oil based formulations) were sprayed at 2% concentration and found moderately effective against stem borer, planthoppers, hispa and leaf folder (Krishnaiah, 2000, Gururaj Katti *et al.* 2005).
4.	*Use of microbials like fungal pathogens* - Fungal pathogens such as *Beauveria bassiana* was found effective against rice hispa (Hazarika and Puzari, 1997). Similarly *Pandora delphacis* was proved very effective against BPH (Narayanasamy, 1995).
5.	*Use of decomposing crabs to control rice bugs:* This is one of the most widely used traditional pest management practice. As the filling of paddy grain starts, locally available crabs are smashed and put on pointed bamboo sticks in terraced paddy fields. A modified technique of using a crab of 2.5 x 3 cm size as bait, 80 - 85 bugs can be trapped per 5 m2 in five days (Bikramjit Sinha *et al.* 2007).

RECENT ADVANCES IN INSECT PEST MANAGEMENT IN RICE

1) E-Pest Surveillance

Few years back, a novel scientific approach to pest surveillance based on real time web based monitoring system of **e-surveillance** using tools of information and communication technology was developed to monitor the swarming caterpillar populations in rice in 13 districts of Odisha. Data on pest infestation collected through scouts along with other generated data related to soil and plant factors is utilized for developing Geographical information system (GIS) maps and correlating effect of weather parameters with pest population dynamics. Based on this information advise was given to farmers so that appropriate pest management measures could be initiated (Fig. 4). The long term data will be helpful for developing pest forecasting models of major pests.

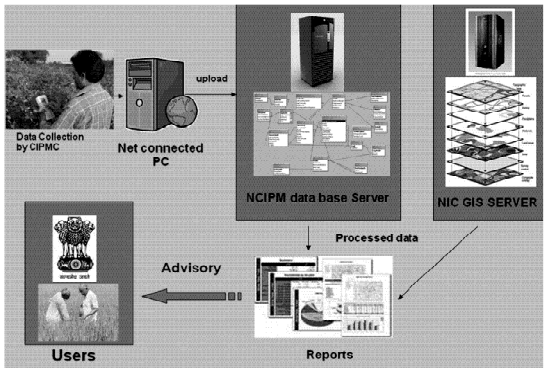

Fig. 4 National e-Pest Surveillance Project

2) Pest forecasting using degree day (DD) models

Temperature is the most critical abiotic factor that exerts profound influence on the development of insects. Insects require certain amount of heat units (degree days) to develop from one life stage to the other. Temperature thresholds and thermal constants are potential indicators of the distribution and abundance. The accumulated degree days (ADD) form the base for developing phenology model to predict populations of pests in the field. Under NAIP project (NAIP C2046), efforts were made to develop phenology based degree day model for leaf folder and planthoppers. (Padmavathi *et al*, 2013). Presently these models are under validation (Fig.5). These models will help the farmer in timing the interventions more effectively.

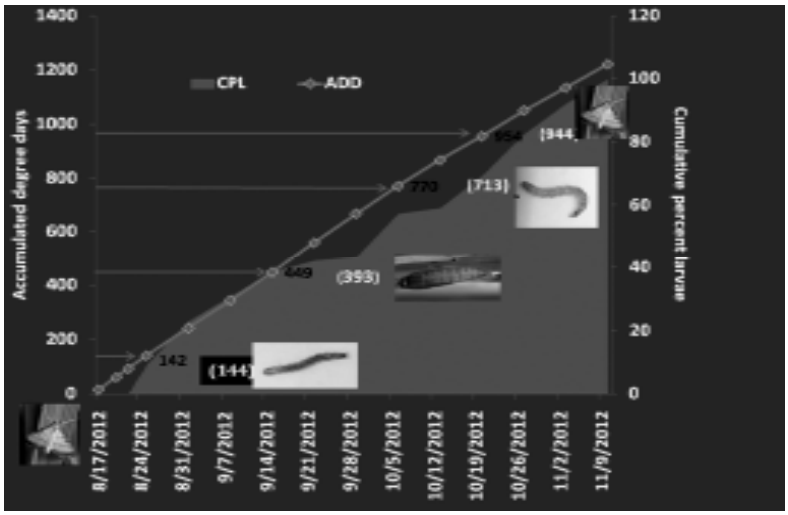

Fig. 5. Phenology based degree day model to forecast rice leaf folder (Padmavathi *et al.* 2014)

Based on daily minimum and maximum temperature recordings of a location, lower and upper threshold temperatures of 11.2 °C and 36.4 °C, accumulated degree days (ADD) required for the development of rice leaffolder from egg to adult was calculated as 445. Using these heat units (DD), development of different stages of rice leaffolder in the field was predicted to advise farmers for their effective management.

3) Hyperspectral radiometry technique for assessment of pest damage

Monitoring of pest damage is generally undertaken by scouts through regular field surveys which are labour intensive, time consuming and also error prone. Radiometry is a reliable alternate and accurate remote sensing technique for potential area-wide assessment of plant health. Characterization of reflectance spectra of pest damage by using known damage levels and specific narrow bands sensitive to the degree of stress were identified. Based on the assumption that stresses interfere with photosynthesis and physical structure of the plants and affect absorption of light energy and reflectance spectrum of plants, hyperspectral remote sensing was found to be able to identify different stresses. Hence, attempts were made to identify spectral characteristics of leaf folder and brown planthopper damage and these were validated using remote sensing data (Padmavathi *et al*, 2014). Field based reflectance studies using hyperspectral radiometer at different damaged fields could distinguish the leaf folder damage levels in visible and NIR regions (Fig. 6).

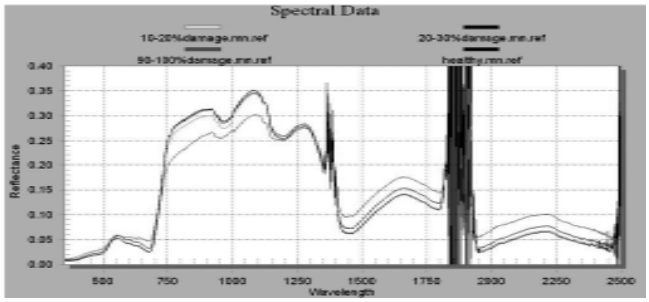

Fig. 6. Spectral reflectance of rice leaf folder damage (Kaul, Haryana)

Remote microscopy diagnosis (RMD) is another new platform which can be a basis for innovative surveillance for rice pests.

4) Host plant Resistance (HPR)

Due to changing pest scenario and frequent situations of two or three pests occurring simultaneously in rice, in recent times the need for developing varieties resistant to multiple stresses has been increasingly felt. Multiple pest resistant varieties such as, Suraksha, Vikramarya, Shaktiman, Rasmi, Daya have already been released for general cultivation in states like Andhra Pradesh, Odisha, West Bengal, Kerala and Madhya Pradesh.

Further, the modern versatile tool of biotechnology has enough potential to overcome some of the inherent problems in conventional resistance breeding. Incorporation of novel genes like cry 1A(b) and cry 1A (c) from suitable *Bacillus thuringiensis* strains into commercial rice varieties for resistance to yellow stem borer is already in advanced stage of testing in India (http://www.i-sis.org.uk/GMRII.php?printing=yes) Improvements in plant transformation methods and availability of plasmid vectors containing multiple gene constructs have enabled the expression of multiple toxins in transgenic plant varieties through gene stacking. Exploitation of lectin genes to confer insect resistance in transgenic plants to hemipteran plant pests not affected by known Bt toxins is also a potential alternative.

Utilization of genetic markers and marker-aided selection is another important area for exploitation and DNA marker technology has helped to tag and map several major resistance genes conferring resistance against hopper pests and gall midge (Sundaram *et al.* 2014).

Other novel biotechnological approaches include utilizing new insecticidal proteins such as *Photorhabdus luminescens* proteins, avidins, bacterial cholesterol oxidase and engineering metabolism of plant defensive and communication compounds. Disrupting gene function by the use of RNAi is another well-established technique in insect genetics based on delivery by injection into insect cells or tissues (Kola *et al.* 2015).

5) Cultural Control

In resource poor situations, cultural practices offer good scope for manipulation to indirectly suppress pest populations particularly in rainfed rice. **Integrated nutrient management** helps to maintain the insect populations and prevents them from increasing to 'pest' level by strengthening plant health,

Table 5. List of Varieties identified as resistant to insect pests in rice

Insect pest	Released varieties
1. Gall midge	Sneha, Pothana, Kakatiya Erramallelu, Kavya, Rajendradhan 202, Karna, Ruchi, Samridhi, Usha, Asha, MDU 3, Bhuban, Samalei, Orugallu, Abhaya, Shakti, Suraksha, Daya, Pratap, Udaya, IR 36, Shaktiman, Tara, Kshira, Sarasa, Neela, Lalat, Phalguna, Mahaveer, Vibhava, Divya, Dhanya Lakshmi, Surekha, Vikram, Kunti, Triguna, Sita, Samleswari, Karma Mahsuri, Dhanarasi, Mahamaya, Jyothi
2. Brown Planthopper	Chaitanya, Krishnaveni, Vajram, Pratibha, Makom, Pavizham, Manasarovar, Co-42, Chandana, Nagarjuna, Sonasali, Rasmi, Jyothi, Bhadra, Neela Annanga, Daya, Aruna, Kanaka, Remya, Bharatidasan, Karthika, Vijeta, Cotton Dora Sannalu, KRH2, PA6201, Hybrid 6129, ADT37
3. White backed planthopper	HKR120, Latha,Narendra 2002, Jitendra, Satyaranjan, HKR 126
4. Green Leafhopper	Vikramarya, Lalat, Khaira, Nidhi. GR12, Gr103, Birsa dhan 108, Birsa Dhan 104, Prakash, CoRH1

which also obviates the need for pesticide use. Splitting nitrogen application and using **slow release forms of N fertilizers** help to meet the dual goal of higher yields and lower pest incidence. Cultural practices are not only eco-friendly but also offer direct benefits to the farmer in pest suppression at no additional cost. In the present day Precision farming context, intensive grid-sampled information obtained by GIS and global positioning system (GPS) is very useful for precision in nutrient application and management with beneficial implications for IPM.

Habitat management is a very promising bio-intensive option in rice IPM. Attempts to modify rice habitat by employing Pusa Basmati variety as "**Trap crop**" for the management of yellow stem borer have been successful (Padmakumari *et al.* 2006 - Fig. 7).

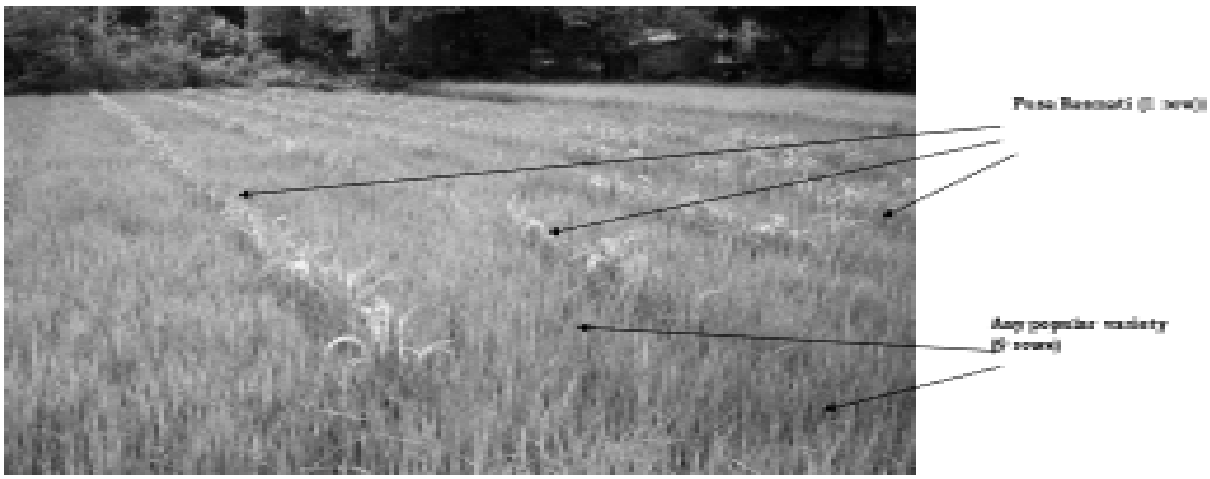

Fig. 7. Trap crop for yellow stem borer management

Of late, organic rice based farming systems have come into focus due to devastating consequences resulting from over reliance on chemical input intensive rice cropping systems (Surekha *et al.* 2011). However, any additional commercial or general environmental benefits arising out from organic rice need to be weighed against existing benefits from chemical based rice farming to the farmers and public.

6) Biological Control

The rich and diverse wealth of biological agents such as predators, parasitoids and insect pathogens and their natural *in situ* interactions in rice ecosystems can be exploited as key component of IPM. Development of **pesticide resistant strains of natural enemies** for inundative releases has contributed to strengthening eco friendly rice IPM (Jalali *et al.* 2006). Increased attention is also being given for the implementation of IPM in rice with specific thrust on the conservation of natural enemies. In this regard, **Farmers Field Schools (FFS) approach** has promising futuristic implications of safety to environment.

Ecological engineering is a novel concept which is gaining popularity among biocontrol advocates. It involves planting of beneficial plant species with nectar-rich flowers that can attract and provide food resources to a wide variety of natural enemies of pests such as parasitoids and predators (Fig.18). Such plants meet the dietary sugar needs of the parasitoids and predators which is important in increasing their longevity and fecundity. Flower species that meet the needs of natural enemies, while denying benefit to pests should be selected based on crop characteristics, key pest and the natural enemies that can be enhanced by habitat manipulation. Shanker *et al.* 2013 studied the diversity of natural enemies harboured by flowering forbs on rice field bunds. Many flowering plants on bunds such as *Ageratum conozoides, Acmella uliginosa*, *Eclipta alba* and *Tridax procumbens* of the family Compositae were found to harbour natural enemies that are beneficial to rice. The longevity of parasitoids was also enhanced by floral diversity in rice fields (Shanker *et al.* 2014). The technique is being validated in multi location across the country under AICRIP. Similarly parasitsation of planthopper eggs (Shanker et al. 2012) and stem borer egg masses (Shanker *et al.* 2015) increased in fields with a flower border.

Fig. 8. Ecological engineering in farmer's field at Nalgonda, Telangana, India

Similarly, **Agro-ecosystem analysis**, a holistic soil and plant health approach involving careful planning, surveillance and monitoring of the crop condition throughout will also be an essential feature of rice IPM in future.

7) Chemical control

Chemical control with its curative effects and ease of application continues to be an important, if not sole, choice of the farmers for managing insect pest populations in rice. In the last few years, newer environment friendly chemicals with novel modes of action and effectiveness at very low doses have fitted well into rice IPM programmes (Table 6). **Use of biopesticides and botanical pesticides** though advocated as environment friendly component of IPM, has limited value because of their moderate efficacy against rice pests.

Of late, role of indigenous technical knowhow's (ITKs) looks quite promising with their low cost, suitability to local environment as well as ready availability at farmers' level for use.

For an effectiveness of chemical control strategy, the correct choice of active ingredient, suitable formulation and application techniques need to be made on the basis of pest biology and crop phenology. **Nano-pesticides or Nano-encapsulated pesticides** are the potential options for targeted delivery of precise quantity of pesticides.

8) IPM dissemination

The dissemination of IPM information is also a key element in the overall role of IPM process in sustainable rice production. Since modern IPM involves knowledge loaded and technology intensive solutions, **information and communication technology (ICT) tool** should be fully exploited to make it user friendly for the farmers. In addition to CD-ROMS, manuals and videos, new ICTs such as mobile phones and internet associated applications should be utilized in the experiential learning processes such as participatory farm research and farmers field schools to speedily connect the farmer clientele to IPM technology.

Future Prospects

Improvements in Integrated Pest Management (IPM) can lead to sound crop health management programs that contribute to resolving the unprecedented challenge of food security, particularly in the wider contexts of climate change, trade globalization, environmental protection, and poverty alleviation. By bringing technology to farmers, IPM has been instrumental in increasing agricultural productivity and sustainability and reducing pesticide misuse in the developing world. IPM implementation at farmers' level involves certain skills and knowledge that help in identification of pest and also their susceptible stages for effective management. IPM options also need to be refined at individual farm level keeping in view the availability and feasibility of farmers. Hence, participatory approach is essential in IPM implementation.

There is a dire need for research to be strengthened so as to improve established IPM methodologies while simultaneously making use of novel methods, such as pest risk assessment, crop modeling, precision agriculture, biotechnology, remote sensing, insect forecasting and decision support systems.

Table 6. Recommended insecticides for the management of rice pests

Stage of the crop	Target insect pests	Recommended insecticides
Nursery	Stem borer, gall midge, thrips	Apply Carbofuran 3G @ 33 kg ha^{-1} (or) phorate 10 G @ 12.5 kg ha^{-1} (or) fipronil 0.3G @ 33 kg ha^{-1} of nursery, 5 to 7 days before pulling the seedlings for transplanting.
Planting to Panicle initiation stage	Stem borer	Apply Cartap 4G @ 25 kg ha^{-1} (or) rynaxypyr 0.4G @ 10 kg ha^{-1} (or) carbofuran 3G @ 25 kg ha^{-1} (or) fipronil 0.3 G @ 25 kg ha^{-1} (or) spray cartap hydrochloride 50 WP/SP @ 1000 g ha^{-1} (or) rynaxypyr 20 SC @ 150 ml ha^{-1} (or) monocrotophos 36 WSC @ 1100 ml ha^{-1}(or)chlorpyriphos 20 EC @ 2000 ml ha^{-1} (or) triazophos40 EC @ 1250 ml ha^{-1}
	Gall midge	Apply carbofuran 3G @ 25 kg ha^{-1} (or) phorate 10 G @ 10 kg ha^{-1} (or) fipronil 0.3 G @ 25 kg ha^{-1}
	Leaf folder	Spray cartap hydrochloride 50 WP/SP @ 1000 g ha^{-1} (or) rynaxypyr 20 SC @ 150 ml ha^{-1} (or) monocrotophos 36 WSC @ 1100 ml ha^{-1}(or) chlorpyriphos 20 EC @ 2000 ml ha^{-1} (or) triazophos 40 EC @ 1250 ml ha^{-1}
	Hispa	Spray triazophos 40 EC @ 400 ml ha^{-1} (or) quinalphos 25 EC @ 1200 ml ha^{-1} (or) chlorpyriphos 20 EC @ 1500 ml ha^{-1} (or) monocrotophos 36 WSC @ 850 ml ha^{-1}
	Case Worm	Drain water from the field and spray monocrotophos 36 WSC @ 850 ml ha^{-1}(or)quinalphos 25 EC @ 1200 ml ha^{-1} (or) carbaryl 50 WP @ 900 g ha^{-1}.
Panicle initiation to booting	Stem borer	Spray cartap hydrochloride 50 WP/SP @ 1000 g ha^{-1} (or) rynaxypyr 20 SC @ 150 ml $ha.^{-1}$ (or) monocrotophos 36 WSC @ 1100 ml ha^{-1} (or) chlorpyriphos 20 EC @ 2000 ml ha^{-1} (or) acephate 75 SP @ 950 g ha^{-1}
	Brown planthopper & White backed planthopper	Spray buprofezin 20 SC @1000 ml ha^{-1} (or) dinotefuran 20 SG @ 200 g ha^{-1} (or) imidacloprid 200 SL @ 125 ml ha^{-1} (or) thiamethoxam 25 WG @ 100 g ha^{-1} (or) clothianidin 50 WDG 30 g ha^{-1} (or) ethofenprox 10 EC @ 500 ml ha^{-1} (or) monocrotophos 36 WSC @ 850 ml ha^{-1} (or) BPMC 50 EC @ 600 ml ha^{-1} (or) acephate 50 WP @ 950 g ha^{-1}
	Leaf folder	Spray cartap hydrochloride 50 WP/SP @ 1000 g ha^{-1} (or) rynaxypyr 20 SC @ 150 ml ha^{-1} (or) monocrotophos 36 WSC @ 1100 ml ha^{-1} (or) chlorpyriphos 20 EC @ 2000 ml ha^{-1} (or) triazophos 40 EC @ 1250 ml ha^{-1}
	Brown planthopper & White backed planthopper	Spray buprofezin 20 SC @1000 ml ha^{-1} (or) dinotefuran 20 SG @ 200 g ha^{-1} (or) imidacloprid 200 SL @ 125 ml ha^{-1} (or) thiamethoxam 25 WG @ 100 g ha^{-1} (or) clothianidin 50 WDG 30 g ha^{-1} (or) ethofenprox 10 EC @ 500 ml ha^{-1} (or) monocrotophos 36 WSC @ 850 ml ha^{-1} (or) BPMC 50 EC @ 600 ml ha^{-1} (or) acephate 50 WP @ 950 g ha^{-1}. Repeat application if hopper population persists beyond a week after application. Alternate the recommended insecticides. While spraying, nozzle should be directed at the basal portion of the plants. Application with power sprayer is preferable.
	Gundhi bug	Spray monocrotophos 36 WSC @ 1500 ml ha^{-1} (or) carbaryl 50 WP @ 1500 g ha^{-1}during afternoon hours.

Futuristic IPM has to consider the impact of climate change on population dynamics and distribution of rice insect pests. As pesticides are part of the IPM toolbox for pests, the focus should be on new-generation selective, low-toxicity pesticides, biopesticides, and improved application technologies. Keeping in view the need for food and nutritional security in the country, there is an urgent need to modernize IPM programs and to continually integrate established and new technologies for the improvement of crop, environment and human health.

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SURVEY ON INSECT PESTS, BIOEFFICACY OF CERTAIN INSECTICIDE MOLECULES AGANIST THRIPS ON CAPSICUM (*Capsicum annuum* L. var. grossum Sendt.) UNDER POLY HOUSE CONDITIONS

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ABSTRACT

Fixed plot survey in and around Hyderabad, Telanganarevealed that thrips, Scirtothripsdorsalis Hood, mites, Polyphagotarsonemuslatus Banks cut worm, Agrotisipsilon (Hufn.), blossom midge, Asphondyliacapsici Barnes and fruit borer, Spodopteralitura Fab incidence was recorded under open field conditions where as aphids and whiteflies were recorded in addition to above insect pests under poly house conditions. Bio-efficacy of insecticides against thripsof capsicum, under poly house conditions in the 2013-14 and 2014-15, revealed that mean thrips population in pre count ranged from 1.07 to 4.34 and post count population was lower with spinosad(0.06 thrips/leaf) followed by diafenthiuron (0.50 thrips/leaf) and thiomethoxam (1.30 thrips/leaf) which were significantly superior over untreated check (5.6 thrips/leaf) and at par with each other. The mean Leaf Curl Index (LCI) of two years revealed that, LCI at one DBS (1.25) was significantly reduced to 0.51 in spinosad treated plants followed by diafenthiuron (1.69 to 0.90) and thiomethoxam (1.82 to 1.16). Whereas, LCI was significantly increased from one DBS to 10 DAS in chlorantraniliprole (2.41 to 2.51),flubendiamide (2.43 to 2.55), spiromesifen (2.51 to 2.64) and triazophos (2.53 to 2.72) and untreated check (2.71 to 2.96) The results obtained from the both years of poly house experiment clearly showed that, spinosadwas significantly superior over rest of the treatments and showed lowest mean no. of thrips per leaf (0.06) and mean reduction of thrips population (98.05 %). Next best treatment was diafenthiuron in reducing mean thrips population (0.50) and increased mean per cent reduction of population (72.98 %) followed by thiomethoxam whichshowed significant superiority in reducing mean thrips population (1.30) and moderate mean per cent reduction of thrips population (72.98).

Capsicum (*Capsicum annuum*L. var. grossumSendt), is commonly known as sweet pepper, bell pepper, Shimla mirch or green pepper. They differ from common hot peppers in size and shape of the fruits, capsanthincontent and usage.It has attained a status of high value crop in India in recent years and occupies a unique place among vegetables in Indian cuisine because of its delicious taste and pleasant flavour coupled with rich content of ascorbic acid, vitamins and minerals. In India, 26^0 -28^0 C day and 16^0 -18^0 C night temperatures are ideal for capsicum cultivation under open field conditions. Various biotic (pest and diseases), abiotic (rainfall, temperature, relative humidity and light intensity) and phenologicalfactors (flower and fruit drop) limits the yield and fruit quality under open field conditions (Kumar *et al.* 1996). Among the biotic factors, insect pests reduces the quality of produce and even a small blemish on the fruit will drastically reduce its market value. Butani (1976) reported over 20 insect species on chillies (*Capsicum* spp.) from India of which thrips, *Scirtothripsdorsalis*Hood, mite, *Polyphagotarsonemuslatus*Banks are among the most damaging pests(Ananthakrishnan, 1971, Krishna Kumar, 1995 and Kumar *et al.* 1996), Gall midge, *Asphondyliacapsici* Barens and nematodes, *Meloidogyne incognita* Chitwoodare serious problems on capsicum under protected condition (Barwal, 2004 and Kaur *et al.* 2010). Recently, termites, ants and non insect pests, snails are becoming major pests of capsicum in the open field (Sunitha *et al.* 2007). Due to these challenges, the scenario of capsicum production has been changing significantly. The protected cultivation is getting preference over open field cultivation for off-season quality production by extending availability of the quality produce, higher productivity and improved nutritional attributes of the polyhouse produce. In order to increase the production and quality, reducethe pest incidence to know the pest scenario of capsicum under field conditions and their management is essential, keeping this in view, the present study was carried out.

MATERIAL AND METHODS

1. Survey on insect pests of capsicum

Survey was carried out in and around Hyderabad, Telangana where the capsicum is extensively cultivated. Fixed plot survey was

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conducted in few selected villages of Ranga Reddy district, scattered around Hyderabad and the data was collected from three villages in Chevella, one village in Vikarabad, one village in Shabad mandals of Ranga Reddy, in which capsicum is cultivated under poly house (PH) conditions. In all these five villages, a total of nine poly houses were surveyed. Four villages in Shamshabad mandal were surveyed, in which capsicum is cultivated under open field (OF) conditions (Table 1). During the survey, for collecting data, five spots (1 m^2 each) were selected in each location (one from centre and four from four corners). In each spot five plants were randomly selected and tagged, from which mean population per leaf (sucking pests) and per cent damage per plant (non sucking pests) were recorded. Mean population / per cent damge of each pest from fourteen fortnights per location was calculated and cumulative mean of four open fields and nine poly houses for each pest was reported and discussed. Expected yield loss and insecticide usage pattern were recorded as per centage and cumulative means were reported and discussed.

2. Bio-efficacy of new insecticide molecules against thrips in capsicum

Poly house experiments were conducted at Horticulture Garden, College of Agriculture, Rajendranagar, Hyderabad in Randamized Block Design (RBD) with three replication.The popular capsicum hybrid, Royal Wonder (Seminis Pvt. Ltd) was choosen for the study. Individual plots were formed with size of 9 m^2 (3m X 3 m). Capsicum seeds were sown on 9th August, 2013 and 16th October,2014 in the well prepared raised nursery bed i.e 1 m width and 5 m length.The 30-35 days age seedlings were transplanted in the main field after providing good irrigation. An inter row spacing of 45 cm and intra row spacing of 30 cm was adopted, to maintain optimum plant population in the field. Transplanting was done on 16-09-2013 and 20-11-2014 during first and second year of investigation. Recommended agronomical practices were followed to raise the sound crop in open and poly house conditions. Different groups of chemicals were selected as treatments and the dosages were applied as foliar sprays against the thrips on capsicum. The efficacy of seven insecticides

Table 1. Details of survey locations in and around Hyderabad,Telangana

S.No	Village	Mandal	Code	Open/poly house/Shade Net
1.	Alluru	Chevella	PH-1	Poly house
	Urella		PH-2	Poly house
	Chevella		PH-3	Poly house
	Chevella		PH-4	Poly house
	Chevella		PH-5	Poly house
2.	Vikarabad	Vikarabad	PH-6	Poly house
	Vikarabad		PH-7	Poly house
	Vikarabad		PH-8	Poly house
3.	Nagarguda	Shabad	PH-9	Poly house
4.	Jalpalli	Shamshabad	OF-1	Open field
	Sathamrai		OF-2	Open field
	Shamshabad		OF-3	Open field
	Mekaguda		OF-4	Open field

PH : Poly House, OF : Open Field

viz., spinosad @ 125 ml ha^{-1}, flubendiamide @ 200 ml ha^{-1}, chlorantraniliprole@ 200 ml ha^{-1}, spiromesifen @ 750 ml ha^{-1}, thiomethoxam @150 g ha^{-1} and triazophos @ 1250 ml ha^{-1}along with untreated check were evaluated against the thrips, *Scirtothripsdorsalis*Hood on capsicum. The first spray was applied when the insect population reached economic threshhold levels (ETL) (Thrips, 2 no./leaf, Kumar *et al*. 2007)and second spray was given at 7 days after first spray. A total of three sprays were applied during the entire experimentation in both the seasons. Same procedure was followed to both open field and poly house conditions.Data was recorded from five terminal leaves (2 from top, 2 from middle and 1 from bottom) per plant. Pre count (1 day before spray) and post count (1,3,5 and 7 days after spray) of the insects was recorded by using destructive sampling procedure. Per cent reduction over control was calculated by using the following formula.

$$\text{Per cent reduction over control} = \frac{\text{Post count population in the control - Post count population in the treatment}}{\text{Post count population in the control}} \times 100$$

Pre count (1 DBS) and post count (mean of 1,3,5 and 7 DAS) population and per cent reduction over control were calculated after each spray. Cumulative mean of three sprays in 2013-14 and 2014-15 under open and poly house conditions and pooled mean of two years were represented in tables and discussed for each recorded pests.

Leaf Curl Index (LCI) was recorded one day before and 10 days after each spray following the methodology of Kumar *et al.* (1996).The observations recorded from the open field and poly house were subjected to statistical analysis (RBD) to know the significance of difference among different treatments. The values in percentages were transformed to angular values and values in number were transformed into square root values before analysis (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Survey on insect pests of capsicum

The insect pests, viz., thrips,*S. dorsalis*, mite, *P. latus*, cut worm, *A. ipsilon*,blossom midge, *A. capsiciandfruit* borer, *S. litura* incidence were recorded, whereas, in poly house in addition to the above pests, aphids, *M. persicae*and whiteflies, *B. tabaci* incidence werealso noticed. The cumulative means of insect population and damage caused by the pests underfour open fields and nine poly house conditions are discussed here under (Table 2).

During the crop season of 2013-14, the mean population of thrips (no./leaf)ranged from 9.60+0.47

Table 2. Population and damage levels of insect pests under open field, poly house and shade net conditions of Telangana

	Telangana			
	Open Field		Poly House	
	Mean ± SD		Mean±SD	
	Lower$	Upper$	Lower	Upper
Thrips*	9.60±0.47	12.24±1.2	1.87±0.66	4.99±1.75
Mites *	5.94±0.79	10.64±2.34	1.10±0.65	4.56±1.42
Aphids *	0.00	0.00	0.68±0.77	2.94±2.06
Whiteflies *	0.00	0.00	0.05±0.30	1.13±0.45
Cut worm#	2.12 ± 0.78	5.33 ± 0.56	1.01 ± 0.70	4.04 ± 0.98
Blossom midge #	2.75±0.49	9.26±3.19	0.66±0.59	4.05±1.53
Fruit Borer #	5.26±0.91	17.8±3.89	1.03±0.59	5.42±0.81

*Mean population per leaf/plant, # Per cent damage per plant. $ Lower and upper limit of insect pest population.

to 12.24+1.20 and for mites 5.94 +0.79 to 10.64+2.34, respectively. The per cent damage per plant caused by cut worm, blossom midge and fruit borer ranged from 2.12+ 0.78 to 5.33 + 0.56, 2.75+0.49 to 9.26+3.19 and 5.26+0.91 to 17.8+3.89, respectively under open field conditions. In poly house the mean population ofthrips, mites, aphids and whiteflies ranged from 1.87 +0.66 to 4.99 + 1.75, 1.10 + 0.65 to 4.56 +1.42,0.68 +0.77 to 2.94 +2.06 and 0.05 +0.3 to 1.13 +0.45, respectively.The per cent damage per plant caused by cut worm ranged from1.01+ 0.70 to 4.04 + 0.98,blossom midge,0.66 +0.59 to 4.05 +1.53 and fruit borer,1.03 + 0.59 to 5.42 +0.8181, respectively during crop season.

The incidence of thrips and mites recorded under open field conditions in the present survey is in line with the findings of Manjunatha *et al*. (2001). They stated that maximum thrips count ranged from zero to 7.80 per leaf whileyellow mite counts ranged from zero to 20.40 per leaf. Similar findings were also reported by (Reddy and Kumar 2005) and (Reddy and Kumar 2006), (Sunitha *et al*. 2007), (Manyam and Byadgi 2013) and (Kumar and Gupta 2014). All the above findings confirm the present reports on thrips and mite incidence under open field conditions in Telangana.

Fruit borer was observed damaging the fruits of capsicum during reproductive stage causing maximum per cent damage of 17.8 $\pm$ 3.89 in all the four open fields during the survey period. (Sunitha *et al*. 2007) also reported 20.68 per cent fruit damage at reproductive stage of capsicum in the open field conditions by fruit borer. The present findings are also in line with the observations made by (Nandini *et al*. 2010) who reported up to 12.50 per cent damage caused by *S. litura*.

The over all observations recorded on the pest incidence in capsicum under poly house conditions are in line with the findings of (Sumit *et al*. 2013) who reported the incidence of *T. vaporariorum*, *M. persicae*, *S. litura*, *H. armigera* and *S. dorsolis*in 82 poly houses of Himachal Pradesh. The present survey carried out on fruit boreris in agreement with the findings of (Vos and Frinkling 1998), (Wood *et al*. 1987), (Sunitha *et al*. 2007) and (Nandini *et al*.2010) who recorded 20.00, 20.68, 26.16 and 20.00 per cent damage, respectively by fruit borer on sweet pepper under protected conditions.

The survey carried out in and around Hyderabad on capsicum pests under poly house cultivation revealed that in addition to thrips and mites, aphids and whiteflies were reported on capsicum.

Efficacy of insecticides against thrips, *S.dorsalis* under poly house condition

2013-14: The results on the efficacy of insecticidal treatments during against thrips, *S.dorsalis*in capsicum are presented in Table 3.

The pooled mean of three sprays against thripsshowed significant difference between the treatments in pre count and post count (Table 3). Mean no. of thrips per leaf in pre count ranged from 1.14 to 5.58, whereas,post count was 0.00 to 7.99. Among the insecticides tested against thrips, population was nil in spinosadfollowed by diafenthiuron(0.52 thrips/ leaf) and thiomethoxam (1.65 thrips/leaf) which were at par with each otherand significantly superior over untreated check (7.99 thrips/leaf). Flubendiamide (4.64 thrips/leaf), triazophos(5.42 thrips/leaf), chlorantraniliprole (4.02 thrips/leaf) and spiromesifen (4.30 thrips/leaf) were at par with untreated check.

The mean per cent reduction over untreated check revealed significantly highest mean per cent reduction in spinosad(100.00%) followed by diafenthiuron (90.3%) and thiomethoxam (77.00%), which were at par with each other and significantly superior over untreated check. Other treatments that followed in descending order of efficacy were chlorantraniliprole (51.00%), spiromesifen(47.70 %), flubendiamide (42.30%) and triazophos (34.50%) and were found to be significantly superior over untreated check.

Mean of the three sprays revealed that, LCI at one DBS (1.37) significantly reduced to 0.68 at 10 DAS in spinosadtreated plants. It was followed by diafenthiuron(1.77 to 0.90) and thiomethoxam (1.93 to 1.12), whereasLCI,significantly increased from 1DAS to 10 DAS in chlorantraniliprole (2.56 to 2.64), flubendiamide(2.65 to 2.79), spiromesifen (2.72 to 2.88), triazophos (2.74 to 2.97) and untreated check (2.95 to 3.21) (Table 4.).

2014 -15

Pooled mean of three sprays against thrips under poly house conditions showed significant

difference between the treatments in pre count and post count (Table 4.). Mean no. of thrips per leaf in pre count was 1.07 to3.10, whereas post count was 0.12 to 3.21. Among the insecticides tested against thrips, lowest no. was recorded in spinosad (0.12 thrips/leaf) which was at par with diafenthiuron (0.47thrips/leaf) and thiomethoxam (0.95 thrips/leaf) and were significantly superior over untreated check (3.21 thrips/leaf) and other treatments.The efficacy in descending order was spiromesifen (2.92 thrips/ leaf)>flubendiamide (2.98 thrips/leaf) >triazophos (3.06thrips/leaf) >chlorantraniliprole (3.07 thrips/leaf) which were on par with untreated check (3.21) (Table 4.).

The mean per cent reduction over untreated check revealed that the highest mean per cent reduction in spinosad (96.10%) which was significantly superior over diafenthiuron (84.74%), thiomethoxam (68.97%), spiromesifen (8.83%) flubendiamide (7.12%), chlorantraniliprole (4.12%) andtriazophos (4.40 %) which were found to be significantly superior over untreated check. However, the former three insecticidal treatments were far superior than the remaining treatments.

In 2014-15 also, insecticidal application exhibited significant effect in lowering the intensity of leaf curl index (LCI) caused by thrips, *S.dorsalis*. Mean of the three sprays revealed that, LCI (1.13)at one DBS significantly reduced to 0.33 at 10 DAS in spinosadtreated plants. It was followed by diafenthiuron(1.60 to 0.90) and thiomethoxam (1.71 to 1.20). Whereas, LCI significantly increased from 1DAS to 10 DAS in chlorantraniliprole (2.25 to 2.37), flubendiamide (2.21 to 2.30), spiromesifen (2.30 to 2.39), triazophos (2.31 to 2.47) and untreated check (2.47 to 2.71) (Table 4).

The present findings are in line with (Reddy and Kumar 2006a) who reported the rating for thrips damage (RFTD) on capsicum to be 0.63 to 0.72 under poly house condition at IIHR, Bangaluru.

Pooled mean of 2013 -14 and 2014-15:

The results with regards to overall cumulative mean efficacy of the treatments against thrips, *S.dorsalis* during the two years under poly house conditions are presented in Table 4. Mean thripspopulation in pre count ranged from 1.07 to 4.34 and post count population was lower with spinosad (0.06 thrips/leaf) followed by diafenthiuron (0.50 thrips/ leaf) and thiomethoxam (1.30 thrips/leaf) which were significantly superior over untreated check (5.6 thrips/ leaf) and at par with each other. The descending order of efficacy in the treatments was chlorantraniliprole (3.55 thrips/leaf)>spiromesifen (3.61 thrips/leaf)>flubendiamide (3.81 thrips/leaf) >triazophos (4.24 thrips/leaf) whichwere found to beat par with untreated check (5.60 thrips/leaf).

The percent reduction over untreated checkrevealed that, the highest per cent reduction of thrips population was in spinosad (98.05%) which was significantly superior over other treatments. Diafenthiuron (87.52 %) and thiomethoxam (72.98 %) were next best treatments. The other treatments in the descending order of efficacy were spiromesifen (28.26), chlorantraniliprole (27.56), flubendiamide (24.71) and triazophos (19.45) which were found to be significantly superior overuntreated check.

The mean LCI of two years revealed that, LCI at one DBS (1.25) was significantly reduced to 0.51 in spinosad treated plants followed by diafenthiuron (1.69 to 0.90) and thiomethoxam (1.82 to 1.16). Whereas, LCI was significantly increased from one DBS to 10 DAS in chlorantraniliprole (2.41 to 2.51), flubendiamide (2.43 to 2.55), spiromesifen (2.51 to 2.64) and triazophos (2.53 to 2.72) and untreated check (2.71 to 2.96) (Table 4 and Figure 1).

The results obtained from the both years of poly house experiment clearly showed that, spinosadwas significantly superior over rest of the treatments and showed lowest mean no. of thrips per leaf (0.06) and mean reduction of thrips population (98.05 %). Next best treatment was diafenthiuronin reducing mean thrips population (0.50) and increased mean per cent reduction of population (87.52%) followed bythiomethoxamwhichshowed significant superiority in reducing mean thrips population (1.30) and moderate mean per cent reduction of thrips population (72.98).

Spinosad, a naturally occurring mixture of spinosyn A and spinosyn D, is a secondary metabolite from the aerobic fermentation of *Saccharopoly sporaspinosa*on nutrient media. The superior efficacy is due to the excitation of insect nervous system leading to involuntary muscle contraction, prostration with tremors and paralysis. These effects are

Table 3. Cumulative efficacy of certain insecticide molecules against thrips, *S. dorsalis* on capsicum under poly house conditions after three sprays during 2013-14 and 2014-15

T.No	Treatments	Dose (g or ml ha^{-1})	2013-14			2014-15			Mean of 2013-14 and 2014-15		
			Mean of three sprays#			Mean of three sprays#					
			Pre count (1 DBS)*	Post count (1,3,5,7 DAS mean)*	Per cent Reduction $	Pre count (1 DBS)*	Post count (1,3,5,7 DAS mean)*	Per cent Reduction $	Pre count (1 DBS)*	Post count (1,3,5,7 DAS mean)*	Per cent Reduction $
T_1	Spinosad 45 SC	125	1.14 (1.46)c	0.00 (1.00)c	100.0 (90.00)a	1.07 (1.41)b	0.12 (1.05)b	96.10 (78.57)a	1.07 (1.43)c	0.06 (1.03)c	98.05 (81.94)a
T_2	Flubendiamide 480 SC	200	3.77 (2.18)abc	4.64 (2.37)ab	42.30 (40.55)c	2.92 (1.98)ab	2.98 (1.99)a	7.12 (15.47)de	3.35 (2.08)abc	3.81 (2.19)ab	24.71 (29.79)de
T_3	Chlorantraniliprole 20 SC	200	3.41 (2.10)abc	4.02 (2.24)ab	51.00 (45.55)c	2.99 (1.99)ab	3.07 (2.01)a	4.12 (11.70)e	3.20 (2.04)abc	3.55 (2.13)ab	27.56 (31.65)d
T_4	Diafenthiuron 25 WP	750	1.52 (1.58)bc	0.52 (1.23)c	90.30 (71.82)b	1.39 (1.54)ab	0.47 (1.14)b	84.74 (66.97)b	1.46 (1.56)bc	0.50 (1.22)c	87.52 (69.28)b
T_5	Spiromesifen 22.9SL	750	3.41 (2.10)abc	4.30 (2.30)ab	47.70 (43.66)c	2.90 (1.97)ab	2.92 (1.98)a	8.83 (17.28)d	3.16 (2.04)abc	3.61 (2.14)ab	28.26 (32.10)d
T_6	Thiomethoxam 25 WG	150	2.35 (1.83)abc	1.65 (1.62)bc	77.00 (61.31)b	1.66 (1.63)ab	0.95 (1.39)b	68.97 (56.12)c	2.01 (1.73)abc	1.30 (1.51)bc	72.98 (58.66)c
T_7	Triazophos 40 EC	1250	4.29 (2.30)ab	5.42 (2.53)a	34.5 (35.29)c	3.00 (2.00)ab	3.06 (2.01)a	4.40 (11.55)e	3.65 (2.15)ab	4.24 (2.28)ab	19.45 (25.63)e
T_8	Untreated check	---	5.58 (2.47)a	7.99 (2.91)a	0.00d	3.10 (2.01)a	3.21 (2.07)a	0.00f	4.34 (2.28)a	5.60 (2.47)a	0.00f
		SEm±	0.16	0.17	2.57	0.14	0.1	0.92	0.09	0.16	1.52
		CD (P= 0.05)	0.51	0.54	7.88	0.42	0.31	2.82	0.27	0.51	4.68
		CV (%)	14.58	15.24	9.18	9.96	10.31	14.95	13.82	15.55	16.44

\# No.ofthrips/leaf, mean of five leaves per plant, ten plants per replication, three replications per treatment.

* Figure in the parenthesis are square root transformed values. $ Figure in the parenthesis are Arc-sin transformed values.

DBS : Days Before Spray., DAS : Days After Spray., NS : Non significant

DOS : Istspray: 30-11-2013; IInd Spray:07-12-2013; IIIrd spray: 14-12-2013. ., DMRT : Means followed by a common letter are not significantly different (P= 0.05)

Table 4. Leaf curl index (LCI) caused by thrips, *S. dorsalis* on capsicum under poly house conditions during 2013-14 and 2014-15

T.No	Treatments	Dose (g or ml ha^{-1})	Mean of three sprays 2013-14		Mean of three sprays 2014-15		Mean 2013-14 and 2014-15	
			1 DBS	10 DAS	1 DBS	10 DAS	1 DBS	10 DAS
T_1	Spinosad 45 SC	125	1.37(1.53)*	0.68(1.29)c	1.13(1.49)	0.33(1.15)b	1.25(1.50)	0.51(1.22)b
T_2	Flubendiamide 480 SC	200	2.65(1.91)	2.79(1.94)ab	2.21(1.79)	2.30(1.81)a	2.43(1.85)	2.55(1.88)a
T_3	Chlorantraniliprole 20 SC	200	2.56(1.88)	2.64(1.90)ab	2.25(1.50)	2.37(1.83)a	2.41(1.84)	2.51(1.87)a
T_4	Diafenthiuron 25 WP	750	1.77(1.66)	0.90(1.37)bc	1.60(1.61)	0.90(1.37)b	1.69(1.64)	0.90(1.37)b
T_5	Spiromesifen 22.9 SL	750	2.72(1.92)	2.88(1.97)a	2.30(1.81)	2.39(1.84)a	2.51(1.87)	2.64(1.90)a
T_6	Thiomethoxam 25 WG	150	1.93(1.71)	1.12(1.45)abc	1.71(1.64)	1.20(1.48)ab	1.82(1.67)	1.16(1.47)b
T_7	Triazophos 40 EC	1250	2.74(1.93)	2.97(1.99)a	2.31(1.81)	2.47(1.86)a	2.53(1.87)	2.72(1.92)a
T_8	Untreated check	--	2.95(1.94)	3.21(1.94)ab	2.47(1.80)	2.71(1.87)a	2.71(1.87)	2.96(1.94)a
		SEm±	0.52	0.72	0.10	0.15	0.11	0.10
		CD (P = 0.05)	NS	0.46	0.31	0.48	0.35	0.32
		CV (%)	12.11	9.62	14.60	12.60	12.60	13.73

* Figure in the parenthesis are square root transformed values.

DMRT : Means followed by a common letter are not significantly different (P= 0.05)

DBS : Day Before Spray., DAS : Days After Spray., NS : Non significant

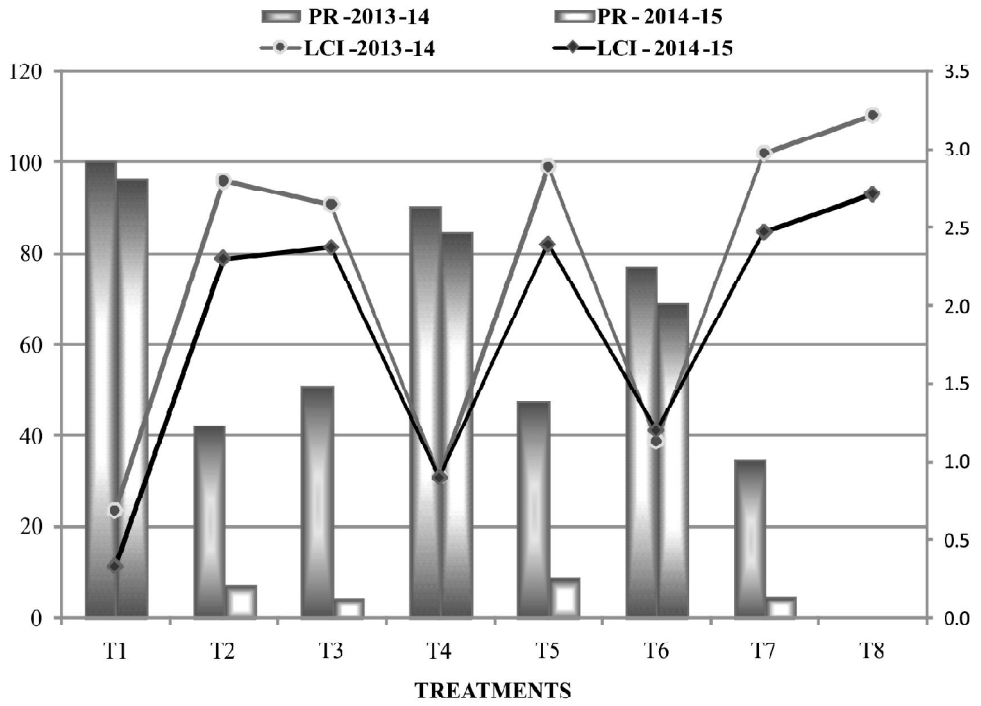

Figure 1. Bio-efficacy of certain insecticide molecules against thrips, *Scirtothrips dorsalis* Hood on capsicum under poly house conditions during 2013-14 and 2014-15 (Percent Reduction (PR) and LCI)

consistent with the activation of nicotinic acetylcholine receptors by a mechanism that is clearly novel and unique. Spinosad also effects GABA receptor function that may contribute further to its insect activity (Sparks *et al*. 2001). The present results are in concurrence with (Prasad and Ahmed 2009) who reported that spinosad was superior in reducing thrips, *S. dorsalis* population and increased fruit yield of chilli in Andhra Pradesh. Similar reports using spinosad @ 0.4ml l^{-1} + White sticky trap@ 40 traps ha^{-1} resulted in the lowest thrips (*T.tabaci)* population with highest marginal benefit cost ratio (1 :1.99) in garlic insect pest management. The efficacy of spinosad @ 75 g a.i.ha^{-1} against*S. dorsalis* in cotton was also reported by (Srinivas *et al*. 2002) and (Bheemanna *et al*. 2009).

In the present study, the next best treatment was diafenthiuron in reducing mean thrips population (1.72) and increased mean per cent reduction of population (79.47). It is a proinsecticide, activated by oxidative desulfurization of the insecticidal carbodiamideand belongs to thiourea group and inhibits the mitochondrial ATP synthesis (Ishaaya *et al.* 1995).

Next in priority was thiomethoxam 25 WG 150 g ml ha^{-1}, whichshowed significant superiority in reducing mean thrips population and moderate mean per cent reduction of thrips population. It is a highly active neonicotinoid insecticide used as foliar application and has systemic properties with relatively low application rate resulting in reduction of thrips population after application in capsicum. The present results are in line with Ghosh *et al.* (2009) who reported that 3rd day and 10th day after application of insecticides, 92.80 and 87.50 per cent reduction, respectively, of thrips population was recorded in thiomethoxam @ 40 g a.i ha^{-1} compared to acetamiprid @ 30 g a.i ha^{-1} and fipronil @ 70 g a.i ha^{-1} in chilli. Similar finding were reported by (Nandini *et al*. 2012), (Raj *et al*.2012) on efficacy of thiomethoxam against thrips. Highest efficacy against thrips was observed with thiomethoxam 25 WG @ 0.1 g l^{-1} followed by indoxacarb 14.5 % SL @ 0.5 ml l^{-1} (Karmakar, 1996). (Sarangi and Panda 2004) also reported that the chemical management of chilli thrips, *S.dorsalis* bythiomethoxam @ 200 g a.i. ha^{-1} was as effective as seedling root dip (SRD).

It is interesting to note that spinosad, diafenthiuron and thiomethoxam reduced the incidence of the thrips population after the three sprays while the rest of the insecticides increased the incidence compared to before spraying. This observation indicated that these three insecticides effectively controlled thrips up to a week after spraying.

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CHARACTERIZATION AND CLASSIFICATION OF RICE GROWING SOILS OF SOUTHERN REGION OF TELANGANA STATE

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ABSTRACT

Ten representative pedons from rice-growing soils of southern Telangana region were characterized and classified. The soils were sandy loam to clay in texture with low permeability. The soils were neutral to slightly alkaline in reaction, low to high in organic carbon, mixed in mineralogy and moderately deep to deep. Bulk density increased with depth and values ranged from 1.26 to 1.81 Mg m^{-3}. Water retentions at 33 kPa and 1500 kPa of soils ranged from 7.9 to 38.7% and 2.2 to 22.1%, respectively. Cation exchange capacity and soil pH followed no definite distribution pattern with depth. The available N was low to medium and available phosphorous and potassium were low to high. The available N, P and K decreased with depth. Based on soil characteristics, the soils of Chevella (P1), Thandur (P4), Shadnagar (P5), Palem (P6) and Narayanpuram (P9) were classified as Alfisols, soils of Ibrahimpatnam (P3), Jadcharla (P7) and Suryapeta (P8) were grouped under Inceptisols, soils of Gollapally (P10) were classified as Entisols and soils of Rajendranagar (P2) were under Vertisols

Rice crop is grown in southern Telangana region in diversified soils and resource environs, predominantly with puddling and waterlogging conditions in lowland systems. Soils vary from red, lateritic, black, alluvial and colluvial soils, with heterogeneity and varied potential for nutrient supplying capacity. Nutrient supplying capacity and availability varies significantly in the waterlogged environs of low land systems due to the different farming situations adopted. The variability and heterogeneity of soil and land resource environs in the Telangana is evidently not meeting the requirements of rice crop.

To improve rice yields, it is important to standardize site-specific technologies on the basis of soil types which necessitates soil characterization. The present study, therefore, was planned to characterize and classify the rice growing soils of the southern Telangana region.

MATERIAL AND METHODS

The southern Telangana region is located between 16p 112 to 17p 312 N latitude and 77p 332 to 80p 522 longitude in the south India. The mean annual rainfall is 1121.6 mm, 74 per cent of which is received during monsoon (mid-June to mid-September). Ten representative pedons (P1 to P10) from Chevella, Rajendranagar, Ibrahimpatnam, Thandur, Shadnagar, Palem, Jadcharla, Suryapeta, Narayanpuram and Gollapally were exposed where all horizons were visible. All pedons were examined morphologically immediately after rice harvest. Soil samples collected from each horizon were analysed for different soil properties *viz.,* particle-size distribution (hydrometer method), bulk density (core method), water retention characteristics (using pressure plate apparatus), saturated hydraulic conductivity (constant head method), pH (1:2.5 soil water solution), organic carbon (Walkley and Black, 1934) and cation exchange capacity (CEC) by saturation with neutral normal NH_4OAc. The soils were classified as per soil taxonomy (Soil Survey Staff, 1998 and Soil Survey Staff, 2006).

RESULTS AND DISCUSSION

Morphological and physical characteristics

The soils had 10YR, 7.5YR and 2.5YR hue and the colour varied from very dark grayish brown to dusky red. Texture ranged from sandy loam to clay. Texture of soils was sandy clay loam (P1, P3, P4, P6, P7, P9, P10), clay (P2), sandy loam (P5) and sandy clay (P8). The paddy soils under study had in general, massive structure at the surface which broke in to subangular blocky or angular blocky structure at subsurface. Structure ranged from granular to subangular blocky in pedons (Table 1).

The clay content ranged from 22.0 to 48.6 per cent and in most of the pedons, clay content increased with depth (Table 2). The increase in clay content is an indication of illuviation of clay from

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Table 1. Morphological properties of the pedons

Pedon No. and Location	Horizon	Depth (cm)	Colour (Moist)	Mottels (Wet)	Texture	Structure		
						C	G	T
P1: Fine-loamy, mixed, iso-hyperthermic Udic Paleustalfs								
P1: Chevella	Ap	0-16	7.5 YR 5/8	5 YR 4/5	scl	f	2	sbk
	Bt	16-45	7.5 YR 6/6	5 YR 5/6	scl	f	2	sbk
	BC	45-75	7.5 YR 5/4	7.5 YR 3/4	scl	f	2	sbk
	C	75-150+	7.5 YR 7/6	7.5 YR 4/1	scl	f	2	sbk
P2: Fine, smectitic, iso-hyperthermic Typic Haplusterts								
P2:Rajendranagar	Ap	0-24	10YR 4/2	10YR 2/2	c	m	3	abk
	Bg	24-45	10YR 2/2	10YR 2/2	c	m	3	abk
	Bss_1	45-110	10YR 3/1	10YR 3/2	c	m	3	abk
	Bss_2	110+	10YR 3/1	10YR 2/2	c	m	3	abk
P3: Fine-loamy, mixed, iso-hyperthermic Typic Haplustepts								
P3:Ibrahimpatnam	Ap	0-15	5 YR 4/3	--	scl	f	1	sbk
	Bw_1	15-45	5 YR 4/4	--	scl	f	2	sbk
	Bw_2	45-70	5 YR 4/6	--	scl	f	3	sbk
	Bw3	70-90	5 YR 4/6	--	scl	m	2	sbk
P4: Fine, mixed, iso-hyperthermic Typic Haplustalfs								
P4: Thandur	Ap	0-16	7.5 YR 5/3	--	scl	f	2	sbk
	AB	16-32	7.5 YR 6/1	--	sc	f	2	abk
	Bg	32-75	7.5 YR 5/2	--	sc	f	2	abk
	Bt	75-110	7.5 YR 5/2	--	sc	f	2	abk
	C	110+	7.5 YR 5/3	--	c	f	2	abk
P5: Fine, mixed, iso-hyperthermic Typic Paleustalfs								
P5: Shadnagar	Ap	0-15	7.5 YR 6/4	--	sl	f	3	sbk
	Bt	15-40	7.5 YR 5/4	--	scl	f	3	sbk
	BC	40-70+	7.5 YR 5/6	--	scl	f	3	sbk
P6: Fine, mixed, iso-hyperthermic Typic Haplustalfs								
P6:Palem	Ap	0-18	2.5YR 4/6	2.5YR 3/4	scl	f	2	gr
	Bt_1	18-66	2.5YR 4/4	2.5YR 3/3	c	m	2	gr
	Bt_2	66-95	2.5YR 3/2	2.5YR 3/3	c	m	2	sbk
	Bt_3	95+	2.5YR 4/6	2.5YR 3/2	c	m	3	sbk

Pedon No. and Location	Horizon	Depth (cm)	Colour (Moist)	Mottels (Wet)	Texture	Structure		
						C	G	T
P7: Fine-loamy, mixed, iso-hyperthermic Typic Haplustepts								
P7:Jadcharla	Ap	0-15	5 YR 4/6	5 YR 3/2	scl	f	2	sbk
	Bw_1	15-36	5 YR 4/4	2.5 YR 4/4	scl	f	2	abk
	Bw_2	36-90	2.5 YR 3/4	2.5 YR 3/2	scl	f	2	sbk
	C	90+	2.5 YR 4/6	2.5 YR 3/3	scl	f	2	sbk
P8: Fine, mixed, iso-hyperthermic Typic Calciustepts								
P8:Suryapeta	Ap	0-12	10 YR 3/2	--	sc	m	2	sbk
	Bk_1	26-Dec	10 YR 3/1	--	scl	m	2	sbk
	Bk_2	26-50	10 YR 3/1	--	sc	m	3	sbk
	BC	50-100	10 YR 4/3	--	sc	m	3	sbk
P9: Fine, mixed, iso-hyperthermic Typic Haplustalfs								
P9:Narayanapuram	Ap	0-15	7.5 YR 3/3	--	scl	f	2	sbk
	Bt_1	15-45	7.5 YR 3/3	--	scl	f	2	sbk
	Bt_2	45-80	7.5 YR 3/4	--	c	f	3	sbk
	C	80-110+	7.5 YR 3/4	--	sc	f	2	sbk
P10: Fine-loamy, mixed, iso-hyperthermic Udic Ustorthents								
P10:Gollapally	A	0-14	5 YR 4/4	--	scl	f	2	gr
	AC	14-26	5 YR 4/4	--	scl	f	2	gr
	C	26-65+	5 YR 3/4	--	scl	f	2	gr

surface to sub-surface (Pardeep Kumar and Verma, 2005; Ratnam *et al.* 2001). The aggregation in these soils was poor in surface and sub-surface horizons. As these soils are under rice cultivation since long, the repeated puddling during rice cultivation could be one of the reasons for poor aggregation in surface horizons. The poor aggregation in sub-surface horizons might be because of clay illuviation under continuous irrigation conditions. Rice soils have poor aggregation because of puddling or wet tillage that destroys soil structure (Dey and Sehgal, 1997).

The bulk density increased with depth in all pedons barring P7, indicating that the lower layers in soil profiles supporting rice cultivation system became compact with time. These results were in conformity with the findings of Ratnam *et al.* (2001). The farmers plough with local (desi) plough which disturb the soil up to 20 cm only and lower layers remain undisturbed for years together which sometime result in pan formation. Because of dominance of silt and clay, the soils retained fairly good amount of water varying from 7.9 to 38.7 per cent (at field capacity). The saturated hydraulic conductivity of surface layers varied from 2.6 to 13.1 cm hr^{-1}. Similar findings were also reported by Reza *et al.* (2010).

Chemical properties

The soils were neutral to slightly alkaline in surface (pH 6.7 to 8.1) and sub-surface horizons (pH 6.4 to 8.7) (Table 3). The organic carbon varied from 2.1 to 9.7 g kg^{-1} in surface and 0.9 to 7.6 g kg^{-1} in sub-surface horizons and decreased with depth. The

Table 2. Physical properties of the pedons

Pedon No and Location	Horizon	Mechanical composition (%)			Bulk density (Mg m^{-3})	Hydraulic conductivity (cm/hr)	Moisture retention (%)	
		Sand	Silt	Clay			33 kPa	1500 kPa
P1:Chevella	Ap	64.0	14.0	22.0	1.39	6.6	19.7	6.5
	Bt	60.0	10.0	30.0	1.26	4.2	22.9	7.6
	BC	66.0	10.0	24.0	1.49	3.5	15.6	5.2
	C	68.0	7.0	25.0	1.51	1.2	13.2	4.5
P2:Rajendranagar	Ap	39.4	18.0	42.6	1.24	3.2	18	10
	Bg	41.4	10.0	48.6	1.32	1.5	32.8	12.6
	Bss_1	42.4	12.0	45.6	1.36	1.6	35.6	20.8
	Bss_2	43.6	14.0	42.4	1.38	0.4	42.8	22.2
P3:Ibrahimpatnam	Ap	63.1	7.1	29.8	1.39	8.4	7.9	2.2
	Bw_1	66.9	6.9	26.2	1.43	9.8	8.1	2.9
	Bw_2	67.3	6.8	25.9	1.55	7.6	9.3	3.7
	Bw3	65.2	6.9	27.9	1.61	6.4	10.1	4.1
P4:Thandur	Ap	56.0	12.0	32.0	1.27	5.8	19.4	10.9
	AB	55.0	11.0	34.0	1.29	2.6	22.9	12.6
	Bg	56.0	7.0	37.0	1.32	3.6	24.6	15.4
	Bt	49.0	6.0	45.0	1.35	2.6	26.2	19.2
	C	52.0	12.0	36.0	1.39	1.6	30.5	21.5
P5:Shadnagar	Ap	77.1	8.9	13.9	1.44	13.1	16.8	12.2
	Bt	68.1	8.3	23.6	1.55	12.6	18.8	13.6
	BC	63.0	8.6	28.3	1.56	11.8	15.2	11.1
P6:Palem	Ap	46.5	19.5	34.0	1.48	2.6	22.9	17.9
	Bt_1	21.8	30.6	48.6	1.56	1.8	30.6	17.2
	Bt_2	29.1	28.2	42.7	1.48	2.2	35.5	22.1
	Bt_3	29.3	26.4	44.3	1.51	4.8	38.7	16.9
P7:Jadcharla	Ap	66.4	7.2	26.4	1.58	8.2	14.6	8.9
	Bw_1	66.2	3.0	30.8	1.59	6.8	12.5	9.4
	Bw_2	67.4	4.0	28.6	1.52	6.1	11.9	8.4
	C	66.0	3.8	30.2	1.57	6	10.9	7.6

Pedon No and Location	Horizon	Mechanical composition (%)			Bulk density (Mg m^{-3})	Hydraulic conductivity (cm/hr)	Moisture retention (%)	
		Sand	Silt	Clay			33 kPa	1500 kPa
P8:Suryapeta	Ap	54.0	8.0	38.0	1.51	3.2	11.2	8.4
	Bk_1	56.0	9.0	35.0	1.56	2.9	10.7	6.2
	Bk_2	57.0	7.0	36.0	1.48	2.7	13.4	9.1
	BC	53.0	8.0	39.0	1.56	2.7	14.5	11.6
P9:Narayanapuram	Ap	65.5	12.5	22.0	1.52	8.8	12.4	6.2
	Bt_1	62.0	7.2	30.8	1.65	5.2	13.4	8.1
	Bt_2	40.3	7.0	42.7	1.81	2.1	15.2	6.6
	C	52.0	8.8	39.2	1.56	1.8	18.3	8.5
P10:Gollapally	A	63.0	10.0	27.0	1.39	3.6	10.1	6.6
	AC	68.0	7.0	25.0	1.61	2.1	14.2	8.7
	C	64.0	6.0	30.0	1.52	1.2	15.3	9.3

temperature during rice cultivation ranged from 13.0 to 39.0 p C. High temperature during most part of the year might be responsible for high rate of decomposition and might be responsible for higher values of organic carbon in surface horizons than in sub-surface horizons. The CEC values varied from 5.9 to 45.1 cmol(p+) kg^{-1} in surface horizons and from 6.4 to 47.0 cmol(p^+) kg^{-1} in sub-surface horizons, which could be in positive correlation with clay content. Similar findings were also reported by Dhanorkar *et al.* (2010).

The available N varied from 110.5 to 328.9 kg ha^{-1} in the surface horizons, whereas sub-surface horizons had available N in the range of 41.0 to 276.6 kg ha^{-1}. Considering ratings of Muhr *et al.* 1965, majority of the soils fell into low to medium category with respect to available nitrogen. The available P varied from 8.3 to 70.1 kg ha^{-1} in surface and 5.4 to 60.6 kg ha^{-1} in sub-surface horizons. Considering the ratings of Muhr *et al.* (1965) the soils were low to high in available P. Available K ranged from 146.7 to 420.1 kg ha^{-1} in surface horizons and 88.0 to 358.6 kg ha^{-1} in sub-surface horizons. Considering the ratings of Muhr *et al.* (1965), these soils could be classified under low to high available K content. These results were similar to those of Rao *et al.* (2008) in the soils of different land farms of Ramachandrapuram mandal of the Chitoor district in Andhra Pradesh.

Soil classification

Based on morphological, physical, physico-chemical characteristics of the soils and climate data, the soils were classified according to Keys to Soil Taxonomy (Soil Survey Staff 2006) pedon 10 was placed in to the order Entisols (does not have any diagnostic horizon). Due to the characters like presence of lithic contact at a depth of above 1 m, decreasing organic carbon content with increasing depth reaching a level of 0.2 per cent OC at a depth of 1.25 m. and not permanently saturated with water, pedon 10 was placed under the sub order Orthents. As the moisture regime is ustic, the pedon 10 was classified as Ustorthents at great group level. It was classified as Udic Ustorthents sub group level because of the present land use condition, with good irrigation practices followed for cultivation of crops in the last three decades. The soil and land resource environs are utilized properly, economically providing water with various sources.This influenced the moisture conditions greatly.

Table 3. Physico-chemical characters and available nutrient contents of pedons

Pedon No and Location	Horizon	pH	EC (dS m^{-1})	OC (g kg^{-1})	CEC (c mol (p+) kg^{-1})	Available nutrients		
						N	P_2O_5	K_2O
						(kg ha^{-1})		
P1:Chevella	Ap	8.1	0.10	9.0	20.9	120.0	70.1	301.6
	Bt	8.3	0.21	6.0	28.6	70.0	60.6	208.1
	BC	8.4	0.16	4.0	14.9	71.0	50.4	180.6
	C	8.6	0.26	4.0	11.7	41.0	31.3	88.0
P2:Rajendranagar	Ap	8.0	0.80	8.0	45.1	215.4	30.6	228.1
	Bg	8.4	0.88	7.6	42.2	204.7	29.4	254.6
	Bss_1	8.7	1.20	6.1	35.2	188.4	24.7	210.0
	Bss_2	8.4	1.21	5.6	32.8	94.0	9.8	97.3
P3:Ibrahimpatnam	Ap	7.1	0.11	4.2	21.3	139.0	8.3	316.9
	Bw_1	7.6	0.11	4.6	25.2	142.0	7.2	239.6
	Bw_2	8.0	0.13	3.2	29.1	120.0	6.9	204.9
	Bw3	8.2	0.12	3.1	33.5	109.0	5.4	183.6
P4:Thandur	Ap	8.0	0.12	7.9	30.0	257.1	60.9	397.3
	AB	8.1	0.52	5.9	32.0	210.1	58.3	188.2
	Bg	8.2	0.18	4.1	35.0	163.0	43.3	181.2
	Bt	8.2	0.21	2.9	43.0	68.9	37.2	100.8
	C	8.1	0.51	2.0	47.0	43.8	20.9	92.4
P5:Shadnagar	Ap	6.7	0.28	2.4	5.9	154.2	18.1	154.6
	Bt	7.1	0.35	1.2	6.4	101.5	10.6	132.3
	BC	7.2	0.36	0.9	7.9	93.3	9.6	108.0
P6:Palem	Ap	7.0	0.60	2.1	15.2	142.6	12.8	146.7
	Bt_1	6.4	1.14	2.7	18.6	144.5	11.6	144.3
	Bt_2	7.1	0.78	2.0	19.2	94.4	9.8	131.2
	Bt_3	6.8	0.32	1.9	22.2	92.6	9.4	136.4
P7:Jadcharla	Ap	6.9	0.68	3.6	14.2	148.2	18.7	149.6
	Bw_1	6.7	0.55	5.2	26.1	150.5	16.4	132.6
	Bw_2	6.8	0.61	4.8	22.1	109.7	11.6	130.2
	C	6.9	0.58	4.1	20.8	62.7	9.4	104.6

Pedon No and Location	Horizon	pH	EC (dS m^{-1})	OC (g kg^{-1})	CEC (c mol (p+) kg^{-1})	Available nutrients		
						N	P_2O_5	K_2O
						(kg ha^{-1})		
P8:Suryapeta	Ap	8.1	0.46	6.2	26.5	110.5	12.5	214.0
	Bk_1	8.0	0.31	5.7	31.0	122.6	11.4	161.2
	Bk_2	7.8	0.26	4.2	32.5	108.2	10.2	109.5
	BC	8.1	0.41	3.0	32.5	96.2	9.2	96.2
P9:Narayanapuram	Ap	6.8	0.34	8.2	18.0	284.6	32.6	316.7
	Bt_1	6.9	0.32	4.0	20.5	181.3	10.1	309.3
	Bt_2	7.3	0.29	3.4	20.9	104.2	8.6	204.5
	C	7.3	0.30	2.1	22.1	83.3	8.4	208.6
P10:Gollapally	A	8.1	0.24	9.7	19.2	328.9	60.7	420.1
	AC	8.1	0.25	6.2	23.8	276.6	43.3	358.6
	C	8.2	0.21	4.8	28.4	158.3	21.4	202.0

The pedons 1, 4, 5, 6 and 9 were classified under Alfisols because of the presence of an argillic (Bt) sub-surface diagnostic horizon and the pedons 3, 7 and 8 were classified under the order Inceptisols because of the absence of any other diagnostic horizon other than cambic (Bw) horizon. As the moisture regime is ustic, the pedons 1, 4, 5, 6 and 9 were classified as Ustalfs, whereas the pedons 3 and 7 were classified as Ustepts at sub order level and were classified as Haplustepts at great group level because the pedons did not have either duripan or calcic horizon and the base saturation is more than 60 per cent at a depth between 0.2 to 0.7 m from the soil surface. The pedons 3 and 7 were classified as Typic Haplusteptsat sub group level because these pedons did not have vertic properties and lithic contact within 50 cm from the soil surface. The pedon 8 were classified as Calciusteptsat great group level because of the presence of a horizon with more than 15% calcium carbonate and this pedon was classified as Typic Calciustepts at sub group level because of absence of lithic contact within 50 cm of mineral soil surface and the absence of petrocalcic, gypsic horizon within 100 cm of mineral soil surface.

The pedon 1 and 5 were classified as “Paleustalfs” at great group level because of the absence of densic, lithic or para lithic content within 15 cm of the mineral soil surface and the lower one half of the argilic horizon, one or more sub horizons with Hue of 7.5YR or redder and chroma of 5 or more in 50 per cent or more of matrix and the pedon 1 was classified as Udic Paleustalfs at sub group level because of the Present land use condition, essentially good irrigation practices were followed for cultivation of crops in the last three decades. The soil and land resource environs are utilized properly, economically providing water with various sources. Thus this influenced the moisture conditions greatly. Further, the moisture was also stored in the depth profile. The pedon 5 was classified as Typic Paleustalfs at sub group level because of an argillic horizon that have hue of 2.5YR (redder) and the value (moist) of three or less.

The pedons 4, 6 and 9 were classified as “Haplustalfs” at great group level because, other than argillic horizon these soils not having any horizon like natic horizon, petro calcic horizon, durepan and plinthite horizons. Further, these pedons did not have vertic properties and lithic contact with in 50 cm from the soil surface. Hence these pedons classified as Typic Haplustalfs at subgroup level respectively.

The pedon 2 was classified as Vertisols at order level and they express their morphology very identical and Clay texture, more than 30 % clay in fine earth fraction of all the horizons.. In these pedons clay exhibited significant sink–source characteristics and have a layer of 25 cm (or) more thick with an upper boundary with in 100 cm of mineral soil surface, that have slickensides which exhibited shiny and smooth surfaces at interspace of peds due to the presence of slikensides in a soil horizon and designated as Bss. These soils had ustic soil moisture regime, hence these pedon were classified as "Usterts" at suborder level and at great group level these pedon were calssified as Haplusterts because this pedon did not have either salic, gypsic and petrocalcic horizons within 100 cm depth. This pedon had EC less than 4 dS m^{-1} and pH more than 4.5. The pedon 2 were classified as Typic Haplusterts at subgroup level because this pedon had deep cracks that remained open for more than 150 cumulative days for most years. Agarwal *et al.* (2012) also classified the soils of Wardha district of Vidharbha region in to Typic Haplusterts based on above features.

The results lead to a conclusion that the rice-growing soils of southern Telangana region were shallow to very deep, moderately well to poorly drained, neutral to slightly alkaline, low to high in organic carbon, low to medium in CEC, moderate to high base saturated and sandy loam to clayey with variation in relation to physiography. Regarding nutrient status, the soils were low to medium in available nitrogen, low to high in available phosphorous and low to high in available potassium. The rice growing soils of Southern region of Telangana studied were classified up to sub-group level in this study.

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EFFECT OF INTEGRATED WEED MANAGEMENT PRACTICES AND BIO-FERTILIZERS ON WEED CONTROL EFFICIENCY AND WEED INDEX IN SOYBEAN [*Glycine max* (L.) Merill]

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ABSTRACT

A field experiment was conducted to study the weed control efficiency varied with the weed management practices. The pre-emergence application of pendimethalin @1.0 kg *a.i* ha^{-1} reduced the weeds by 50-60 per cent and thus largely eased out the crop-weed competition during early seedling establishment stage. The weed control efficiency was 80 per cent at 40 days due to integrated weed management and hand weeding at 25 days. This is the crucial time when the crop should be free of weeds. Maximum weed control efficiency of 96-97 per cent was at 60 days due to hand weeding at 25 and 45 DAS. This was much higher than the weed control efficiency of 68-69 per cent due to integrated weed management at this stage. The weed control efficiency was 72-73 per cent at 40 days and 62-64 per cent at 60 days due to pre and post emergence application of herbicides. Low weed index of 4.64 during 2014 and 5.30 during 2015 was due to the integrated weed management treatment. Thus this treatment can be an option to the farmer by losing 4-5 per cent expected seed yield of soybean if labour is not available or manual weeding is not possible after rains. The pre and post emergence application of weedicides recorded weed index of about 18 during the 2 years. But, the weed index in un-weeded crop was 52-53 per cent. If the farmers are confronted with the problem of weeding mainly due to severe labour shortage as often encountered, it is better to forego 18 per cent yield reduction by adopting the pre and post emergence herbicide applications than to lose half the production by leaving the crop to grow freely with the weeds.

Soybean [*Glycine max (L.) Merill*] is a miracle golden bean of the 20th century and occupies third place among oilseed crops of Telangana State. It is a rich source of protein (40-42 %) and quality oil (20-22%). Protein is rich in valuable amino acid with 5% lycine. Soybean suffers from heavy infestation of complex weed flora belonging to grasses, broad leaf weeds, sedges and perennial types. They emerge in several flushes depending on the rainfall distribution pattern making their effective control difficult. The crop is highly sensitive to early weed infestation during the seedling stage and the critical crop-weed competition during 3-4 weeks after sowing (Jha *et al*. 2014) The losses caused by weeds are more than any other factor like insects, nematodes, diseases and rodents etc. (Chavan *et al*. 2015). Hand weeding and blade harrowing are traditionally practiced to ward off weeds, loosen the soil for good aeration and conserve the moisture. The indiscriminate urbanization resulting in labour shortage and spiraling wages compel the farmers to switch over to the chemical weed control. Presently about 90% of the area cultivated soybean is treated with herbicides (Peer *et al*. 2013). The use of herbicides apprehend to have direct or indirect consequence on non-targeted organisms including soil micro flora in the field. Low weed control efficiency due to herbicides than the cultural method of weed management has also been documented earlier by Upadhyay *et al*. (2012) and Rani *et al*. (2004).

MATERIAL AND METHODS

A field experiment was conducted to study the effect of integrated weed management practices and biofertilizers on weed control efficiency and weed index of *kharif* soybean [*Glycine max* (L.) merill] at Agricultural College Farm, Rajendranagar, Hyderabad in spilt plot design during 2014 and 2015 on sandy loam having 7.8 pH and EC 0.21 dS m^{-1} and very poor in nutrient status with 0.35 per cent OC and 226,18 kg ha^{-1}, available N, P and K respectively. The treatments comprisis of pre-emergence application of pendimethalin @ 1.0 kg a.i ha^{-1} followed by hand weeding 25 DAS (W1), Pre emergence application of pendimethalin @ 1.0 kg a.i ha^{-1} followed by post-emergence application of imazethapyr @ 100 g a.i ha^{-1}+ quizalofop-p-ethyl @ 50 g a.i ha^{-1} 25 DAS (W2), Pre–emergence application of pendimethalin @1.0 kg a.i ha^{-1} followed by post-emergence application of odyssey i.e. imazethapyr + imazamox @ 70 g a.i ha^{-1} at 25 DAS (W3), Hand weeding at 25 and 45 DAS (W4) and un-weeded

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check (W5) as remain plots and sub plot treatments were recommended dose of fertilizers @ 30:60:40 kg ha^{-1} NPK (F1), RDF+ seed treatment with rhizobium @ 250g10kg^{-1}seed (F2), RDF+seed treatment with rhizobium @ 250g10kg^{-1} seed + phosphate solubilizing bacteria @ 5 kg ha^{-1} (F3), RDF + seed treatment with rhizobium @ 250 g10 kg^{-1} seed + phosphate solubilizing bacteria @ 5 kg ha^{-1} + potassium solubilizing bacteria@ 5kg ha^{-1}(F4). Recommended fertilizer dose of 30:60:40 kg ha^{-1} NPK was applied at the time of sowing in the form of urea single super phosphate and muriate of potash. The seed rate adopted was 63 kg/ha.The biofertilizers *Brady rhizobium japonica* and phosphate solubilizing bacteria were mixed as per the treatments in jaggery solution prepared @ 250 g for 10 kg seed. The seed was thoroughly mixed with the solution and shade dried. The potassium solubulizing bacteria were applied @ 5 kg ha^{-1} after mixing with FYM. The seeds were dibbed at the rate of two hill $^{-1}$ 10 cm apart in 30 cm rows. The crop was sown on 10th July in 2014 and 18 th June in 2015 weed control efficiency (WCE) was calculated at 20, 40 and 60 DAS using the following formula and expressed in percentage.

$$WCE\ (\%) = \frac{DWC - DWT}{DWC}\ 100$$

Where,

DWC = Dry weight of weeds in un-weeded control plot

DWT = Dry weight of weeds in weed control treatment plot.

Weed index (WI) was calculated for different treatments using the formula as suggested by Gill and Vijaykumar (1969).

$$WI\ (\%) = \frac{(X-Y)}{X}\ 100$$

Where,

X = yield from weed free check or maximum yield treatment

Y = yield from treatment for which weed index is to be calculated

RESULTS AND DISCUSSION

The weed control efficiency ranged from 53.1-60.5 per cent during 2014 and 51.2 - 59.1 per cent during 2015 at 20 DAS due to the pre-emergence application of pendimethalin @ 1.0 kg *a.i* ha^{-1} (Table 1). This is useful for the young growing seedlings to develop well by using the resources effectively and grow vigorous. Hand weeding at 25 days preceded with pre-emergence application of pendimethalin @ 1.0 kg *a.i* ha^{-1} eliminated all the weeds. Hence, high weed control efficiency of 80.7 to 82 per cent was obtained in 2014 and it was 79-80 per cent during 2015 at 40 DAS. Maximum weed control efficiency of 96-97 per cent was at 60 DAS due to hand weeding at 25 and 45 DAS. The weed control efficiency due to integrated weed management sharp declined to 68-69 per cent by 60 days mainly due to the relatively large gap of 35 days after weeding on 25 days than the gap of 15 days due to hand weeding. The weed control efficiency due to pre and post emergence herbicides was about 70-73 per cent at 40 days and 60-64 per cent at 60 DAS. The results emphasize that the weeds are ought to be eliminated by 45 DAS. Low weed control efficiency due to herbicides than the cultural method of weed management has also been documented earlier by Upadhyay *et al.* (2012) and Rani *et al.* (2004). Better weed control efficiency was obtained due to the integrated weed management than the cultural methods by Habimana *et al.* (2013).

Weed index is the reduction in yield of soybean seed due to the presence of weeds in comparison to the hand weeding treatment. The integrated weed management by the pre-emergence application of pendimethalin @ 1.0 kg *a.i* ha^{-1} and hand weeding at 25 days recorded least weed index of 4.64 per cent during 2014 and 4.72 per cent during 2015 (Table 2). It clarifies that the integrated weed management produced 3.5-5.0 per cent low seed yield than due to hand weeding at 25 and 45 DAS. This is a great solace to the farmer to oversee the need for second weeding at 45 DAS. Depending on the pressing need the farmer has the option to go for pre and post emergence herbicide application with a loss of 17 to18 per cent of the seed yield than the huge loss of about 52 per cent by allowing the weeds to grow free. Upadhyay *et al.* (2012) also recorded least weed index of 3.1 per cent when imazethapyr @ 100 g was applied along with 750 ml adjuvant and 1.0 kg ha^{-1} ammonium sulphate compared to 22.9 per cent by the application of imazethapyr @ 100 g *a.i* ha^{-1}. Similar views by Meena and Dhaka (2013)

Table 1.Weed control efficiency (%) as influenced by weed management treatments during 2014 and 2015

Treatment	2014			2015		
	Days after sowing			Days after sowing		
	20	40	60	20	40	60
W1 : PE Pendimethalin @ 1kg *a.i* ha^{-1}fb Hand weeding 25 DAS	60.5	82.4	69.4	59.1	80.2	68.3
W2 : PE Pendimethalin @ 1kg *a.i* ha^{-1}fb PoE Imazethapyr @ 100 g *a.i* ha^{-1}+Quizalofop- P-ethyl @ 50g *a.i* ha^{-1}25 DAS	55.6	72.0	62.8	53.5	70.8	61.8
W3 : PE Pendimethalin @ 1kg *a.i* ha^{-1}fb PoE Imazethapyr + Imazamox@ 70 g *a.i* ha^{-1}25 DAS	53.1	73.2	64.1	51.2	73.0	64.0
W4 : Hand weeding at 25 and 45 DAS	0.0	80.7	97.0	0.0	79.3	96.0
W5 : Unweeded check	-	-	-	-	-	-

Table 2.Weed index (%) as influenced by weed management treatments during 2014 and 2015

Treatment	Weed index (%)	
	2014	2015
W1: PE Pendimethalin @ 1kg *a.i* ha^{-1}fb Hand weeding 25 DAS	4.64	4.72
W2: PE Pendimethalin @ 1kg *a.i* ha^{-1}fb PoE Imazethapyr @100 g *a.i* ha^{-1}+ Quizalofop- P-ethyl @ 50 g *a.i* ha^{-1}25 DAS	18.41	17.00
W3: PE Pendimethalin @ 1kg *a.i* ha^{-1}fb PoE Imazethapyr + Imazamox@ 70 g *a.i* ha^{-1}25 DAS	17.95	17.06
W4: Hand weeding at 25 and 45 DAS	0.00	0.00
W5: Unweeded check	51.94	51.58

revealed that the least weed index of 2.4 per cent by the post emergence application of imazethapyr @ 75 g *a.i* ha^{-1} followed by hand weeding at 35 days. Jha *et al*. (2014) also reported least weed index of 8.86 was due to the post emergence application of imazethapyr @ 100 g *a.i* ha^{-1} in contrast to 11.40 to 44.62 due to other herbicides. With the above findings it can be concluded that compared to chemical treatments handweeding has proved to record high weed control efficiency and weed index.

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SIGNIFICANCE OF HOMESTEAD TECHNOLOGIES OF RAJENDRA AGRICULTURAL UNIVERSITY (RAU) AS A MEANS OF LIVELIHOODS FOR RURAL WOMEN OF BIHAR

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ABSTRACT

Women have been the deprived and under privileged members of the society. According to the census 2011 (Provisional Population Totals- India), it was estimated that 69.08 per cent of women population of India lived in rural areas. In case of Bihar State, it is 88.85 per cent. The overall literacy rate of female population in India is 65.46 per cent whereas, it is 46.40 per cent in case of Bihar (Census of India, 2011). Poor socio-economic conditions is the reason that they are not able to derive maximum benefits from training activities and developmental programs. This itself suggests the quantum of attention and measure that need to be taken by the State Government through its various functionaries at different levels, so that a majority of the female population of the state is not neglected. Data were collected in the year 2013 with the help of a structured interview schedule comprising of eighteen socio-personal, economic, communicational, psychological and situational variables to explicit the profile characteristics of rural women of Bihar and to assess the significance of selected nine homestead technologies of Rajendra Agricultural University (RAU) as a means of their livelihoods. The findings of the study showed that the respondents had medium level of overall personal, socio-economic, communicational, psychological and situational profile characteristics. Vermicompost, apiculture and mushroom production technologies were the most sought after enterprises as a means of livelihood for rural women of Bihar.

Women are the world caretakers of home and perform a variety of tasks. No nation can think of its full development by ignoring the welfare of women. Nearly 70 per cent of Indian rural women are involved in agriculture and are responsible for 60-80 percent of food production. They play a major role in animal husbandry, horticulture and poultry which are their main sources of income. They are also more involved in small-scale enterprises. These include fruit & vegetable preservation, tailoring, papad and badi making, basket, broom, rope making, tasar silk cocoon rearing, lac cultivation, oil extraction, bamboo works, etc.

Rural women's education and extension contacts enable them to acquire access and avail new information and evaluate benefits of alternative sources of economically useful information. Her enlightenment will change the face of rural India. It is a pre-requisite to study the profile characteristics of rural women before designing and implementing any program so that it can be tailored and made apt according to their socio-economic background. The data will help policy makers to frame strategies and to formulate developmental programs for them. Keeping these facts in view the study on "Significance of Homestead Technologies of Rajendra Agricultural University (RAU) as a Means of livelihoods for Rural Women of Bihar" was conducted with the following objectives-

1. To study the profile characteristics of rural women
2. To assess significance of homestead technologies of RAU as a means of livelihood of the respondents.

Grewal *et al* (1993) noticed that 38 per cent of peasant women were illiterates and a majority of them were wives of small and marginal farmers. They obtained information on different technologies from their family members, friends followed by farmers and neighbours. Only 2.0 per cent of women used literature as a source of information.

Roy (2005) found that majority of the respondents were educated up to middle school (21.66%) followed by primary school education (16.66%), can read only (15.41%), high school (12.9%), can read & write (12.5%), illiterate (9.16%), graduation & post graduation (7.08%) and intermediate (4.63%).

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Rani and Rao (2007) inferred that Association of Lady Entrepreneurs of Andhra Pradesh (ALEAP) provided counselling and incubation, special incentives, training facilities for prospective women entrepreneurs and also provided strategic tie-ups with national and international agencies including ZDH, a German Federation to avail modern training facilities offered by those agencies.

MATERIAL AND METHODS

An interview was scheduled to elicit information on eighteen independent variables *viz*. age, education, family size, occupation, family income, family support, information source utilization, economic motivation, scientific orientation, innovativeness, perceived attributes of homestead technologies, value orientation, risk orientation, input availability, rural customs, market intelligence, institutional support and socio-capital aspects. Data were collected with the help of structured interview schedule and also by personally interview of 225 rural women who were exposed to the selected nine homestead technologies of Rajendra Agricultural University, Pusa, Bihar *viz*. fruit & vegetable preservation, stitching & embroidery, value addition to garments, arts & craft making, value added products from cereals & pulses, mushroom production, value added mushroom products, vermicomposting and apiculture.

Psychological and situational variables were studied by framing positive and negative statements on a three point continuum by assigning score of 3, 2 and 1 for positive and vice-versa for negative statements. Respondents were categorised as low, medium and high based on the mean and standard deviation. Data were also collected to elicit information on number of women engaged in the selected homestead technologies as entrepreneurs and the net income realised from each of these enterprises.

RESULTS AND DISCUSSION

1. Majority (70.67 %) of the respondents were young in age, followed by middle aged (27.56%) and old aged (1.77%) respectively. Rural women who were exposed to the selected homestead technologies only constituted the respondents for the study. Hence, it can be inferred that young women were more exposed to such technologies and that they had more interest and enthusiasm in gaining information about such technologies.
2. Majority (58.22%) of the respondents had small family size, followed by medium (36.89 %), very large (2.67%) and large (2.22%) family size. It signifies that there is a growing awareness about small family size norm even in rural areas and also there is increase in number of nuclear families compared to joint family system.

Table 1. Distribution of respondents based on their personal profile (N=225)

Socio-personal variables	Category	Frequency (f)	Percentage (%)
Age	Young	159	70.66
	Middle aged	62	27.56
	Old	4	1.78
Family size	Small (2-6)	131	58.22
	Medium (7 to 11)	83	36.89
	Large (12 to 16)	5	2.22
	Very large (17 to 22)	6	2.67
No. of occupations	0-1	54	24.00
	2-3	139	61.78
	4-5	32	14.22

3. Majority (61.78%) of the respondents had 2-3 occupations followed with 0-1 (24.00%) occupations and 4-5 (14.22%) occupation.

4. Majority (29.33%) of the respondents had high school level of education, followed by (24.00%) with no schooling (illiterate). The percentage of respondents for middle school, functional literacy, college education and primary school education were 21.33, 15.11, 8.45 and 1.78 percentages respectively. The result signifies that the educational level of the women was quite good and that it is getting better in rural areas. (Fig.1).

5. About 34.67% of the respondents had horticulture (fruits & vegetable) as their main occupation followed by agriculture. Wage worker/ labourer was the subsidiary occupation for 47.11% of the respondents (fig.2).

6. Majority (75.56 %) of the respondents had medium family income, followed by high (13.33 %) and low income (11.11 %). There were nearly 3-4 earning member in most of the respondents families. They were involved in various occupations like service, agriculture, caste occupation and wage worker etc. to meet the monthly family expenditure.

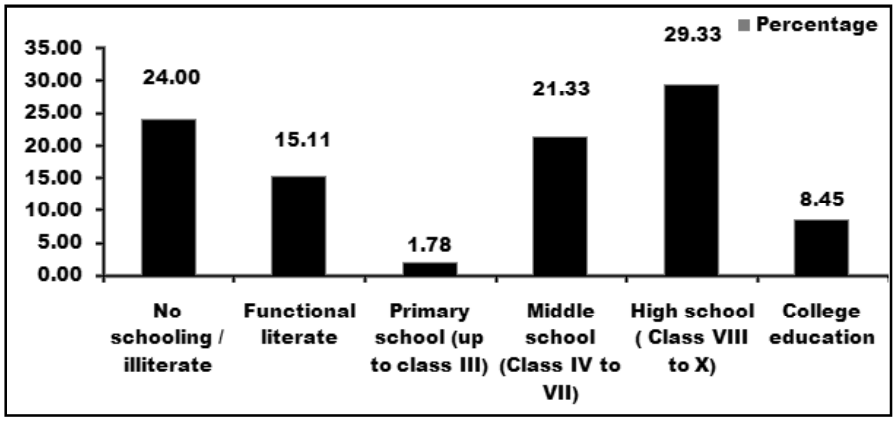

Fig 1. Distribution of respondents based on education.

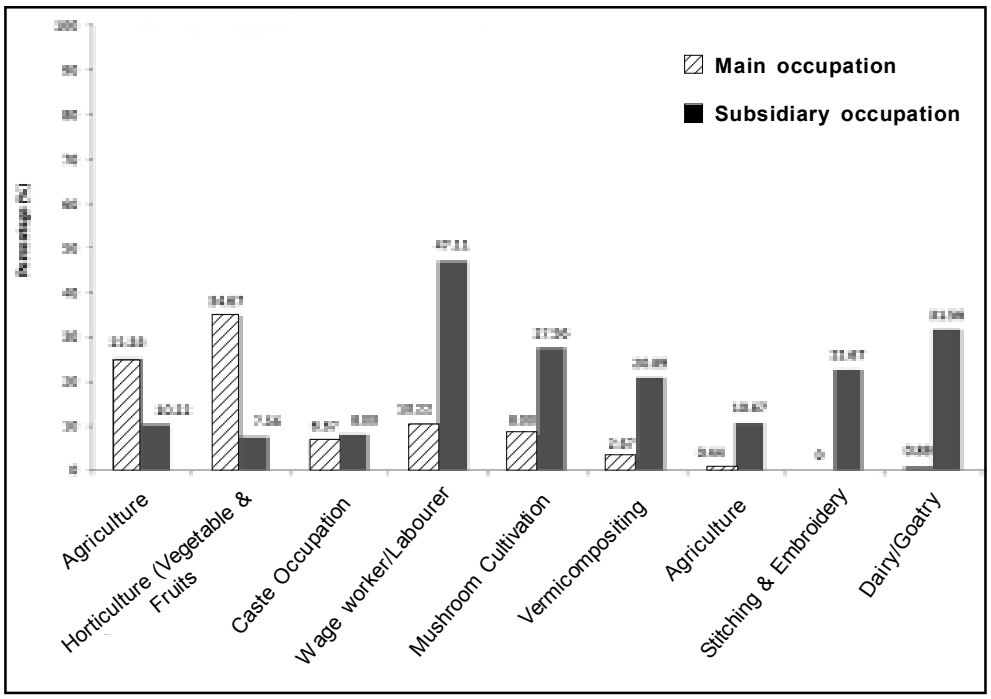

Fig 2. Distribution of respondents based on occupation

Table 2. Distribution of respondents based on extent of family support from various personnel

(N=225)

Family Support	Husband		Parents		In-laws		Relatives		Friends		Neighbours		Any other (children etc.)	
	f	%	f	%	f	%	f	%	f	%	f	%	f	%
Greater extent	179	79.56	114	50.67	105	46.67	62	27.56	64	28.45	84	37.33	47	20.89
Considerable extent	42	18.66	66	29.33	70	31.11	55	24.44	48	21.33	121	53.78	19	8.44
Upto a little extent	2	0.89	20	8.89	31	13.78	86	38.22	59	26.22	17	7.56	8	3.56
Nil	2	0.89	25	11.11	19	8.44	22	9.78	54	24.00	3	1.33	151	67.11
Total	**225**	**100.0**	**225**	**100.00**	**225**	**100.0**	**225**	**100.0**	**225**	**100.0**	**225**	**100.0**	**225**	**100.0**

Note: f= frequency %= percentage

7. Majority (55.56 %) of the respondents family support was medium followed by high (28.0 %) and low (16.44 %).
8. Majority of the respondents had greater support from their husbands (79.5%**)**, followed by parents (50.67%**)**, in-laws (46.67%**)** and friends (28.45%**)**. It suggests that the family members of the respondents were very supportive and encouraging their spouse, daughters or daughter's in-laws to gain information or to attend training programs so that they could adopt new and improved homestead technologies for better family life.
9. Majority (78.67%) of the respondents utilized information sources to a medium extent for gaining knowledge on the selected homestead technologies followed by higher (20.0%) and lower extent (1.33%).
10. Majority (58.22%) of the respondents possessed medium level of economic motivation, followed by high (24.0%) and low (17.78%) levels of economic motivation. The reason might be due to greater family support extended to the respondents by their family members which might have motivated them to perceive the homestead technologies from economic point of view.
11. Majority (68.0 %) of the respondents had medium level of scientific orientation followed by low (18.67 %) and high (13.33 %) level of scientific orientation. It may be attributed to the fact that almost 60 per cent of the respondents were educated from middle school to college level and 70.67% of them were of young age.
12. Majority of the respondents (69.34 %) had medium level of innovativeness. About 17.33 per cent of them had low level while 13.33 per cent had high level of innovativeness. This is because they possess medium level of scientific orientation. Young people are always more innovative than middle and old age people and it may also be an important factor contributing to their innovativeness as majority (70.67%) of them were of young aged.
13. Majority (68.45 %) of the respondents had medium level of perception on attributes of homestead technologies followed by high (17.33%) and low (14.22 %) level of perception. This might have been influenced by their attitude towards homestead technologies of RAU which showed that majority of them had favourable attitude towards the technologies.
14. Majority (69.78%) of the respondents had medium level of value orientation. The rest of the respondents were equally distributed under low (15.11%) and high (15.11%) categories of value orientation. It signifies that rural women still place high importance to their values, morals and these values might have influenced their knowledge acquisition behaviour and adoption of homestead technologies.
15. Majority (65.78%) of the respondents had medium level of risk orientation, followed by high (20.0%) and low (14.22%) levels of risk orientation. It highlights the fact that rural women were less inclined to take risk in running an enterprise or entering into a new enterprise. It might be due to the fact that majority (75.56%) of them had medium level of family income that somehow supports their family needs and had the fear of facing financial scarcity.
16. Majority (59.11%) of the respondents had medium level of access to inputs, followed by low (25.33%) and high (15.56%) level of access to inputs.
17. Majority (55.56%) of the respondents had access to inputs for their enterprises outside the village (more than 5 km) followed by 33.33 per cent outside the village (less than 5 km) and 11.11 per cent within the village.
18. For majority (44.00%) of the respondents, the inputs needed to adopt the homestead technologies or to run it as an enterprise was adequately met followed by 29.78 per cent and 26.22 per cent of the respondents for whom the inputs needed were inadequate and not available, respectively.
19. For majority (38.67%) of the respondents, the inputs were made available after a week's time (> 7 days), followed by (34.22%) immediately available and (27.11%) available within a week's time (1-7 days). It can be inferred from the results that the inputs are available in the approachable vicinity of the respondent's home but were not made available immediately to the respondents.

Table 3. Profile characteristics of the respondents

(N=225)

Variables	Category		
	Low	Medium	High
Family income	25 (11.11)	170 (75.56)	30 (13.33)
Family support	37(16.44)	125 (55.56)	63(28.0)
Information source utilization	3 (1.33)	177(78.67)	45 (20.0)
Economic motivation	40(17.78)	131(58.22)	54(24.00)
Scientific orientation	42(18.67)	153(68.00)	30(13.33)
Innovativeness	39(17.33)	156(69.34)	30(13.33)
Perceived attributes of homestead technologies	32(14.22)	154(68.45)	39(17.33)
Value orientation	34(15.11)	157(69.78)	34(15.11)
Risk orientation	32(14.22)	148(65.78)	45(20.00)
Input availability	57(25.33)	133(59.11)	35(15.56)
Rural customs	31(13.78)	164(72.89)	30(13.33)
Market intelligence	53(23.56)	135(60.00)	37(16.44)
Institutional support	32(14.22)	157(69.78)	36(16.00)
Socio-capital aspects	30(13.33)	167(74.22)	28(12.45)

20. Majority (72.89%) of the respondents faced rural customs to a medium extent followed by low (13.78%) and high (13.33%) categories. This suggests that there was a shift in rural customs in the selected locale from a rigid, traditional and conservative society to a flexible and progressive society. There was betterment in the position of women in rural society and they were allowed to enter into entrepreneurial activities.

21. Majority (60%) of the respondents had medium level of market intelligence, followed by low (23.56%) and high (16.44%) level of market intelligence. It infers that the respondents had adequate level of market intelligence which is one of the pre-requisite to become a successful entrepreneur.

22. Majority (69.78%) of the respondents had medium level of institutional support, followed by high (16.0%) and low (14.22%) levels. The study showed that there was appreciable extent of technical support but poor financial and marketing support which the respondents expect from such institutions.

23. Majority (74.22%) of the respondents had medium level of socio-capital aspects, followed by low (13.33%) and high (12.44%) level of socio-capital aspects. It can be inferred from the data that class and caste system in rural areas are becoming insignificant with the changing time.

It can be inferred from Table (5) that majority (53.33%) of the respondents were entrepreneurs in vermicompost making followed by stitching & embroidery (47.11%), mushroom production (29.78%), value addition to cereals and pulses (11.11%), apiculture (9.78%), fruit & vegetable preservation (4.44%)) and value added mushroom products (2.22%). None of the respondents had taken up value addition to garments and art & craft making technologies as an enterprise.

The data in fig. (3) shows that the income of the respondents ranged from Rs. 800 to 1000 per month in fruit & vegetable preservation enterprises, Rs. 150 to 1500 per month in stitching & embroidery enterprise, Rs. 500 to 1000 per month in value added

Rani, S. B and Rao, K. D. 2007. Perspectives of

Table 4. Distribution of respondents based on distance, adequacy and timelines of inputs

(N=225)

Distance	Frequency (f)	Percentage (%)
Within the village	25	11.11
Outside the village <5 km	75	33.33
Outside the village >5 km	125	55.56
Adequacy		
Adequate	99	44.00
Inadequate	59	26.22
Not available	67	29.78
Total	225	100.00
Timeliness		
Immediately	77	34.22
1-7 days	61	27.11
More than 7 days	87	38.67

Table 5. Distribution of respondents as entrepreneurs of homestead technology

(N=225)

Homestead Technology	No. of entrepreneurs (n)	Percentage (%)	Minimum net return (Rs./ month)	Maximum net return (Rs./ month)	Mean net returns (Rs./ month)
Fruit & Vegetable preservation	10	4.44	800	1000	960
Stitching & embroidery	106	47.11	150	1500	325
Value addition to garments	0	0.0	-	-	-
Art & craft making	0	0.0	-	-	-
Value addition to cereals & pulses	25	11.11	500	1000	742
Mushroom production	67	29.78	1000	3000	1400
Value added mushroom products	5	2.22	500	1000	780
Vermicompost technology	120	53.33	1500	5000	2050
Apiculture	22	9.78	1000	3000	1850

3000 per month in mushroom production enterprise, Rs. 500 to 1000 per month in value added mushroom products enterprises, Rs. 1500 to 5000 per month in vermicompost enterprises and Rs. 1000 to 3000 per month in apiculture enterprise.

The mean net returns were highest in vermicompost enterprise followed by apiculture, mushroom, value added products from cereals and pulses in second, third and fourth positions respectively.

Upadhyay *et al.* (2011) in their study reported that the suggestions given by rural women to overcome the constraints include availability of loan facility and subsidy, post harvest storage facility, availability of quality spawn, marketing facility, supply of information at right times, technical guidance through skill training and reduced cost of mushroom spawn. The most important considerations are market net working, intensive training program for mushroom cultivation and its value addition, formation of SHG for credit linkage and real empowerment of women.

CONCLUSION

It can be concluded from the results of the study that the respondents had medium level of overall personal, socio-economic, communicational, psychological and situational characteristics. Some of the homestead technologies have contributed significantly in improving the economic condition of rural women. There are still a number of homestead technologies that have not been taken up as enterprises by the rural women. Hence, there is a need to unearth reasons thereof and take appropriate remedial measures. As most of the enterprises can be carried out from their homes, there is more potential for these technologies in shaping the lives of rural women and making them economically empowered.

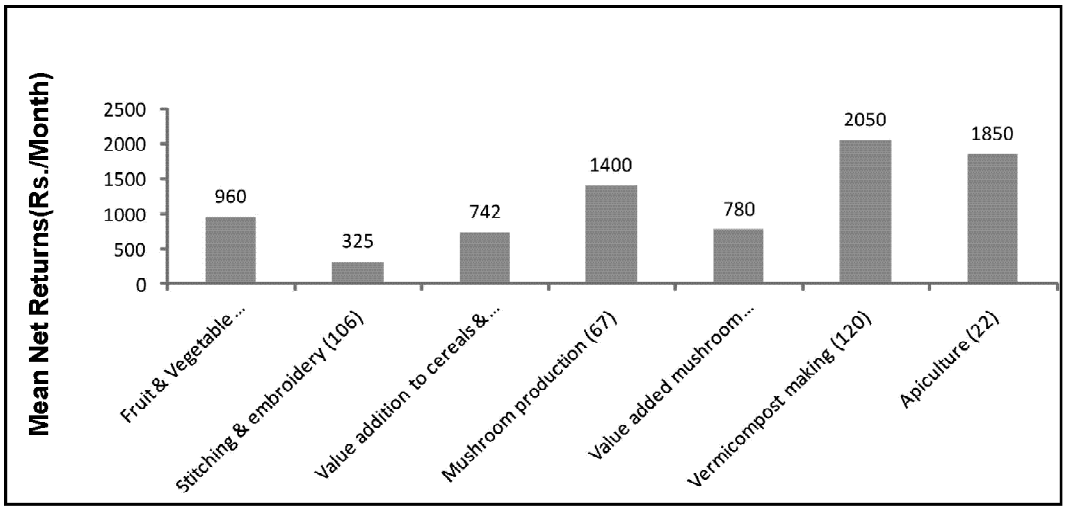

Fig. 3 Distribution of respondents as entrepreneurs of homestead technology

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TREND OF FERTILIZER CONSUMPTION IN TELANGANA

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ABSTRACT

Over the last three decades, N, P, K and total NPK and its per hectare consumption in Telangana observed an increasing trend. The absolute NPK consumption was increased by 4.6 times while per hectare consumption was increased by 4.3 times. The NPK per hectare consumption was 51 kg/ha during 1985-86 which increased to 221 kg/ha during 2014-15. The per hectare nitrogen consumption was more compared to phosphorous and potassic fertilizers during the study period. The CAGR of total NPK consumption was 5.25 per cent for the period of 30 years (1985-2015). The coefficient of variation of per hectare consumption of total NPK consumption was 36.58 per cent for the study period. The CAGR and coefficient of variation in consumption of K overtime was more than N and P. The ratio of per hectare consumption of N: P: K was 9:4:1 and 10:3:1 during 1985-86 and 2014-15 respectively. The per hectare fertilizer consumption in Telangana has deviated from the recommended doses for efficient use of fertilizer.

The agricultural production can be increased either by bringing more area under the plough or by increasing productivity. Cultivated land area has been shrinking due to increase in population and demand for other purposes. Owing to the limited net cultivated area, the only option available to increase the productivity is by using modern technology in an efficient way. The modern technology includes HYV seed, fertilizer, plant protection chemical, irrigation etc. The introduction of HYVs in Indian agriculture from 1966 onwards, gave a path to increase demand of inputs. Among these modern technology or inputs, fertilizers play a vital role in the modern agriculture technology. Fertilizer consumption per hectare is one of the important components for deciding yield rate in agriculture production. The application of essential plant nutrients, particularly major and micronutrients in optimum quantity and right proportion, through correct method and time of application, is the key to increased and sustained crop production. Nevertheless, the scientific crop production insisted on optimum input use. Therefore, it is important to understand fertilizer use behavior over time. With the growing popularity of modern agriculture, fertilizer consumption has increased in India over the years. Telangana State is 29th state of India formed on 2nd June 2014, bifurcated from erstwhile Andhra Pradesh. As several studies are done on undivided AP, the present paper examines the growth of chemical fertilizer consumption and its variation over time for Telangana State, which will help the policy makers as well as fertilizer industry to adopt corrective measures.

MATERIAL AND METHODS

The present study is done in Telangana State for the period of 30 years (1985-86 to 2014-15) of main fertilizer nutrient viz. nitrogen (N), phosphorous (P) and potash (K). The time series data were collected from the secondary published sources, *viz.,* various publications such as Fertilizer Statistics, New Delhi for the period of 1985-86 to 2011-13 and Season and Crop Report, Government of Telangana for the period of 2013-14 and 2014-15. The data interpretation is done with the help of averages, growth rate and coefficient of variation.

1. Compound Annual Growth Rate: The compound annual growth rate function was specified as follows:

$Y = AB^t e^u$

$Log (Y) = Log (A) + t Log (B)$

$CAGR = (Antilog (B)-1) X 100$

Where,

Y = Consumption

A = Intercept

t = Year

B = Regression coefficient

CAGR = Compound annual growth rate in terms of percentage.

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2. Annual Growth Rate

The annual growth rates of fertilizer consumption for different periods were calculated by using the formula given below

$$\text{Annual growth rate} = \frac{Y_t - Y_{t-1}}{Y_{t-1}} \times 100$$

Where, Y_t= Consumption at year 't', Yt -1 = Consumption at year t-1

3. Coefficient of Variation (C.V)

In order to study the variation in the fertilizer consumption over the year, co-efficient of variation has been estimated. The coefficient of variation is given as:

$$C.V = \frac{S.D}{Mean} \times 100$$

Where S.D= Standard deviation

RESULTS AND DISCUSSION

1. Relative consumption of fertilizer in Telangana to all India level

Consumption of fertilizer in Telangana State relative to that of India is shown in Table 1. It is evident from the table that the consumption of fertilizer both in all India and in Telangana State increased over the years. The fertilizer consumption in all India level increased from 84 lakh tonnes in 1985-86 to 256 lakh tonnes in 2014-15. Similarly, for Telangana State also the fertilizer consumption has increased from 2.41 lakh tonnes in 1985-86 to 11 lakh tonnes in 2014-15. The compound annual growth rate (CAGR) was 4.01 and 5.25 for all India and Telangana state data respectively during the 30 years of study. Further, the share of fertilizer consumption of Telangana to total all India level has increased over time, which was only 2.84 percent during 1985-86 increased to 5 percent during 2000s and it was further increased to 4.6 percent during 2014-15.

2. Pattern of fertilizers consumption in Telangana

In order to analyze the trends and fluctuations in the consumption of N, P, K and total NPK, the annual average growth rate was calculated as shown in Table 2.

From the table it was observed that the total NPK consumption was 2.41 lakh tonnes during 1985-86 increased to 11.27 lakh tonnes during 2014-15. Similarly, separate N, P and K consumption also increased over the years. Overall, total NPK consumption was increased 4.6 times during 1985-86 to 2014-15, while during the same period N, P and K consumption has increased 5.6, 3.8 and 5.1 times, respectively. The compound annual growth rate (CAGR) of total NPK consumption was 5.25 per cent for the period of 30 years (1985-2015). Among the major fertilizers, CAGR of K was highest (8.11 %) followed by N (5.12 %) and P (4.65 %). The reason for the higher CAGR of K is due to less consumption in 1980s as farmers give more preference to

Table 1. Share of fertilizer consumption of Telangana to all India (lakh tonnes)

	India	Telangana State	% share
1985-86	84.74	2.41	2.84
1990-91	125.46	5.52	4.40
1995-96	138.76	6.63	4.78
2000-01	167.02	8.73	5.23
2005-06	203.40	10.30	5.06
2010-11	281.22	14.81	5.27
2014-15	256.20	11.78	4.60
CAGR	4.01	5.25	

Source: Fertilizer Statistics, New Delhi and Season and Crop reports, Government of Telangana, various issues

Table 2. Nutrient wise consumption of fertilizers in Telangana (lakh tonnes)

	Nitrogen (N)	AGR	Phosphorous (P)	AGR	Potash (K)	AGR	NPK	AGR	N:P:K
1985-86	1.56	-	0.69	-	0.16	-	2.41	-	10: 4:1
1986-87	1.66	6.59	0.71	2.98	0.16	2.13	2.53	5.26	10: 4:1
1987-88	1.69	1.91	0.95	34.32	0.18	9.28	2.82	11.46	10: 5:1
1988-89	2.85	67.94	1.25	31.39	0.25	41.78	4.35	53.97	11: 5:1
1989-90	3.20	12.38	1.36	8.34	0.24	-2.51	4.80	10.37	13: 6:1
1990-91	3.62	13.07	1.61	18.34	0.30	21.73	5.52	15.00	12: 5:1
1991-92	3.50	-3.11	1.64	1.88	0.30	2.83	5.44	-1.34	11:5:1
1992-93	3.49	-0.34	1.49	-8.76	0.21	-30.40	5.20	-4.55	16: 7:1
1993-94	3.82	9.51	1.30	-13.17	0.22	6.13	5.34	2.86	17: 6:1
1994-95	4.14	8.15	1.37	5.72	0.34	50.05	5.84	9.32	12:4:1
1995-96	4.61	11.48	1.64	19.63	0.38	13.86	6.63	13.53	12:4:1
1996-97	4.89	6.01	1.58	-3.47	0.40	4.54	6.87	3.58	12:4:1
1997-98	4.14	-15.24	1.78	12.45	0.30	-26.36	6.22	-9.51	14:6:1
1998-99	4.70	13.55	1.99	12.08	0.44	50.66	7.14	14.89	11: 4:1
1999-2000	5.41	14.95	2.31	15.89	0.58	30.97	8.30	16.21	9:4:1
2000-01	5.74	6.22	2.37	2.42	0.62	6.92	8.73	5.21	9:3:1
2001-02	4.76	-17.19	1.95	-17.58	0.63	1.37	7.34	-15.97	8:3:1
2002-03	4.19	-11.97	1.50	-23.20	0.51	-19.34	6.19	-15.59	8: 3:1
2003-04	4.82	15.10	1.73	15.36	0.70	36.86	7.24	16.95	6:2:1
2004-05	4.23	-12.34	1.72	-0.30	0.88	26.23	6.83	-5.76	4:2:1
2005-06	6.47	53.14	2.66	54.24	1.17	32.79	10.30	50.79	5: 2:1
2006-07	6.16	-4.75	2.59	-2.39	1.28	9.51	10.04	-2.52	4:2:1
2007-08	6.62	7.46	2.61	0.53	1.49	16.23	10.72	6.79	4:2:1
2008-09	7.35	10.96	3.27	25.34	1.92	29.26	12.54	17.00	3:2:1
2009-10	6.82	-7.13	3.08	-5.80	1.70	-11.30	11.61	-7.42	4:2:1
2010-11	8.85	29.64	4.04	31.11	1.93	13.13	14.81	27.60	5:2:1
2011-12	8.66	-2.12	4.25	5.32	1.07	-44.36	13.98	-5.59	8:4:1
2012-13	7.38	-14.75	2.82	-33.64	0.81	-24.15	11.02	-21.22	9:3:1
2013-14	9.78	32.42	2.86	1.44	0.75	-7.30	13.39	21.55	13: 3:1
2014-15	8.27	-15.41	2.68	-6.29	0.82	9.24	11.78	-12.07	10:3:1
CAGR	5.12		4.65		8.11		5.25		
CV	42.26		43.05		76.16		43.65		

Source: Fertilizer Statistics, New Delhi and Season and Crop reports, Government of Telangana, various issues

nitrogenous fertilizer. But due to the awareness of importance of K along with increase in availability of this fertilizer, the growth of K consumption is higher than the other two fertilizers. This result is supported by the ratio of N:P:K, which shows that the share of nitrogen in the total consumption of NPK was higher in 1980s (N:P:K =13: 6:1 during 1989) and 1990s (N:P:K=17: 6:1 during 1993). However, the NPK ratio has reduced from 2000s onwards except for the two recent years i.e., 2013 and 2014.

The annual growth rate (AGR) of the consumption of fertilizer has shown a fluctuating

trend. The annual growth of total NPK consumption was highest during 1988-89 (53.97 %), which might be due to overall good monsoon condition prevailed in the country. The findings also coincided with the studies of Senger *et al.* (1996) and Jeyathi *et al.* (2013) at all India level. The total consumption of NPK showed a highest negative growth rate during 2012-13 (-21.22%). The annual growth rate of N consumption reached its maximum level of 67.94 per cent during 1988-89 and the lowest in 2001-02 (-17.19) The annual growth rate of P consumption reached its maximum level of 54.24 per cent during 2005-06 and its lowest during 2013-14 (-33.64 %). For K fertilizer, the maximum annual growth rate was observed during 1998-99 (50.66%). Further, total fertilizer consumption shows a maximum level of 53.97 per cent during 1988-89 while the lowest negative growth rate was observed during 2012-13 (-21.22 %). Thus, there were fluctuations in fertilizer consumption over the study years. The coefficient of variation for NPK was 43.65 per cent for a period of 1985-86 to 2014-15. Among these three fertilizer nutrients, highest CV in fertilizer consumption during the same period was observed in case of K (76.16 %) followed by P (43.05%) and N (42.26%).

3. Nutrient wise per hectare consumption of fertilizers in Telangana

The total fertilizer consumption in absolute terms may not give clear idea. Therefore, along with the examination of trend in absolute terms it is also appropriate to examine trend in fertilizer consumption per hectare of gross cropped area over time. The per hectare consumption of fertilizer in Telangana State was presented in Table 3. It is evident from the table that the per hectare consumption of individual nutrients and total NPK has increased over the years. The per hectare NPK consumption was 51 Kg/ha during 1985-86 which increased to 221 Kg/ha during 2014-15. The per hectare N consumption was more compared to P and K fertilizer during all the study years. The ratio of per hectare consumption of N:P:K was 9:4:1 and 10:3:1 during 1985-86 and 2014-15 respectively. The balanced recommended dose for N, P and K is 4:2:1 (Chand and Pandey, 2008). So, the per hectare fertilizer consumption in Telangana is deviated from the recommended doses for efficient use of fertilizer.

4. Growth and coefficient of variation of per hectare fertilizer consumption

The growth and coefficient of variation of per hectare fertilizer consumption was shown in Table 4. The CAGR of all the three fertilizers consumption and total NPK showed a positive growth rate over the study period. The growth rate of per hectare total NPK consumption was 4.58 per cent while growth rate among the separate fertilizer nutrients was highest in K (7.43 %) followed by N (4.46 %) and P (3.99 %). Both P and K has negative growth rate during 2005-06 to 2014-15. The coefficient of variation (CV) of per hectare consumption of total NPK was 36.58 per cent for the study years and it was highest during 1985-86 to 1994-95, however it was reduced in the subsequent decades. The CV of K was highest (71.85 %) followed by P (35.89 %) and N (34.79 %).

Table 3. Per hectare consumption of fertilizer in Telangana (Kg/ha)

	Nitrogen (N)	Phosphorous (P)	Potash (K)	NPK	N:P: K Ratio
1985-86	33.43	14.77	3.37	51.58	9:4: 1
1990-91	71.81	31.89	5.87	109.57	12:6:1
1995-96	99.46	35.36	8.27	143.09	12: 4:1
2000-01	110.81	45.66	12.01	168.48	9:4:1
2005-06	126.43	51.93	22.82	201.18	6: 2:1
2010-11	150.78	68.80	32.86	252.44	5:2:1
2014-15	155.58	50.46	15.50	221.54	10: 3:1

Table 4. Growth and coefficient of variation of per hectare fertilizer consumption in Telangana State

	Compound Growth Rate				Coefficient of Variation (CV)			
	Nitrogen	Phosphorous	Potash	NPK	Nitrogen	Phosphorous	Potash	NPK
1985-86 to 1994-95	12.55	8.95	7.18	11.26	33.75	26.44	25.33	30.44
1995-96 to 2004-05	0.12	0.67	10.26	1.02	5.99	11.75	33.58	7.03
2005-06 to 2014-15	2.29	-0.47	-8.40	0.57	8.71	16.53	36.49	8.97
1985-86 to 2014-15	4.46	3.99	7.43	4.58	34.79	35.89	71.85	36.58

CONCLUSION

From the above discussion it was concluded that, over the last three decades, N, P, K and total NPK and its per hectare consumption observed an increasing trend with slight fluctuation in some years. The absolute NPK consumption was increased by 4.6 times while per hectare consumption was increased by 4.3 times. During the year, 1988-89, fertilizer consumption showed a maximum annual growth rate. This might be due to favorable moonson and easy availability of fertilizers in the state. The per hectare N consumption was more compared to P and K fertilizer in all the study years. The CAGR of total NPK was 5.25 per cent for the period of 30 years (1985-2015). The ratio of per hectare consumption of N:P:K was 9:4:1 and 10:3:1 during 1985-86 and 2014-15 respectively, So, the per hectare fertilizer consumption in Telangana State is deviated from the recommended doses for efficient use of fertilizer. The growth rate and variation overtime was more for K than N and P.

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TECHNOLOGICAL GAP ANALYSIS IN CHILLI PRODUCTION TECHNOLOGY IN PRAKASAM DISTRICT OF ANDHRA PRADESH

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ABSTRACT

An ex-post-facto research design was used to analyze technological gaps in chilli production technology in Prakasam district of Andhra Pradesh during the year 2015-16. One hundred and fifty farmers from ten villages of five major chilli growing mandals represented the sample. Half of the farmers had medium technological gap followed by high and low gap. High technological gap was observed in the K fertilizer management (57.40%), manures use (55.11%), time of transplanting (54.46%), P fertilizer management (54.30), micronutrient management (51.80%), N fertilizer management (48.22%) and pest and disease management (46.67%). Education, farming experience, mass media exposure, innovativeness, economic motivation, extension participation and trainings undergone were negatively correlated with technological gap significantly at 0.01 level. The major constraints expressed by the chilli farmers were low market price, high incidence of thrips (92.00%), labour shortage (90.00%), increased cost of cultivation (87.33%), poor marketing facilities (80.00%), mixing of 2-3 insecticides in a single spray (78.67%), poor seed quality, insufficient irrigation facilities (76.00%), severe virus incidence (74.66%) and micro nutrient deficiencies (72.00%). More than half of the chilli farmers felt non availability of commercial nursery in the village (66.00%), colour patches on capsules with sprinkler irrigation (61.33%), spodoptera and midge problem (55.33%) and incidence of dieback and root rot (53.33%) were the constraints in chilli cultivation

Chilli is one of the important vegetable spices grown all over the world except in colder parts. Chilli is mainly used as culinary supplement to add flavour, colour, vitamin and pungency. India is the world leader in chilli production followed by China and Pakistan, with production of approximately 1.1 million tones annually. Chillies account for 20–30 per cent of India's total spice exports. India also has the maximum area dedicated to the production of this crop. Chilli is a universal spice of India. It is cultivated in all the states and union territories of the country. As per the latest statistics, India produced 800,100 tones of dry chilli from an area of 9, 30,000 hectares. India is the only country which is rich in many varieties with different quality factors. The major chilli producing states in India, namely, Andhra Pradesh, Karnataka, Maharashtra, Orissa, Rajasthan and Tamil Nadu, contribute around 86 per cent of the total area under chilli crop cultivation in the country and 90 per cent of the total Indian produce. Andhra Pradesh is the largest producer of chillies in India and contributed 26 per cent to the total area under chillies, followed by Maharashtra (15 %), Karnataka (11 %), Orissa (11 %) and Madhya Pradesh (7 %). The remaining states contributed 22 per cent of the total area under chillies. In Prakasam district chilli is one of the important commercial crops with an area of 7676 ha.

In spite of the various efforts, the improved technology is not generally accepted by the farmers in all respects. As such there always appear to be a gap between the recommended technology by the scientists and its use at farmer's level. Chilli cultivation could prove beneficial to the farmers dependent on this crop, only when the farmers take care of certain recommendations regarding technologies involved in the cultivation of Chilli crop. Moreover, as all of us known that development and acceptance of modern agricultural technology is the prime attention for increasing production, yet their cultivation pattern varies from farmer to farmer according to their personal, psychological and social characteristics. The new technology developed by Agricultural Universities and research institutes, it has been observed that either the same has not reached to the farmers' field or farmers are reluctant to adopt this technology. The technological gap is a major problem of increasing production in the country. Hence, the present investigation was undertaken with the objectives to study the level of technological gap of chilli production technology, to ascertain correlates

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of technological gap in chilli production technology and to analyze the constraints in chilli cultivation.

MATERIAL AND METHODS

Ex-post facto research design was adopted for the study. The study was conducted during 2015-16 in Prakasham district of Andhra Pradesh. Considering maximum area under chilli cultivation as criteria, five mandals *viz.*, Marturu, Parchuru, Inkollu, Karamchedu, and Ballikurava were selected. From each mandal two villages having highest area under chilli cultivation were selected purposively. From each selected village, 15 farmers growing chilli were selected by simple random sampling procedure, thus, making the total sample size 150. All the chilli recommended package of practices recommended by Y.S.R. Horticulture University, Andhra Pradesh were included in the schedule were administered to the respondents after pre-testing and the responses were obtained on a three point continuum as fully adopted, partially adopted and not adopted and scores of 3, 2 and 1 were assigned, respectively. Any remarkable deviation from adoption of normal recommendation was treated as partial adoption. The maximum score that a respondent could obtain was 54 and minimum was 18. The actual score was deducted from maximum score of the respondents to find out the technology gap of recommended practice of individual. Technology gap has been defined as the proportion of gap in the adoption of practices recommended and it expressed in percentage (Ray *et. al.,* 1995).

The technological gap of a particular practice expressed in percentage was:

$$\text{Technological gap} = \frac{\text{Maximum possible score} - \text{Actual score obtained}}{\text{Maximum possible score}} \times 100$$

The data on adoption levels of chilli farmers were collected by using pre tested schedule employing personal interview method. The respondents were divided into three categories *viz.,* low, medium and high based on their mean technological gap and standard deviation. The responses were scored, quantified, categorized, tabulated and analyzed using mean, standard deviation, frequencies and percentage. Correlation analysis was carried out to assess the relationship between profile characteristics of farmers and their technological gap. Each chilli farmer was also interviewed by posing open ended questions so as to unearth constraints he/she has experienced and analyzed by calculating frequencies and percentages.

RESULTS AND DISCUSSION

Technological gap in chilli production technology

It is evident from table 1 that, half (50.67%) of chilli farmers belonged to medium category of technological gap followed by high technological gap of 26.00 per cent and 23.33 per cent belonged to low technological gap category. The reason for medium and high technological gap was due to partial adoption of spacing, number of seedlings per hill, manure use, N,P,K fertilizer management and pest & disease management. The findings are in conformity with the findings of Goudappa *et al (*2012).

From table 2 it could be inferred that there was no technological gap with respect to land preparation, seed treatment, varieties/hybrids, method of transplantation, irrigation, weed management and harvesting. Being commercial crop, farmers were cultivating high yielding hybrids recommended to their areas. Further, farmers as a result of their farming experience have themselves realized the usefulness of these practices also; hence most of the respondents were convinced about the profitability and practicability of these recommendations. More technological gap was observed in the K fertilizer management (57.40%), manures (55.11%), time of transplanting (54.46%), P fertilizer management (54.30), micronutrient management (51.80%) and N fertilizer management (48.22%). Majority of the chilli farmers had applied nitrogen, phosphorus and potassium fertilizers more than recommended quantity. The reason given by the respondents for this behavior was that more fertilizer would give more yields. Also many respondents did not have the correct knowledge about the recommended fertilizer dosage. Possible reason for

over adoption of all the three (N, P and K) fertilizers might be 'lack of knowledge', most of them believed that application of recommended quantity of N,P,K fertilizer was not sufficient to get the expected yield and hence over adoption. Similar result was reported by Goudappa *et al (*2012). Farmers were unable to use recommended manure as it was a costly affair and insufficient quantities available to them. It was observed in the study area that cattle population was declining over the years due to high cost of their maintenance, hence resulting in reduced availability of FYM. The produced FYM might not be sufficient to meet the individual's requirement. The major reason for prevalence of micronutrient deficiencies was top dressing of complex fertilizers even at 4 months age of the crop. Another reason for more technological gap in micronutrient management was lack of knowledge of the farmers in diagnosing micronutrient deficiencies and disease symptoms. Considerable gap was recorded with respect to time of transplanting this was because of delayed monsoon and insufficient rains.

With respect to pest and disease management, 47 per cent gap was recorded. Pesticides and fungicides were applied more than recommended quantity by the respondents. The result has brought out the alarming situation prevailing in the study area. That is to say, if this situation continues then the pests become highly resistant and become difficult to control ultimately farmers have to stop growing Chilli due to high cost of cultivation and low quality products due to residual effect of chemicals. Hence, there is need to propagate the IPM practices by the concerned extension agencies on top priority. Spacing also another aspect where 37 per cent gap was recorded, as it is an important practice which decides the number of plants per acre in turn the yield level; farmers should be educated about the recommended spacing and its advantages. It could be seen from the table that there is one third of technological gap in number of plants/hill and post harvest technology. The major reason for number seedlings per hill was to maintain more number of plants per unit area due to lack of knowledge.

Relationship between personal and socio-economic characteristic of chilli farmers and their technological gap

Perusal of table 3 revealed that education, farming experience, mass media exposure, innovativeness, economic motivation, extension participation and trainings undergone were negatively correlated with technological gap significantly at 0.01 level. It is known that these are the variables which expose farmers to latest technologies and leads to higher adoption. This ultimately leads to reduced technological gap. Education was the factor which made the farmers to acquaint with day to day technological interventions leading to reduced technological gap. Farming experience was the variable which contributed for reduced technological gap as it facilitated adoption of suitable varieties with recommended packages of practices in chilli production with their vast experience. Mass media exposure was another important variable which helped the chilli farmers to be more knowledgeable with respect to recent chilli production recommendations. Farmers innovativeness was the major contributing factor for reduced technological gap as it facilitates them to get familiar with recent advances. Economic motivation also played a crucial role in reducing gap as the farmers with more economic motivation tried to adopt cost reduction and high yielding technological interventions. Through regular contact with the extension personnel of developmental departments, NGOs and other organizations, farmers come closer with change agents and tried to confirm the results of new technologies. This finding is in line with findings of Gopiram (2005). Training undergone impart knowledge and skill to the farmers on latest management practices. An individual who receives training become more knowledgeable, skilful and develop rationale and adopt improved farming practices which helped in reaping higher harvests. It was found that age, land holding and social participation were not significantly related with technological gap in chilli cultivation which indicated that there was no association between them. This finding is in conformity in the findings of Singh *et al*. (2010) , Raghavendra (2010) Kiranmayi *et al.,*(2016).

Table 1. Distribution of respondents according to their overall technological gap

n=150

Category	Frequency	Percentage
Low(<29.42)	35	23.33
Medium(29.42-37.15)	76	50.67
High(>37.15)	39	26.00
	150	100.00
Mean= 33.29		**SD=3.86**

Table 2. Technological gap in adoption of recommended chilli cultivation practices

n=150

S.No	Recommended practices	Technological gap
1.	Land preparation	0.00
2.	Seed treatment	0.00
3.	Seedling age	27.33
4.	No. of seedlings/hill	33.33
5.	Method of transplanting	0.00
6.	Time of transplanting	54.46
7.	Varieties/hybrids	0.00
8.	Spacing	37.33
9.	Manures	55.11
10.	N Fertilizers Management	48.22
11.	P Fertilizers Management	54.30
12.	K Fertilizers Management	57.40
13.	Micronutrients	51.80
14.	Pest and disease management	46.67
15.	Irrigation	0.00
16.	Weed management	0.00
17.	Harvesting	0.00
18.	Post harvest technology	33.33

Table 3. Correlation of personal and socio-economic characteristic of chilli farmers with their technological gap

n=150

S. No.	Independent variable	"r" value
1.	Age	0.16
2.	Education	-0.48 **
3.	Land holding	0.11
4.	Farming experience	-0.36 **
5.	Mass media use	-0.44 **
6.	Innovativeness	-0.61 **
7.	Social participation	0.21
8.	Economic motivation	-0.53 **
9.	Extension participation	-0. 35 **
10.	Trainings undergone	-0.65 **

** Significant at 1 per cent

Constraints expressed by the farmers in Chilli production

From table 4 it could be observed that great majority of the chilli farmers expressed low market price, high incidence of thrips (92.00%), labour shortage (90.00%), increased cost of cultivation (87.33%), poor marketing facilities (80.00%), mixing of 2-3 insecticides in a single spray (78.67%), poor seed quality, insufficient irrigation facilities (76.00%), severe virus incidence (74.66%) and micro nutrient deficiencies (72.00%) as their major constraints. The probable reason for the expressed major constraints was the chilli crop was grown as commercial crop which made the farmers to go for over adoption of chemical fertilizers as well as pesticides leading to not only increased cost of cultivation but also increased pest and disease incidence and micronutrient deficiencies. Poor seed quality was attributed to the prevalence of fake seed companies with increased demand for seed with increased area of cultivation. Due to insufficient rains with poor ground recharge was the reason for insufficient irrigation which was leading to increased cost of cultivation ultimately. Micronutrient deficiencies were the major constraint which was due to over adoption of phosphoric fertilizers as top dressing throughout the crop reason. Hence there is even need to educate farmers on quality seed purchase, right time and method of chemical fertilizer and pesticide application by the department of Horticulture.

More than half of the chilli farmers felt non availability of commercial nursery in the village (66.00%), colour patches on capsules with sprinkler irrigation (61.33%), spodoptera and midge problem (55.33%) and incidence of dieback and root rot (53.33%) were their major constraints. Majority of the farmers were depending on commercial nurseries which results in vulnerability to viral diseases. Almost fifty per cent (48.00%) of the farmers expressed poor net returns was the major problem. This problem was attributed to increased cost of cultivation and high price fluctuations. Non availability of cold storage facilities locally (42.66%), indiscriminate use of pesticides (36.00%), root grub problem (34.00%) and leaf spot diseases (30.66%) were some of the other constraints perceived by the chilli farmers of Prakasam District. Biradar and Chandrgi (2013) in their study, 'Socio Economic Profile of Chilli Farmers and their Constraints in Chilli Cultivation in North Eastern districts of Karnataka' revealed that majority (78.33%) of the farmers expressed problem of price fluctuation followed by inadequate irrigation (62.50%) and same per cent of them expressed the non availability of labourers at critical stages and high wages, non-availability of good quality inputs at proper price at right time (59.17%).

Table 4. Constraints expressed by the farmers in Chilli production

(n=150)

S. No.	Constraints	Freq	Per cent
1.	Low market price	138	92.00
2.	High incidence of thrips	138	92.00
3.	Labour shortage	135	90.00
4.	Increased cost of cultivation	131	87.33
5.	Poor marketing facilities	120	80.00
6.	Mixing of 2-3 insecticides in a single spray	118	78.67
7.	Poor seed quality	114	76.00
8.	Insufficient irrigation	114	76.00
9.	Severe Virus incidence	112	74.66
10.	Micronutrient deficiency	108	72.00
11.	Non availability of commercial nursery in the village	99	66.00
12.	Colour patches on capsules with sprinkler irrigation	92	61.33
13.	Spodoptera and midge problem	83	55.33
14.	Incidence of dieback and root rot	80	53.33
15.	Poor net returns	72	48.00
16.	Non availability of cold storage facilities locally	64	42.66
17.	Indiscriminate use of pesticides	54	36.00
18.	Root grub problem	51	34.00
19.	Leaf spot diseases	46	30.66

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RESOURCE PRODUCTIVITY AND PRICE SPREAD ANALYSIS OF PADDY MARKETING IN ANDHRA PRADESH

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ABSTRACT

The present study was undertaken in the year 2011-12 in Nalgonda district of Andhra Pradesh to study the resource productivity and price spread analysis of paddy. A sample of 15 farmers and 70 intermediaries were selected. Cobb Douglas production function analysis was employed to know the resource productivity of paddy. The coefficient of multiple determination, R^2 indicated that 77 percent of the variation in income was explained by the independent variables included in production function. Production coefficient of area and marketing costs had turned out to be significantly influencing the income of the farmers. Labour costs were negatively significant. Returns to scale was 1.81 which is more than unity indicating increasing returns to scale. Two marketing channels were identified for price spread analysis in the study area. Marketing costs borne by producer, trader, processor, wholesaler and retailer were Rs.117.02, Rs. 40.63, Rs. 96.46, Rs. 96.28 and Rs. 34.18 in channel I. Marketing costs borne by producer, processor, and retailer in channel II were Rs. 115.86, Rs. 118.72 and Rs. 39.60. In channel I retailer secured high margin followed by processor, wholesaler and trader. Producer share in consumer's rupee was high in channel I (70.66) compared to channel II (58.80). Marketing efficiency in channel II was high compared to channel I.

Paddy is one of the principal crops which is staple diet of the majority of population in the country. The area under paddy cultivation in India was 39.16 M ha and production was 85.59 MT in India. In Andhra Pradesh the area under paddy cultivation in 2011-2012 agricultural year was 3.2 lakh hectares and production was 104.88 lakh tones in the year 2013. The income from paddy not only depends on the production but also on its efficient marketing. The paddy growers of Nalgonda district have been using different marketing channels for its disposal and feel that the intermediaries enjoy the undue share of consumers rupee which effect their margin. A dynamic and vibrant marketing system with adequate supply chain infrastructure has been felt necessary to keep pace with the changing agricultural production and growing marketable surplus. To achieve an efficient system of buying and selling of agricultural commodities, most of the state governments and Union Territories have enacted legislations to provide for development of agricultural produce markets. The purpose of regulation of agricultural markets was to protect farmers from the exploitation of intermediaries and traders and also to ensure better prices and timely payment for his produce. Farmer cannot sell his produce directly in bulk except on retail basis to the consumers. Farmers have to bring their produce to the market yard. The processor can not buy the produce at the processing plant or at the warehouse. The produce is required to be transported from the farm to the market yard and then only it can be purchased and taken to the plant. There is thus an enormous increase in the cost of marketing and the farmers getting a low price for their produce. Therefore, present study was undertaken to work out the resource productivity and producers share in consumer rupee through various marketing channels.

MATERIAL AND METHODS

The present study was carried out in Nalgonda district of Telangana. Suryapet Agricultural Market Committee was selected for present study. A sample of 15 farmers and 70 intermediaries which consists of 15 commission agents, 15 traders, 10 processors, 15 wholesalers and 15 retailers were selected. Cobb- Douglas production function was selected to know the resource use efficiency. The usual form of the Cobb-Douglas production function is as follows:

$$Y = a X_1^{b_1} .. X_2^{b_2} ... X_3^{b_3} ..... X_n^{b_n} ..... \mu$$

Y = Gross income in rupees per hectare; X_1 = Area in hectares; X_2 = Material costs in rupees per hectare; X_3 = Labour charges in rupees per hectare;

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X_4=Productivity quintal per hectare; b_1 to b_4 = Production elasticities of factors X_1 to X_4; a = Intercept; 'μ' is the random error.

Returns to scale : The sum total of production elasticities of all the inputs (S b_i) indicate returns to scale. If , S b_i =1 Constant returns to scale ; S b_i > 1 increasing returns to scale; S b_i < 1 decreasing returns to scale. Marginal value productivity indicates the expected increase in gross income forthcoming from the use of an additional unit of relevant input, while the level of other inputs remaining unchanged. The estimated coefficients of the relevant independent variables were used to compute the marginal value products (MVP) and their corresponding marginal factor costs (MFC). The ratio of the MVP to MFC was used to determine the resources efficiency as shown in the following equation (Rahman and Lawal 2003). r = MVP/MFC. As the MFC is price of input per unit, the MFCs of all the inputs will vary while calculating the ratio of MVP to MFC. However, the denominator will always be one, and therefore, the ratio will be equal to their respective MVP (Majumder *et al*. 2009).

Total marketing costs

Total marketing cost is both in cash or in kind incurred by the producer and the various intermediaries involved in the sale and purchase of the commodity till the commodity reaches the ultimate consumer. This is computed as follows

$C = C_f + Cm_1 + Cm_2 + Cm_3 + Cm_4 + \ldots\ldots\ldots\ldots Cm_m$

C = Total cost of marketing of the commodity

C_f = Cost paid by the producer from the time the produce leaves the farm till he sells it

Cm_1 = Cost incurred by i^{th} middleman in the process of buying and selling the product.

Price spread is the difference between the price paid by the consumer and price received by the producer for an equivalent quantity of farm produce.

This is the difference between the total payments (cost+ purchase price) and receipts (sale price) of the middleman (i^{th} agency). The percentage margin of i^{th} middleman Pmi was calculated.

$$Pmi = P_r - (P_{pi} + Cmi) / P_m$$

Where,

Pmi = Percentage margin of i^{th} middleman.

Pri = Total value receipt per unit (sale price)

Ppi = Purchase price of good (purchase price)

Pmi = Cost incurred in marketing per unit.

Producer's share in consumer's rupee

It is the price received by the producer as a percentage in the consumer's price. If P_c is consumer's price and P_F is the producer's price, then the producer's share in consumer's rupee (P_s) is expressed as follows.

$$Ps = \frac{P_F}{P_c} X\,100$$

Analysis of marketing efficiency under different marketing channels.

For this Shepherd's formula and Acharya's method were used to draw appropriate conclusions. Shepherd suggested that the ratio of the total value of goods marketed to the marketing cost is a measure of efficiency. Higher value of marketing efficiency (ME) indicates higher efficiency and vice-versa.

$$ME = \left[\frac{V}{I} - 1\right] X\,100$$

Where

ME = Index of marketing efficiency

V = Value of the goods sold or price paid by the consumer (retail price)

I = Total marketing cost

Acharya suggested that ratio of price received by the farmer to sum of the marketing cost and marketing margins is a measure of efficiency. Higher value of marketing efficiency (ME) indicates higher efficiency and vice-versa.

$$ME = \frac{FP}{MC+MM}$$

Where

ME = Index of marketing efficiency

FP – Price received by the farmer

MC – Total marketing costs

MM – Net marketing margins

RESULTS AND DISCUSSION

Cobb-Douglas production function analysis was taken up to know the resource use efficiency of paddy and presented in Table1. From the coefficient of multiple determination, R^2 for the production function fitted for paddy farmers indicated that 77 percent of the variation in income was explained by the independent variables included in production function. Production coefficient of area had turned out to be positive and significant at 1 per cent level. The coefficient for material costs had turned significant at 5 per cent level. The area under paddy cultivation had an elasticity of 0.50, indicating that one per cent increase in the land area would bring 0.50 per cent increase in the production. These results are corroborated with a similar study done by Suresh and Reddy (2011). Similarly, a one per cent increase in material costs would bring 1.38 per cent increase in the production. Hence increasing these factors would substantially contribute to income of paddy growing farmers. The expenditure incurred on labour showed a negatively significant effect indicating their excessive use. The returns to scale were 1.810 which is more than unity and thus characterized by increasing returns to scale. The allocative efficiency indicated the price response of the farmers. The allocative efficiency of 1 indicated that the farmers were price efficient in allocating that particular resource in paddy cultivation. The allocative efficiency of more than 1 indicates the under-utilization of that particular resource and scope to increase in its application till the ratio is reached to 1. The results indicated that the MVP to MFC ratio was highest in the case of area (15.05) followed by material costs (5.30). This indicated that bringing in more land under paddy cultivation would bring out the economies of scale and would result in higher productivity. The result for material costs indicated that an increase of one rupee in material cost would yield a return of Rs 5.30. This showed that the application of material should be enhanced in the paddy cultivation to reap higher benefits. While the MVP to MFC ratio turned to be negative on expenditure towards labour (-1.65) implying uneconomic and excessive use of labour. Hence there is need to reduce the use of labour to produce the same level of production.

Table 1. Cobb - Douglas production function estimates and MVP to MFC ratios of paddy

Variables	Coefficients	MVP/MFC
Intercept	24.846	
Area (ha)	0.505 *** (0.171)	15.05
Material costs(Rs)	1.380 ** (0.643)	5.30
Labour costs(Rs)	-0.151 ** (0.076)	-1.65
Productivity(qt)	0.076 (0.150)	-
Returns to scale	1.810	
R^2	0.77	
N	15	

Note: 1) Material costs include seed, FYM, fertilizers, plant protection chemicals.

2) Labour costs include ploughing, sowing, manures, fertilizers and plant protection chemical application and harvesting costs.

3) Figures in parenthesis are standard errors

4) **Significant at 5 % level, ***Significant at 1% level

Marketing costs, margins and price spread in paddy

Marketing channels are the routes through which produce reaches the final consumer. Two predominant marketing channels were identified in the study area. Channel-I consists of Producer - Commission agent - Processors (Rice millers) - Wholesaler - Retailer - Consumer. Channel-II consists of Producer - Processors (Rice millers) - Retailer - Consumer. The farmers in channel-I bring their produce to Suryapet market. In Channel-I, commission agents act as important market intermediaries and producers sell the produce to processors through commission agents. Paddy is marketed through secret tender system in the Suryapet APMC. Most of the processors in channel - I are trader - cum - processors. In channel II, producers sell their produce to local processors through local agents/brokers. After processing, rice is purchased by retailers through brokers. The retailers purchase rice from processors and in turn sell to consumers.

The costs incurred by producer and intermediaries in handling paddy were worked out and presented in Table 2. Channel I was predominant in Suryapet market which is the major market for paddy. The trader purchases the paddy through secret tender system at APMC, Suryapet. Total marketing costs i.e., percent share in consumers price for paddy was 24.87 per cent in channel I and 24.17 percent in channel II and total profit margins of intermediaries i.e., percent share in consumers price was 22.18 per cent in channel I and 16.29 per cent in channel II. Out of total marketing costs (Rs. 499.11 in channel I and Rs. 431.18 in channel II), about 54.39 percent was incurred at rice miller level, 8.14 per cent at traders level, 6.84 at wholesalers level and 7.16 at retailers level in channel I. In case of channel II, marketing costs at processors level was 66.54 per cent and at retailers level 8.52 per cent. The rice millers incurred an amount of Rs. 175.05 and Rs. 190.53 per quintal of paddy towards processing in channel I and channel II. It was observed from Table 3 that producers share in consumers rupee was higher in channel II (70.64 per cent as against 58.80 per cent in channel I). In channel II farmer sells his produce directly to the processor which will reduces the number of middleman problem. These results were corroborated with Parveender *etal* (2013) that marketing costs of paddy in channel I and channel II were Rs. 451.01 and Rs.498.52 in their study. About 54.39 percent of cost was incurred at the rice miller level, (34.18 per cent at wholesaler level, 35.77 per cent of costs at retailer level). Zala and Gondaliya (2011) concluded that the percentage cost for processing of paddy per quintal was 50 at rice millers level in middle Gujarat state. Farmers received a net price of Rs. 1062.98 and Rs. 1144.14 per quintal of paddy in channel I and channel II respectively. Total marketing margin includes 27.08 percent of rice millers, 13.53 per cent of traders, 21.62 percent of wholesalers and 37.74 percent of retailers in channel I. In channel II marketing margins at processors level was 53.55 per cent and at retailers level 46.44 per cent. From Table 3, it was evident that the consumers purchasing price or retailers selling price of one quintal of rice was Rs. 3351.11 and Rs. 2973.23 in channel I and channel II respectively. Producers share in consumers rupee was high in channel II (70.66) compared to channel I (58.80). Thus it is clear that the marketing channel in which marketing costs and margins were low had turned out to be most efficient. The marketing efficiency in Acharya's and Shepperd methods were high in channel II compared to channel I. Marketing efficiency was 1.24 in channel I and 1.66 in channel II in Acharya's method and 4.02 in channel I and 4.03 in channel II in Shepherd's method.

CONCLUSION

Paddy is an important market oriented crop in Telangana. From the results obtained in this study it is concluded that the sum of elasticities ("bi) of paddy was 1.810, indicating increasing returns to scale. Two marketing channels were identified in the study area. Marketing costs and margins were high in channel I compared to channel II because of involvement of more number of intermediaries. Producer's share in consumer's rupee was high in channel II than channel I. Suryapet market is very big market for paddy arrivals. At the time of bulk arrivals market will not be able to accommodate the farmers produce. The price received by the farmers was lower in the post harvest period. Farmer who could withhold their produce and sold in later period will receive higher prices. The purchase of paddy was under taken by three major agencies i.e. village merchant (village sale), traders and processors (regulated market sale). Direct selling to rice-millers rather than traders is the

best alternative for paddy growers for fetching highest net price in regulated markets. Tendency of paddy sale in post harvest season should be minimized by developing suitable sized storage structures, preferably by constructing godowns in villages and linking of credit advancement with marketing of the produce through cooperative marketing societies.

Table 2. Marketing costs for paddy (Rs/q)

S.No	Particulars	Channel I		Channel II	
		Paddy (Rs/q)	Rice (Rs/q)	Paddy (Rs/q)	Rice (Rs/q)
1	**Costs incurred by producer**				
	a) Labour charges	10.05	16.78	13.54	22.61
	b) Gunny bag	20.15	33.65	21.48	35.87
	c) Transportation	45.00	75.15	37.86	63.22
	d) Weighing charges	3.03	5.06	3.17	5.29
	e) Commission charges	23.60	39.41	25.20	42.08
	e) Miscellaneous	15.19	25.36	13.91	23.22
	Total	**117.02**	**195.42**	**115.86**	**193.48**
2	**Costs incurred by trader**				
	a) Labour charges	9.25	15.44	--	--
	b) Rent for Building	15.00	25.05	--	--
	c) Market fee	16.38	27.35	--	--
	Total	**40.63**	**67.85**	--	--
3	**Costs incurred by processors**				
	a) Loading and unloading	5.15	8.60	8.97	14.97
	b) Transportation	30.57	51.05	32.76	54.70
	c) Bagging	23.70	39.57	35.34	59.01
	d) Weighing charges	3.64	6.07	3.50	5.84
	e) Broker Charges	21.60	36.07	25.15	42.00
	c) Market fee	11.80	19.70	--	--
	Total	**96.46**	**161.08**	**105.72**	**176.52**
4	**Costs incurred by wholesaler**				
	a) Transportation	17.96	30.00	--	
	b) Hamali	5.22	8.73	--	
	c) Broker charges	10.92	18.25	--	
	Total	**34.18**	**56.98**	--	
5	**Costs incurred by retailer**				
	a) Transportation	16.01	26.75	13.61	22.73
	b) Bagging	4.79	8.00	5.61	9.38
	c) Hamali	3.89	6.50	4.79	8.00
	d) Weighing	3.47	5.80	3.10	5.18
	e) Brokerage charges	7.53	12.58	12.48	20.85
	Total	**35.77**	**59.63**	**39.60**	**66.14**

Note: Channel-I: Producer- Commission agent - Processors (Rice millers) -Wholesaler - Retailer- Consumer. Channel-II: Producer- Processors (Rice millers) - Retailer- Consumer.

Table 3. Price spread and marketing margins for paddy and Rice (Rs/q)

S.No	Particulars	Channel I		Channel II	
		Paddy	Rice	Paddy	Rice
1.	**Producer**				
	Gross price received	1180.00	1970.60	1260.00	2104.20
	Marketing costs	117.02	195.42	115.86	193.48
	Percent share of costs	23.44	23.44	24.93	24.93
	Net price received	1062.98	1775.18	1144.14	1910.72
2.	**Trader**				
	Marketing costs	40.63	67.85	--	--
	Percent share of costs	8.14	8.14		
	Margin	60.28	100.66	--	--
	Percent share of margins	13.53	13.53		
3.	**Processor**			--	--
	Purchase price	1280.91	2139.11	1144.14	1910.72
	Marketing costs	96.46	161.08	118.72	198.26
	Processing costs	175.05	292.33	170.53	284.78
	Percent share of costs	54.39	54.39	66.54	66.54
	Margin	120.60	201.40	155.64	259.91
	Percent share of margins	27.08	27.08	53.55	53.55
4.	**Wholesaler**				
	Purchase price	1672.42	2793.92	--	--
	Marketing costs	34.18	56.98	--	--
	Percent share of costs	6.84	6.84		--
	Margin	96.28	160.48	--	--
	Percent share of margins	21.62	21.62		--
	Selling price	1802.88	3011.38	--	--
5.	**Retailer**				
	Purchase price	1802.88	3011.38	1609.03	2687.08
	Marketing costs	35.77	59.63	39.60	66.14
	Percent share of costs	7.16	7.16	8.52	8.52
	Margin	168.06	280.10	134.95	225.38
	Percent share of margins	37.74	37.74	46.44	46.44
6.	Consumer Purchase price	2006.71	3351.11	1783.58	2973.23
7.	Total cost incurred	499.11	833.29	431.18	720.92
	Percent share in consumers price	24.87	24.87	24.17	21.48
8.	Total profit margin	445.22	620.76	290.59	485.29
	Percent share in consumers price	22.18	22.18	16.29	16.29
9.	Price spread (C_p-P_p)	826.71	2064.45	523.58	869.03
	Producer share in consumer price	58.80	58.80	70.66	70.66
	Marketing Efficiency (Acharya method)	1.24	1.24	1.66	1.66
	MarketingEfficiency(Sheperd's method)	4.02	4.02	4.13	4.13

Note: 1 quintal of paddy produce 60 kg rice, 19 kg broken rice, 10 kg bran, 20 kg husk, 3 kg waste. * 1 qt of rice is equivalent to 167 kg of paddy.

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INFANT AND YOUNG CHILDREN FEEDING PRACTICES AND NUTRITIONAL STATUS OF TRIBAL CHILDREN

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ABSTRACT

Nutritional status of children is directly affected by infant and young child feeding practices below two years of age, ultimately impacts survival. The ideal food for the young infant is human milk which has the specific characteristics that match the growing infants' nutritional requirements. Cross sectional study was carried out to know the infant and young child feeding practices in Mahabubnagar district of Telangana state, which is major cause for latter development of children. Purposive random sampling technique was used to select the subjects for the study. Subjects for the study comprised of 120 members. Mothers with youngest child in the age group of 4 – 24 months were included in the study. Simple descriptive statistics was used for analyzing the results. The study revealed that young children feeding practices and diet during pregnancy were the major contributing factors for malnutrition among the children. Forty per cent of the mothers are ignorant about the importance of colustrum, 63 per cent of mothers have low awareness on timely initiation of breast feeding, 43 per cent of mothers were unaware of type of foods to be given and initiation time weaning. Only 7 per cent tribal women initiated breast feeding within one hour. Forty per cent of children were in mild nutritional status. Prevalence of malnutrition was due to delayed initiation of supplementary foods. Malnutrition continues from infancy and it effects child growth and development in latter stages of life.

Infant feeding practices comprise of both breast feeding as well as complimentary feeding and plays a major role in determination of growth and development of children. Infant and young child feeding practices below two years directly affects child's survival, hence it is very important stage for improved nutrition, health and development of children. Appropriate diet is essential for proper growth and development of children especially in the first two years of life, (Aggarwal *et al.* 2008). World Health Organization recommends (WHO, 2008) exclusive breast feeding for the first six months of life, with the addition of complementary feeding from the six months of life and continued breast feeding for at least two years of life. Early introduction leads to displacement and late introduction leads to malnutrition. Displacement of breast feeding can lead to infections and indigestion due to various foods, which further contributes to weight loss and malnutrition.

Breast feeding is healthiest and best food for the growth of children. Feeding different foods according to age is also important method that fulfils the infants' needs and child morbidity and mortality. After birth, the health of the baby depends upon the nurturing practice adopted by the family. Breast milk is the natural first food for babies, it provides all the energy and nutrients that the infant needs for the first few months of life. It is also important for sensory and cognitive development and also protects the infant against infectious and chronic diseases. Exclusive breastfeeding for 6 months is the optimal way of feeding infants. For all infants, breastfeeding remains the simplest, healthiest and least expensive feeding method that fulfils the infants' needs. It has been observed that infants aged 0-5 months if not breastfed have seven-fold and five-fold increased risk of death from diarrhoea and pneumonia. The United Nations Children's Fund (UNICEF,1996) has estimated that exclusive breastfeeding in the first six months of life can reduce under-five mortality rates by 13% in developing countries. Breast-feeding has declined worldwide in recent years, as a result of urbanization, marketing of infant milk formulae and maternal employment outside the home. Studies in India have also shown a decline in breast-feeding trends, especially in urban areas. The breast feeding practices vary among different regions and communities in India. Frequent monitoring of changing trends in these practices is therefore necessary in societies undergoing highly dynamic states of development. Infant feeding practices refer generally to meet nutritional and immunological needs of the body at different stages of child's growth. Breast milk is vital for a child's survival.

However, faulty habits arising from ignorance, superstition and wrong beliefs are responsible for aggravating malnutrition in communities. The effect

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of infant feeding practices are largely socio-economic. Unfortunately, majority of children in India live under such economic and environmental conditions that hamper their growth and development. The increase in age of the baby leads to increased food requirement for healthy and strong growth. The baby requires different nutrients which must be provided through supplementary foods from 6 months of age. The awareness of mothers regarding feeding practices affect the nutritional status and health of infants, which can be vastly improved through nutrition education, health related awareness and cooperation of mothers. Therefore, in the present paper, an attempt has been made to find the feeding practices of infants and young children among tribal women.

The key childcare practices that could impact on child nutrition include care of pregnant and lactating mothers, breast feeding and feeding young children, care of children during illness, psychosocial care of children, food preparation, storage and hygiene. However, these practices are largely, dependent or modified by availability of resources for its implementation. These resources include family factors like knowledge and beliefs with regards to child rearing, the health and nutritional status of the care provider, control of resources and autonomy for child care like role of gender in society such as decision making role and employment of caregiver, workload and time constraints for providing child care and social support, such as availability of alternate caregivers, sharing of workload, father's role in child care and community support. Intrinsic characteristics of child is also important as some children may grow well and thrive in the absence of good care whereas, more care is required for some children who are born with low birth weight and birth defects. The present study aimed at to study the feeding practices of young children among tribal families.

MATERIAL AND METHODS

Cross sectional study was undertaken to identify the infant and young child feeding practices among tribal families in Telangana state. Mahabubnagar district was selected for the present study. Purposive sampling was used to select the subjects, mothers with younger children in the age group of 4-24 months were included in the study. These mothers were selected by house-to-house survey with the help of anganwadi workers. Total 120 mothers were interviewed in local language with the help of pretested and predesigned proforma. The relevant information regarding the socio-demographic structure of family and the infant feeding practices followed in young children were noted by observation and interviewing the respondents. The result was analyzed and discussed by using frequencies and percentages.

RESULTS AND DISCUSSION

Table 1. Socio economic profile of tribal families

(N= 120)

S.No	Socio economic profile	Frequency	Percentage
1.	**Age distribution in years**		
	20-25	83	69
	25-30	19	16
	30-35	18	15
2	**Type of family**		
	Nuclear	93	78
	Joint	27	22
3	**Literacy status**		
	Illiterate	78	65
	Primary	25	21
	Graduation	17	14
	Post graduation		
4.	**Income source**		
	Wage labour	63	53
	Agriculture	34	28
	Petty business	23	19

From the table, it was found that 69 percent of women were in the age group of 20-25 and it was followed by 16 percent of subjects in the age group of 25 - 30 years of age. Only 15 percent were in the age group of 30-35 years. Seventy eight percent of women were from nuclear families and twenty two percent of subjects were from joint families. Sixty five percent of women had no schooling, followed by twenty one percent of subjects had primary level of education. Only few fourteen percent of subjects were graduates. Income sources of these subjects were daily wages, agriculture and petty business. Fifty two percent of subjects were engaged as wage labor, twenty eight percent worked in their own agriculture farm and twenty percent were earning income through petty business.

breast milk. Sixty one percent of subjects gave honey and 39 percent gave sugar water to the new borns. It was told during group discussion that feeding colustrum was not good for health, hence it was discarded. Sixty three percent of families initiated breast feeding after six hours, thirty percent of subjects initiated breast milk within six hours and only seven percent within one hour.

Reasons for discarding colustrum reported were such as causing diarrhoea and as not good for health. Forty three percent of women reported that initiation of supplementary foods after one year and only 37 percent of women initiated supplementary foods within one year. The findings were similar with

Table 2. Infant and Young children feeding practices

(N=120)

Details of feeding practices	Frequency	Percentage
Fed	33	27
Not Fed	87	73
Pre lacteal feeds		
Honey	73	61
Sugar water	47	39
Initiation of breast milk		
< One hour	9	7
1 - 6 hours	36	30
> 6 hours	75	63
Reasons for discarding colustrum		
Bad for health	47	40
Causing diarrhea	73	60
Introduction of supplementary foods		
6 months	23	20
6 - 12 months	45	37
> 12 months	52	43
Type of complementary foods		
Cereals	47	40
Cereals and vegetables	13	11
Cereals and pulses	43	36
Fruits	6	5
Animal and poultry products	11	8

From the table it was found that 73 percent of subjects, did not fed colustrum to their babies and only 27 percent fed colustrum . Jaggery or sugar water was given immediately after birth, instead of

with Dasgupta, 2014 who reported that 34 percent had started breastfeeding within one hour after birth, 29 percent did not get colostrum and 31 percent had pre lacteal feeding mainly in the form of water and

Table 3. Frequency distribution of children (<1 year) based on nutritional status

(N=45)

Mid arm circumference	Nutritional status of children	Frequency	Percentage
>14	Normal	15	33
12.5-14	Mild & Moderately malnourished	21	47
<12.5	Severely malnourished	7	16

honey only. It was recommended that initiation of breast feeding should be within one hour after birth and no pre lacteal foods should be given after birth. It was also recommended that complementary feeding should be given along with mother's milk by the age of six with locally available food, but the study revealed that only 6 percent of children of less than six months of age and thirty two percent of 6 to 23 months of age had started complementary feeding before reaching six months. Forty percent of women were un aware of importance of colustrum, as it boosts immunity of the child. Type of foods that were given to children included cereals and pulses. Majority of the subjects revealed that egg and meat products were introduced after three years. Fruits were rarely given to the children. Most of the supplementary foods were based on cereals. Only thirty six percent of women reported that they feed the children with rice mixed with dhal water by adding salt to it.

From the table , it was found that 47.0 percent of children were in the mild nutritional status and followed by 33.0 percent of children in normal nutritional status. Forty seven percent of children were in mild nutritional status, sixteen percent of children were in moderate nutritional status and 4.0 percent of children were in severely under nourished. These findings were similar with study conducted by Rao, K.M. (2015), where the overall wasting among under five children was about 13.0 percent. However, it was high (15.3%) among infants (weight-for-length, <median-2SD). About 5.0 per cent of children in general, had severe wasting (weight-for-length, <median-3SD) indicative of severe acute malnutrition (SAM).

CONCLUSION

Findings of the study revealed that only few mothers had awareness on importance of breast feeding and initiation of breastfeeding after one hour. Though maternal and child health care facilities were available, knowledge on young child feeding practices was low. This implies that there is a need to deliver the knowledge related to young child feeding practices to reduce the spectrum of problems related to malnutrition.

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EFFECT OF ORGANIC ZINC SUPPLEMENTATION ON PERFORMANCE, BIOCHEMICAL PARAMETERS AND DEPOSITION OF ZINC IN EGGS IN WHITE LEGHORN LAYERS

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ABSTRACT

An experiment was conducted with an aim to study the effect of organic Zn supplementation on performance, egg quality parameters, biochemical parameters and retention of Zinc in White Leghorn layers. One forty four layers at thirty eight weeks age were randomly allotted to 144 replicates considering each bird as a replicate. The hens were reared in individual California type cages having the provision of individual feeding. A corn-soybean meal, deoiled ricebran basal diet (BD) was prepared for layers to meet the nutritional requirements, as recommended by NRC (1994) except Zn. Experimental diets were viz., BD with 35 ppm Zn supplementation from ZnSO4 (inorganic) and BD with Zn- bioplex (organic) at 35, 70 and 105 ppm. Each diet was allotted to 36 replicates and fed ad libitum from 38 to 50 weeks of age. Body weights, feed intake and feed conversion ratio (FCR) were measured period wise. At the end of each 28 days period, eggs were collected during the last 5 days from all the birds to record egg weight and egg quality parameters. The Zn content in egg was measured using Atomic Absorption Spectrophotometry. At the last week of feeding trial, blood samples were collected from 8 birds of each dietary treatment to collect serum and measure total protein. Increasing the concentration of organic Zn from 35 ppm to either 70 or 105 ppm in diet had no further advantage on feed intake, FCR, hen day egg production, egg weight, body weight gain, egg quality parameters and serum Ca and P values significantly ($P>0.05$). However, serum total protein concentration was significantly ($P<0.05$) higher (3.44 g/dl) in layers supplemented with 70 ppm organic Zn compared to other. Similarly, the Zn deposition in eggs was not increased though increasing the Zn supplementation from 35 to 105 ppm as organic Zn. It is concluded that dietary Zn concentration of 35 ppm is optimum in the diets of WL layers for egg production and proper egg quality.

Zinc (Zn) is a dietary essential mineral for all the animals, found to be ubiquitous in all the living cells. It is a cofactor for more than 300 metallo enzymes and influences various biological functions, encompassing DNA synthesis, cell division and gene expression (Prasad,1991). Hence, Zn is known to affect growth, reproduction, immune response of birds by influencing enzyme activity (Chesters, 1997) or by influencing mitogenic hormones, signal transduction, gene transcription and RNA synthesis (Mc Donald, 2000). It also plays an important role in egg shell membrane formation as it is a cofactor of several enzyme systems responsible for carbonate formation and mucopolysacharide synthesis (Idowu*et al.*,2011). Zinc must be supplemented in diets of livestock and poultry to meet its nutritional requirement because of the poor availability of the mineral from plant feed ingredients due to binding with phytic acid.

Zinc is commonly added to the poultry diets to meet the nutrient requirements. NRC (1994) recommended 35 ppm of Zn for White leghorn (WL) layers which appeared to be considering laying performance as the only criterion. However, subsequent results have shown that higher Zn supplementation had beneficial effects on layers (Idowu*et al.*, 2011). The poor bioavailability from inorganic sources has lead to addition of these sources in high amounts with a large safety margin, often exceeding the bird requirement which causes high concentrations of Zn in excreta and their accumulation in environment and it interferes with absorption and metabolism of other minerals like copper.

Organic trace minerals are effective alternative trace mineral sources for satisfying the trace mineral needs of commercial layers with greater bioavailability, there by potentially reducing the excretion of minerals into the environment. Numerous experiments have been conducted during the last decade to estimate bioavailability of different organic zinc sources viz., Zinc methionine (Zn-met), Zinc lysine (Zn-lys), Zn proteinate (Zn-prot) and their effect on animal and poultry performance. However the information on effect of organic Zn supplementation on egg production, egg quality as well as its deposition in egg is scanty.

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MATERIAL AND MEHTODS

EXPERIMENTAL DIETS, BIRDS AND MANAGEMENT, EXPERIMENTAL PROCEDURE:

Table 1. Ingredient composition and nutrient composition of basal diet fed to WL layers

Ingredient	(g/kg)
Maize	184.2kg
Soybean meal	74.2kg
DORB	1.26kg
Salt	1.35kg
DL-Methionine	300gm
Di-Calcium phosphate	4.55kg
MnSo4	96gm
FeSo4	90gm
CuSo4	12gm
Stone grit	32.7kg
Breeder Vitamin premix1	300gm
Choline chloride, 50%	300gm
Toxin binder	300gm
Antibiotics	150gm
Tylosine	150gm
Total	300kg
Metabolizable energy(kcal/kg)	2650
Protein (%)	17
Crude fibre (%)	7
Calcium (%)	3.65
Available phosphorus (%)	0.65
Lysine (%)	0.8
Methionine (%)	0.3

1 Vitamin premix provided per kg diet: Vitamin A, 20000IU; Vitamin D3, 3000IU; Vitamin E, 10mg; Vitamin K, 2mg; Riboflavin, 25mg; Vitamin B1,1mg; Vitamin B6,2mg; Vitamin B12, 40mcg and Niacin, 15 mg

According to zinc concentration in the selected inorganic or organic source, four experimental diets were prepared, where T1 was designed as control and T2, T3 and T4 as test diets. These diets consisted of basal diet supplemented with added Zn from either inorganic or organic sources. The inorganic source of zinc used in the present investigation was ZnSO4 and amount of Zn in this source was 22 per cent. Organic source of Zn used in the study was zinc bioplex and contained 15 per cent Zn.

The experimental diets used in this study were

T1 - BD + 35ppm Zn supplementation from ZnSO4 (inorganic source)

T2 - BD + 35 ppm Zn supplementation from zinc bioplex (organic source)

T3 - BD + 70 ppm Zn supplementation from zinc bioplex (organic source)

T4 - BD +105 ppm Zn supplementation from zinc bioplex (organic source)

144 White Leghorn laying hens of IWK strain at 38 weeks of age were randomly distributed into 4 treatment groups with 36 birds of each. Each bird was considered as a replicate. The hens were reared in individual California type cages having the provision of individual feeding. Uniform manage mental conditions were be provided to all the groups during the three periods (each 28 days). Feed and water were offered and the birds were raised under identical management conditions.

Production Parameters

Data on Hen day egg production was recorded from 38 to 50 weeks for 3 laying periods of 28 days each. The per cent hen day (%HD) egg production was calculated for each treatment for each of the laying periods.

Egg Quality Parameters

Internal egg quality parameters were recorded at each laying period from the eggs laid by a bird consecutively for three days. Totally 8 eggs per treatment were utilized for measurement of egg quality traits viz., egg weight, shell weight, shell thickness, albumen weight, yolk weight, and yolk color.

The weight of each egg was recorded with electronic digital balance to the accuracy of 0.1g. The eggs were broken on egg breaking stand. Haugh unit score (HU), a measure of internal quality was evaluated as per the procedure of Kondaiah *et al*. (1983). The yolk was separated from the albumen and weighed nearest to 0.1 g accuracy.

The shell strength was measured using kalpak universal testing machine (KIC-1100-C No120301) with 20kg load strength (plate 4). The egg density was measured by using digital density balance with 0.0001g/cm3 accuracy.

Biochemical Profile

After 10 weeks of experiment 2ml of blood was collected from 8 birds of each treatment from the wing vein into an eppendorf tube. Then the blood was incubated for 3 hrs. at 37°C and centrifuged at 5000 rpm for 10 minutes. Then the serum was separated and collected into another eppendorf tube and stored at -20°C for estimation of total protein (TP245), Calcium, Phosphorus by using spectrophotometer with commercially available kits.

Estimation of Zn concentration in egg

Zn was estimated from 32 eggs (8 from each dietary treatment) in each period by using Atomic Absorption Spectrophotometer. Egg Zn concentration was determined as per the method described and modified by Arenz *et al*. (1977) using Atomic Absorption Spectrophotometer. Samples of egg contents were collected from each test group.

Livability

The data on livability was calculated based on the mortalities recorded period wise as and when they occurred.

Statistical analysis

Data were subjected to statistical analysis under completely randomized design employing one-way analysis of variance (Snedecor and Cochran 1989). The means of different treatments were compared with Duncan's multiple range test (Duncan 1955). Significance was considered at $P<0.05$ levels.

RESULTS AND DISCUSSION

Production Performance

Egg production varied between 71-78%, 70-71% and 69.11%- 71.82% during period 1, 2, and 3, respectively and the average egg production during the entire course of study was 70.76% to 73.56%. Increasing the concentration of organic Zn from 35 ppm to either 70 or 105 ppm had no further advantage on egg production. The egg weight recorded during period 1, 2, 3 and overall ranged between 53.33 - 55.39, 55.02 - 56.32,54.48 - 56.35 and 54.56 - 54.73g respectively and it was comparable among treatment and control groups ($P>0.05$).

Increasing the concentration of organic Zn from 35 ppm to either 70 or 105 ppm had no further advantage on egg production. The decrease in egg production along with increased ambient temperatures are supported by the previous findings reported by many researchers Deandrade *et al.* 1977; Vohra*et al.* 1979). The increase in egg production by the supplementation of Zn - Met led to expectation to prevent egg production from decreasing under hot climate environment. However, in the present study, no positive effect of dietary organic Zn supplementation on egg production was observed, even though the higher bioavailability

of organic sources compared to inorganic Zn sources. The positive effect of Zn-Met on egg production was reported when laying hens were given diets with 1,800 mg Zn-Met/kg The daily feed consumption of layer birds supplemented with inorganic Zn in control and organic Zn in test diets was ranged from 95.85-102.87, 90.12-93.86, 87.3189.98 and 91.68-94.32 in periods 1, 2, 3 and overall, respectively. Slight reduction in daily feed intake was observed during period 3, but without any significant difference.

polysaccharide (d"500 ppm) or Zn-proteinate (d"800 ppm) had FCR comparable with that of higher levels of Zn supplementation as ZnO (2000 ppm).

The body weight gain during first period varied from 59.61 to 98.61g. The overall weight gain showed a positive trend in all the diets except treatment 3 (Organic Zn 70 ppm) where in birds lost 19.14g weight. No significant (P>0.05) difference could be noticed on body weight gain due to replacement of inorganic Zn with organic one or increasing the levels of organic Zn in the diet.

Table 2.Effect of organic zinc supplementation on production performance of White Leghorn layers. (38 – 50 wks over all period)

Treatment (Zn in ppm)	Hen day egg production(%)	Egg Weight(g)	Feed Consumption (g/day)	FCR (feed/egg mass)	Body weight gain (g)
Inorganic -35	71.22	56.01	91.68	2.332	101.36
Organic -35	73.10	54.56	94.32	2.404	107.27
Organic-70	70.76	54.73	92.25	2.417	-19.14
Organic-105	73.54	54.69	93.01	2.347	72.38
SEM	0.794	0.378	0.900	0.030	31.33
N	36	36	36	36	36
P value	0.534	0.497	0.759	0.704	0.464

The results on FCR revealed that replacement with organic Zn at 35ppm or increase in concentration to 75 and 105 ppm in subsequent diets had no significant (P>0.05) effect and the values ranged from 2.307-2.491, 2.337-2.395, 2.345-2.706 and 2.332-2.417 in period 1, 2, 3, and overall. The results on FCR revealed that replacement with organic Zn at 35ppm or increase in concentration to 75 and 105 ppm in subsequent diets had no significant effect. This might be due to comparable feed intakes, egg production and egg weights amongst the four treatments. Similarly, Swiatkiewicz and Koreleski (2008) reported that partial or complete substitution of inorganic Zn and Mn oxides with amino acid complexes had no effect on feed intake and feed efficiency by dietary treatments. Similar findings were observed by Carlson *et al*. (2004) who reported that lower levels of Zn supplementation as Zn

EGG quality parameters

The albumen quality of eggs measured as Haugh Unit Score was recorded as 73.56-76.93 during first period (38 - 42 weeks), second period (42 - 46 weeks), third period (46 - 50 weeks) and overall period (38 - 50 weeks), there was a reduction in Haugh Unit Score and the values were 60.90- 67.62, 62.58-64.98 and 65.77-68.78, respectively. The albumen % in organic zinc supplemented treatments were from 59.23-59.81 and in control group where inorganic zinc was supplemented albumen% was 58.71. The albumen quality parameters were not significantly (P>0.05) influenced by the dietary treatments and periods. As seen from the Table 3,percentage of yolk for the experimental period from 38 - 50 weeks was not significantly (P>0.05) influenced by the dietary treatments and periods. Zinc supplementation has been reported to improve egg shell quality because it is a component of the enzyme carbonic anhydrase,

which supplies the carbonate ions during egg shell formation Klecker *et al.* (2002) reported that the addition of Zinc had enhanced the utilization of Ca in hens and improved the qualitative parameters of the egg shell no effect of organic zinc aminoacid complex on egg production in Hyline brown laying hens during early production phase; however in older laying hens, organic Zn positively affected egg shell quality.

source and level of Zn supplementation(table 4) and the concentration varied between 50.33 and 52.03 ppm. The Zn retention in eggs of the birds supplemented with 70 ppm Zn was higher compared to all other dietary groups but without any significant difference (Table 4).

Table 3. Effect of organic Zinc supplementation on egg quality of White Leghorn layers (38 - 50 weeks, period 1)

Treatment (Zn in ppm)	Egg weight (g)	Albumin (%)	Yolk (%)	Egg shell (%)	Shell Thickness (mm)	Haugh Unit	Specific gravity	Shell breaking strength (Newton)
Inorganic-40	55.34	58.71	32.61	8.67	0.352	66.92	1.06	20.13
Organic-35	54.91	59.81	31.50	8.78	0.358	67.82	1.06	16.33
Organic-70	54.65	59.62	31.43	9.00	0.359	68.78	1.04	18.73
Organic-105	54.65	59.23	31.86	8.89	0.358	65.77	1.06	19.04
SEM	0.171	0.243	0.246	0.056	0.002	0.546	0.005	0.770
N	8	8	8	8	8	8	8	8
P value	0.464	0.410	0.322	0.202	0.549	0.255	0.426	0.371

The mean values of all shell quality parameters were not significantly (P>0.05) influenced by organic Zn supplementation at 35, 70 and 105 ppm levels. The highest shell percentage was observed with diet supplemented organic Zn at 70 ppm and lowest with 35 ppm inorganic Zn supplementation. The shell breaking strength values were at the range of 16.33 newtonto 20.13newton. The overall thickness (mm), shell breaking strength (N) and shell percentage (%) among test groups ranged from 0.352-0.359, 16.33-20.13 and 8.69-9.00, respectively. There was no significant (P>0.05) effect of organic Zn supplementation on specific gravity of eggs.

Zinc deposition in eggs

The Zn concentration (ppm) in eggs was not affected significantly (P>0.05) by variation in the

Serum biochemical constituents

Serum total protein values among all dietary treatments were varied from 2.17 to 3.44 g/dl and it was significantly (P<0.05) higher (3.44 g/dl) in layers supplemented with 70 ppm organic Zn compared to other dietary treatments. The Phosphorus levels of white leghorn layers varied insignificantly (P>0.05). Non significant levels of serum Ca and P were comparing feeding of inorganic with organic Zn in breeding cocks which corroborated with the present finding. In contrast to this, Al- Daraji and Amen (2011) reported significantly higher levels of serum Ca and P on increasing Zn concentration in the diet by addition of 100 mg of Zn per kg of diet than that of control in broiler breeders from 58-66 weeks of age. The significant increase of serum Ca and P as reported by Al- Daraji and Amen (2011) might be due to higher level of Zn in the diet (Table 5).

Table 4. Effect of organic zinc supplementation on Zn deposition in eggs in White Leghorn Layers

Treatment (Zn in ppm)	Period 1	Period2	Period3	Average
Inorganic40	55.4082	47.6513	51.3825	51.4807
Organic-35	55.4556	47.1824	50.5592	51.0657
Organic-70	56.4031	48.1636	51.5314	52.0327
Organic-105	54.6546	46.2325	50.1180	50.3350
SEM	0.62488	0.63690	0.47190	0.37618
N	8	8	8	8
P value	0.821	0.760	0.697	0.456

Livability

There was no mortality observed either in treatment supplemented with inorganic Zn or treatments supplemented with organic Zn.

CONCLUSION

Increasing the concentration of organic Zn from 35 ppm to either 70 or 105 ppm had no further advantage on production parameters, egg quality parameters.Supplementation of organic Zn enhanced the serum total protein concentration and had no effect on P concentration significantly. The Zn concentration in eggs was not affected significantly by variation in the source and level of Zn supplementation Overall, it is concluded that 35 ppm Zn concentration is optimum in the diets of White leghorn layers for production and proper egg quality.

Table 5. Effect of organic or inorganic Zinc supplementation on serum biochemical profile of White leghorn layers

Treatment (Zn in ppm)	Calcium	Phosphorus	Total protein	Calcium
Inorganic40	23.6413a	5.5300	3.4413a	23.6413a
Organic-35	19.0738ab	6.4213	3.2713a	19.0738ab
Organic-70	15.8988b	6.3700	2.1738b	15.8988b
Organic-105	21.8088ab	6.8475	2.9538a	21.8088ab
SEM	1.27355a	0.29867	0.12445	1.27355a
N	8	8	8	8
P value	0.151	0.484	0.000	0.151

a, b Means with different superscripts in a column differ significantly (P d” 0.05)

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Research note
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INFLUENCE OF FOLIAR NUTRITION ON DRY MATTER PRODUCTION AND NUTRIENT UPTAKE OF RAINFED Bt. COTTON (*Gossypium hirsutum* L.)

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Cotton (*Gossypium hirsutum* L.) is maintaining its unique name and fame as the 'King of Fibres' and 'White Gold' because of its higher economic value among cultivable crops for quite a long period. The rainfed cotton when grown on red soils yield levels are low due to poor agronomic practices, especially fertilization. Nutrient management in cotton is again a complex phenomenon due to simultaneous production of its vegetative and reproductive parts during the active growth stage. Cotton needs the highest quantity of nutrients at squaring, blooming and boll development. Augmentation of nutrient supply through foliar application at such critical stages may increase yield (Bhatt and Nathu, 1986). Cotton mainly grown as the rainfed crop and occurrence of dry spells and water logging situations are common due to vagaries of monsoons. Under such situations foliar application is recommended instead of soil application. The advantages of foliar feeding are quick plant response, small quantity of nutrient, compensation for the lack of soil fixation, avoiding root uptake problems, increased yield and fibre quality in cotton.

A field experiment was conducted to study the "Performance of Bt. cotton (*Gossypium hirsutum* L.) to foliar supplementation of nutrients under rainfed conditions" at College farm, College of Agriculture, Rajendranagar during *kharif,* 2015 on a sandy loam soil with neutral pH (6.50) and low organic carbon (0.34 %). The experimental site was low in available N (135.8 kg ha^{-1}), medium in available P (P_2O_5 60.0 kg ha^{-1}) and K (K_2O 243.5 kg ha^{-1}), respectively. The experiment was laid out in a randomized block design (RBD) with 9 treatments and replicated thrice with a net plot area of 5.4 m X 3.6 m. An intra *hirsutum* cotton hybrid KCH-14K59 (BG II) having semi determinate plant type was used as a test cultivar sown on 25th June 2015 with a spacing of 90 x 60 cm. All foliar sprays were applied at 45, 65 and 85 days after sowing (DAS). Recommended dose of fertilizers (150:60:60 kg ha^{-1}) and other package of practices were uniformly adopted in all the treatments for growing healthy crop.

Data revealed that dry matter production differed significantly due to foliar application of nutrients and ranged between 3798 to 4594 kg ha^{-1}(Table 1). Higher dry matter production was recorded with foliar application KNO_3 @ 2% (4594 kg ha^{-1}) as compare to other treatments and was on par with panchagavya @ 3% (4452 kg ha^{-1}) and Triacontanol @ 0.1% (4384 kg ha^{-1}) and significantly superior over rest of the treatments. The increase in dry matter due to KNO_3, Panchagavya and Traicontanol over control was 20.9, 17.2 and 15.4 percent respectively. Significantly lower dry matter production was recorded with control (3798 kg ha^{-1}) and was on par with foliar application of DAP @ 2% (3909 kg ha^{-1}).

Increased dry matter production with foliar application of nutrients was due to balanced fertilization and foliar application might have improved nutrient availability resulting in greater uptake of nutrients, higher plant height, monopodial, sympodial branches and LAI due to cell elongation, cell wall thickening coupled with increased leaf and stem weight (Cheinae and Martin, 1970), facilitating higher photosynthetic activity (Luo *et al.,* 2015) and better translocation of photosynthates there by higher dry matter. These results also confirm results recorded by Shivamurthy and Biradar (2014), Sritharan *et al.* (2013) and Rajendran *et al.* (2011).

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Table 1. Effect of foliar application of nutrients on dry matter production and nutrient uptake of rainfed Bt. cotton at final harvest.

Treatments	Dry matter production (kg ha^{-1})	Uptake (kg ha^{-1})		
		N	P	K
T_1-Control (water spray)	3798	84.0	24.83	75.0
T_2-KNO_3 (13-0-44) @ 2%	4594	109.3	36.00	100.0
T_3-18:18:18 WSF @ 2%	4063	95.3	28.16	84.9
T_4-Urea @ 2%	4137	98.2	29.03	86.4
T_5-Di ammonium phosphate (DAP) @ 2%	3909	92.9	28.11	80.5
T_6-Vermiwash (1:5)	4255	98.8	29.45	86.2
T_7-Humic acid @ 0.2%	4193	96.8	28.92	85.3
T_8-Traicontanol @ 0.1%	4384	103.2	31.52	90.2
T_9-Panchagavya @ 3%	4452	104.0	32.33	92.1
S.Em ±	73	4.3	0.88	3.2
CD (p=0.05)	219	12.7	2.65	9.5

Nitrogen uptake ranged between 84.0 to 109.3 kg ha^{-1}. Higher nitrogen uptake was recorded with foliar application KNO_3 @ 2% (109.3 kg ha^{-1}) as compared to other treatments and was significantly superior over control (84.0 kg ha^{-1}) and was on par with DAP @ 2% (92.9 kg ha^{-1}) and 18:18:18 WSF @ 2% (95.3 kg ha^{-1}). With an increase over control of 25.3, 10.6 and 13.5 percent respectively. Lower nitrogen uptake was recorded with control.

Phosphorus uptake ranged between 24.83 to 36.0 kg ha^{-1}. Higher uptake was recorded with foliar application KNO_3 @ 2% (36.0 kg ha^{-1}) compared to other treatments and was significantly superior over rest of the treatments. The increase due to KNo_3 application over control was 45.0 percent. Significantly lower phosphorus uptake was recorded with control (24.83 kg ha^{-1}) and was significantly inferior over rest of the treatments.

Higher potassium uptake was recorded with KNO_3 @ 2% (100.0 kg ha^{-1}) and was on par with panchagavya @ 3% (92.1 kg ha^{-1}) which were significantly superior over rest of the treatments. The per cent increase due to application of KNo_3 and panchagya over control was 33.3 and 22.8 respectively. Significantly lower potassium uptake recorded with control (75.0 kg ha^{-1}) than rest of the treatments except folier application of DAP @ 2% which was on par with later treatment.

Foliar nutrition might helped in moisture and nutrient conservation in the leaves (Virdia and Patel 2000), which would have stimulated the plant height, expansion of leaf and higher photosynthetic activity consequently accumulation of more dry matter (Constable *et al.* 1990) there by resulting in higher uptake of nutrients (Table 1). These findings are in line with Luo *et al.* (2015) and Vinayak Hosamani *et al.* (2013).

Based on the experimental results, it could be concluded that foliar application of KNO_3 @ 2% at 45, 65 and 85 DAS was found to increase dry matter production and nutrient uptake of *Bt.* cotton under rainfed conditions.

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Research note
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DIGITAL PLATFORM IN AGRICULTURE – AN EVALUATIVE STUDY OF INFORMATION AND ITS UTILITY BY THE FARMERS

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An Information and Communication Technology (ICT) in agriculture is an emerging field focusing on the enhancement of agricultural and rural development in India. ICTs offer a great opportunity to facilitate the flow of information and technology services delivery especially to the farmers (Maningas, 2006). Information pertaining to sowing, soils, price and pests and diseases control helps farmers to take better decisions in farm activities. At present, there are many ICT initiatives by government, non-government and private organizations in the field of agriculture (Anupindi, 2003). ICT projects like Kisan Call Center, e-Choupal, IFFCO Kisan Sanchar Limited, Farmers' Portal, mKisan and iKisan, etc. Digital Platform in Agriculture (DPA) is launched by a private company (eFresh Agribusiness pvt ltd.) in Telangana, Andhra Pradesh, Maharashtra, Karnataka, Gujarat, Tamilnadu and Punjab in India.

This platform provides information on crop cultivation, market prices, weather forecasts, expert system to identify the type of machineries to be used, fertilizer dose, plant protection chemicals, crop insurance, customized information seek for farmers on various schemes of Govt./Banks,etc. which useful to the farmers and traders. DPA is set up in a prominent location among to cater to ablock of village's area. DPA is in the form of a large screen dashboard with touch screen having multilingual content. DPA center has one field manager, one FDC manager and two admin associates who assist farmers and agents in using this portal and also assists illiterates in using computers in querying their requirements. This portal was launched during the year 2014 on pilot basis in selected districts. For scaling up, it is important for the company to analyze critically the strength and weaknesses of the portal and its content and also to know the farmers' perception and difficulties in using this system. In the past, works have been conducted on role of information communication technologies for developing better management skills in agriculture and allied sectors (Braj and Singh 2007), ICTs for rural development (Meera, 2002) and ICTs for agriculture development (Vedakumari, 2005). However, in this background, this study was taken up with the objective of studying the perceptions and utilization pattern of DPA by the farmers.

The study was conducted in one of the districts where DPA was implemented on pilot basis, viz. Jagtial district of Telangana state. A total of 55 farmers were selected randomly from five randomly selected villages. The survey was conducted during Jan to Mar, 2017 using pre-tested schedule through personal interview method. The data collected were tabulated and analyzed by using simple statistical tools like frequencies and percentages in order to draw valid conclusions.

The results pertaining to the satisfaction level of DPA perceived by the farmers and the utilization pattern of DPA is presented below along with the profile of farmers selected for the study.

The profile of the sample farmers showed that more than half of the selected farmers were in middle age group and over half of them were having education up to secondary or primary level while just 9 per cent were illiterates (Table 1). Further, analysis of size of land holdings showed that about half of the land was owned by small and marginal farmers and 40 per cent of farmers belonged to medium category who were able to cultivate a variety types of crops in their piece of land. About 45 per cent of the farmers were having farming experience of 15-30 years while 42 per cent

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have experience less than 15 years. The results also showed that nearly 80 per cent of farmers used DPA services frequently. These findings are in line with findings of Dhaka and Chayal (2010).

due to various constraints such as lack of local language interface and mobile app is still under development.

The farmers were asked to give their perception about various features of the portal in three-

Table 1. Profiling farmers based on their socio-economic characteristics

(N=55)

S.No	Characteristics	Number of respondents	Percentage
I	**Age**		
1.	Young (< 30 years)	7	12.7
2.	Middle (30 to 45 years)	30	54.5
3.	Old (>45 years)	18	32.7
II	**Education**		
1.	Graduate &Above	17	30.9
2.	Secondary	19	34.5
3.	Primary	14	25.5
4.	Illiterate	5	9.1
III	**Size of land holding**		
1.	Marginal (< 2.5)	11	20.0
2.	Small (2.5-5.0)	16	29.0
3.	Medium (5.0-10.0)	22	40.0
4.	Large (>10.0)	6	11.0
IV	**Farming experience**		
1.	Less than 15years	23	42.0
2.	Between 15-30years	25	45.0
3.	More than 30years	7	13.0

Utilization Pattern of DPA

The platform is more preferred by the farmers as about 80 per cent of them were using it regularly, i.e., at least on weekly basis (Table 2). About 13 per cent of the farmers have not used this platform

point scale, viz., highly satisfied, satisfied and not satisfied. The results showed that about two-third of the sampled farmers was highly satisfied for the information about plant protection chemicals, plant growth regulators and fertilizers (Table 3). The

Table 2. Frequency of use of Digital Platform for Agriculture

(N=55)

S.No	Frequency	Number of respondents	Percentage
1.	Daily	11	20.0
2.	Weekly	32	58.2
3.	Monthly	5	9.1
4.	Never used	7	12.7

company having loads of information on these items and hence, farmers were contended in using them. Similarly, about half of the farmers expressed high level of satisfaction with the information on varietal selection and input price, i.e., information pertaining to the availability of agriculture machinery, seeds and fertilizes etc.The farmers perceived that market information including daily updates on the prices of agricultural commodities in local nearby markets as one of the most preferred DPA services. Information on weather parameters such as rainfall, temperature and humidity was considered to be more useful. The results also showed that about 90 per cent of the sample farmers were satisfied with the information on weed management, irrigation technology and market information while about two-thirds of the farmers expressed satisfaction on information available in this portal about other crop cultivation technologies which includes information related to intercropping, crop rotation, organic farming, natural farming, etc. The only feature, which the farmers were not satisfied in this portal, was the availability of information about Government schemes. However, recently, the company has taken initiatives to add more information about Government schemes such as Pradhan Mantri Fasal Bima Yojana (PMFBY), Pradhan Mantri Gram Sinchai Yojana (PMGSY), Kisan Vikas Patra (KVP) and Soil Health Card Scheme to this portal, the process is in progress. Similar features in utilization of ICT in agriculture and rural development by farmers were also reported by Meena *et al*. (2011).

There is an increasing realization about the potential of digital platform in agricultural technology dissemination. The farmers are realizing that digital platform is an important source of information and advisory system for developing agriculture. The results based on data collected from 48 farmers, who are aware of this portal, are presented in Table 4. It revealed that direct access to information emerged as important benefit with about 87 per cent of farmers revealing this as their foremost utility for which they were using this portal. The next most frequently mentioned benefit was rich subject matter coverage. DPA services were providing useful information on market intelligence, weather forecast, early warning and management of disease and pests, production

Table 3 . Level of satisfaction of farmers on DPA

S. No	Type of information	Highly Satisfied (%)	Satisfied (%)	Not satisfied (%)
1.	Varietal selection	43.75	39.59	16.66
2.	Plant protection chemicals	68.75	20.83	10.42
3.	Plant growth regulators	68.75	25.00	6.25
4.	Fertilizers	66.66	22.92	10.42
5.	Irrigation technology	35.42	58.33	6.25
6.	Weed management	18.75	70.83	10.42
7.	Harvesting technology	31.25	41.67	27.08
8.	Market information	37.50	45.83	16.67
9.	Other crop cultivation technology	12.50	52.08	35.41
10.	Government Schemes	29.17	27.08	43.75
11.	Input price	52.08	20.84	27.08

N=55; 7 are unaware; 48 are aware and gave their responses.

Table 4 . Benefits of DPA for the farmers

S. No	Benefits	Frequency	Percentage
1	Direct access to information	47	86.8
2	More subject matter coverage	45	81.0
3	Minimize time and distance barriers	43	78.2
4	Reliable and timely information	40	72.0
5	Improve the quality of decision making	38	69.2
6	Reduction in transaction cost	36	65.7

N=55; 7 are unaware; 48 are aware and gave their responses.

practices, post-harvest management, etc. The third highest utility was saving time and getting information all round the clock. Reduction in transaction costs of buyers of agricultural products through e-transaction of cash and distributing payments either to farmers directly or via associations or cooperatives and improving the quality of decision making were other useful benefits drawn by the farmers through the use of DPA.

Digital platforms have the potential to revolutionize the rural areas and farming, if it is adopted by the farmers in a large area, as it has potential to provide all necessary information and services to the farmers at a cheaper cost. It helps in increasing agricultural production, processing, and marketing and livelihood opportunities. Digital platform provides services and information that are highly useful in scientific management of farm in many parts of the country. This DPA has more than just information; it provides input sale services, connecting the farmers to markets, etc.The greatest strength of the DPA presently lies in its information content related to input prices, weather and plant protection chemicals. The company should work on improving features of DPA like providing the contents in local language and developing mobile application for ease of access to this platform.

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Research note
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NEED ASSESSMENT OF PARENTS WITH AUTISTIC CHILDREN

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Autism is a neurobiological disorder, which affects the brain and thereby the whole body. It is reflected in terms bodily impairments such as deficits in social relations, communication with repetitive and self stimulatory behaviors. Unique characteristics of autistic children create many unique challenges to parents. These parents are under going through lot of stress in dealing with their autistic children. Research studies revealed that parents of autistic children with lower income have more unmet needs than the parents with higher income (Brezis *et al.* 2015; Hodgetts, Zwaigenbaum and Nicholas, 2015). Thus presence of an autistic child in the family has a multidimensional effect in varied ways such as generating special needs not only for the child but also for the parents at personal or social or at wider community level. Though parents take the key role in taking care of the children and the families at the root level, their needs are often overlooked in research. In Indian studies not much emphasis has been put on parent's general as well as specific needs. This area of study is almost non- existent in the state of Telangana. Therefore the present study was undertaken to assess the needs of parents with autistic children.

This is study was conducted in the twin cities of Hyderabad and Secunderabad with an Expost-facto research design. Snow-ball sampling technique was adapted to trace the sample based on the rarely availability criteria of the sample. The sample of the study was comprised of 60 parents of children with autism, with or without associative conditions. The data was collected through a direct face-to face interview by using the NIMH Family Needs schedule – Parents (Peshwaria *et al.* 1995), to know the specific needs of parents with autistic children. The schedule consists of 13 areas of identified needs which further had specific items under each area specifying needs of parents. The schedule was filled with parental responded scores as the score '1' indicated 'little need', '2' indicated 'moderate need' and '3' indicted 'high need' for each item under each area. Then the collected data was coded and analyzed by using frequencies and percentages. Then the data was analyzed to find out the specific felt needs of parents with autistic children as given below.

As per the data collected two-thirds of the parents of this study were in the age group of 31to 40 years. Half of the parents were graduates followed by post graduates. One third of the sample (33%) were earning above 40000 rupees per month.

It includes 13 areas such as Information on autism conditioning, Child management, Facilitating interaction, Services, Vocational planning, Hostel facilities, Personal-emotional, Personal- social, Support- physical, Financial needs, Family relationships, future planning needs and government benefits and legislations.

It was revealed from the above table that, parents have expressed their high level counseling needs for counseling on planning suitable vocations for the child (62%), training needs on child's behavior management (55%), information on management of emotions by self (45%), information on existing and new benefits and legislations (45%), information on etiology, characteristics and children's nutritional requirements (43%), guidance in planning a secure future for the child (42%). This may be due to parental insecure feelings and worries for the uncertainty of the child's future, unresolved negative attitudes about the child's abilities lack of proper awareness of the child's specific characteristics, lack of training on child management techniques and availability of resources for autistic children (Bashir, Khurshid and Quadri, 2014). The findings were on par with the study of Derguy *et al.* (2015).

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Moderate needs were often expressed by parents with regards to provision for relational support (68%), information on social support systems (53%), guidance on family relationship management (47%) and support to reduce financial burdens (47%). This might be due to unique characteristics of the child, difficulties in accessing and understanding information from the existing sources as it is highly vague, lack of fund/ resources, lack of time in attending the care for the child, due to small families, presence of personal health issues and lack of availability of child care facilities and respite care services for autistic children (Harper *et al.* 2013). Information on social support systems were needed to meet friends and other parents with similar kind of problems, to share their feelings as they felt only those people can understand their problems to the utmost level and can give good suggestions for their betterment.

Few parents expressed high needs on provision for respite care services and transportation services for the child (15%), support to reduce financial burdens (12%), provision for boarding facilities to the child (10%), guidance on relationship management (7%) and provision for relational support (7%), for the child, which may be due to parents are unable to manage the child due to the unique nature of the disability, presence of co-morbid conditions and multiple disabilities, both the parents were working

Table 1. Distribution of parents of autistic children based on felt needs

(N=60)

Sl. No	Category of needs	High		Medium		Low	
		F	%	F	%	F	%
1.	Vocational planning (counseling on planning suitable vocations for the child)	37	62	21	35	2	3
2.	Child- management (counseling on child's behavior management)	33	55	23	38	4	7
3.	Personal- emotional (information on management of emotions by self)	27	45	27	45	6	10
4.	Government benefits and legislations (information on existing benefits and legislations and need for new policies)	27	45	23	38	10	17
5.	Information on Child's Condition (Etiology, characteristics and their nutritional requirements)	26	43	19	32	15	25
6.	Services (referral services, therapies and treatment)	25	42	20	33	15	25
7.	Future planning (guidance in planning a secure future for the child)	25	42	21	35	14	23
8.	Personal- social (counseling on social support systems)	18	30	32	53	10	17
9.	Support- physical (provision for respite care services and transportation services for the child)	9	15	31	52	20	33
10.	Financial (support to reduce financial burdens)	7	12	28	47	25	42
11.	Hostel facility (provision for boarding facilities to child)	6	10	4	7	50	83
12.	Family relationship (guidance on relationship management)	4	7	28	47	28	47
13.	Facilitating interaction (provision of relational support)	4	7	41	68	15	25

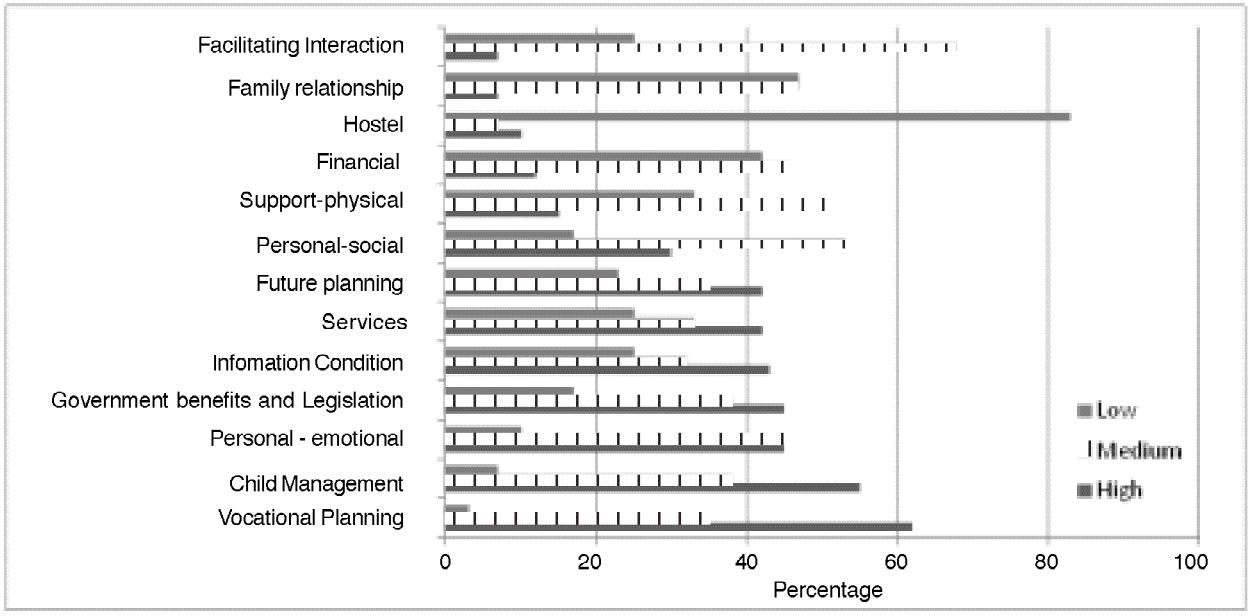

Fig. - Distribution of parents based on felt needs

and unable to take out time for constant supervision of the child, lack of awareness about the disability, no proper understanding between the parents and among family members about the child's condition.

The study is very much helpful in understanding the unique needs of parents with autistic children. Hence the organizations working for children with autism as well as their families, the service centers should organize parent education programs and provide information about autism, suitable vocations, existing policies and programs. They have to conduct training programs on handling the children, parenting, self management, relationship management etc. Government should establish more number of quality respite care service centers to facilitate the parents in terms of child care. Parent associations and parental groups need to be established to provide emotional support for the parents of Autistic children. Mass media should also cover the various aspects of children with autism.

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Research note
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DEVELOPMENT AND EVALUATION OF TOMATO POWDER IN CORPORATED RICE BASED COLD EXTRUDATES

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Rice contains approximately 7.3% protein, 2.2% fat, 64.3% available carbohydrate, 0.8% fiber and 1.4% ash content (Zhou *et al.* 2002). Due to its hypoallergenic properties and absence of gliadin, rice is considered as good source for making gluten free food products. Rice flour has become an attractive ingredient in the extrusion industry due to its bland taste, attractive white colour, hypoallergenicity and ease of digestion (Kadan *et al*. 2003).

Tomato is third vegetable next to potato and sweet potato in consumption. Although tomatoes are commonly consumed fresh, over 80 % of tomato consumption is through processed products such as tomato pulp, puree, paste, sauce, juice, powder and peeled whole tomato (Temitope *et al*. 2009). Tomato powder is widely used in soups, instant sauce premixes, ketchups, sambar, rasam mix, puddings, bakery products, health foods, sweets, biscuits, baby foods, confectionaries, snacks etc (Nagamani, 2014).

The physico-chemical characteristics of extruded products depend on the raw ingredients such as rice, wheat and corn. It may be possible to improve the physico-chemical properties and the lycopene content of the snacks by manipulating the base ingredients (Dehgan-shoar *et al*., 2010).

Rice noodles also known as rice vermicelli made from rice, is a popular type of dish served in Asian countries. The manufacturing method for the production of rice vermicelli is a conventional process which is a non-continuous long process with problematic high energy consumption, high loss, and low hygiene problem. The rice noodles are judged by their uniformity, cooking and eating quality. Plasticity of dried noodles, whiteness, low cooking loss, retention of shape or firmness, and non-sticking when cooked are desirable properties of extruded rice noodles (Charutigon *et al.* 2008).

Three cultivars of tomatoes Pusa Ruby, Lakshmi and US440 were screened for lycopene content (Ranganna, 2003) and the cultivar having high lycopene content was selected for further processing. Tomatoes were processed into fine powder according to method of Nagamani, (2014).

The composite flours were prepared using rice flour and refined wheat flour in three different combinations i.e 40:60, 50:50 and 60:40. Two different types of pasta control extrudates Tagliatelle and Cavatelli were prepared by using composite flour through continuous kneading to desired crumbly consistency similar to moist breads. Sheeting of dough was made by a process of folding and passing through roller of pasta presto making machine several times. Sheeted dough was extruded through a suitable die and cut to have desired size of extrudates. The control extrudates were steamed for 20 min and spread over tray with wire mesh for drying.

The mean scores of sensory evaluation for the pasta extrudate Tagliatelle showed that colour ranged from 6.47 to 7.00; texture 6.47 to 6.60; taste 6.40 to 6.67; flavor 6.40 to 7.80 and overall acceptability from 6.40 to 7.33 for the three extrudates when incorporated with rice flour of 40, 50 and 60% levels. The results showed significant difference ($p< 0.05$) in the colour in comparison with control extrudates of Tagliatelle when added with rice flour between 40 to 60%. The colour of extrudate with 50% rice flour was rated high in comparison to 60 and 40% of rice flour. The least score for colour was given to extrudate made with 60% rice flour. Similarly the texture and taste had no significant difference in the

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hedonic scoring. Flavor and overall acceptability properties also showed significant difference ($p< 0.05$) between the three extrudates. The extrudate with 40% rice flour had better scores for flavor than the other two extrudates. Significant difference was seen in overall acceptability of TC_1, TC_2 and TC_3. Among all the extrudates control made with 40% rice flour and 60% refined wheat flour were accepted by the panel.

The mean sensory scores of pasta Cavatelli extrudates for colour ranged from 6.60 to 7.40; texture 6.47 to 8.27; taste 6.40 to 7.67; flavor 6.47 to 7.93 and overall acceptability from 6.47 to 7.53 for the three extrudates when incorporated with rice flour of 40, 50 and 60% levels.

The results showed significant difference ($p< 0.05$) in the colour compared to control extrudates when added with rice flour between 40 to 60%. The colour of extrudate with 50% rice flour was rated high in comparison to 60 and 40% rice flour. The least scored for colour was given to extrudate made with 60% rice flour. The extrudate with 40% rice flour had better scores for texture than the other two extrudates. Similarly the flavour and overall acceptability had significant difference ($p< 0.05$) in the hedonic scoring. Taste, flavor and overall acceptability scores of extrudates made with 40% rice flour had the highest rating than the remaining two samples. Significant difference was seen in overall acceptability of CC_1, CC_2 and CC_3. Among them CC_1 was having high score and accepted by the panel members.

There was a significant difference between the two types of extrudates. Between the two types of extrudates (Tagliatelle and Cavatelli) the overall acceptability of Cavatelli prepared with 40% rice flour and 60% refined wheat flour was having high scores. Hence this combination was accepted for incorporation of tomato powder at 5, 10, 15 and 20% and subjected to sensory evaluation by semi-trained panel of 15 members from PGRC, PJTSAU using 9 point hedonic scale evaluated the extruded products for colour, texture, flavour, taste and overall acceptability (Meilgaard *et al.* 1999).

Table 1. Mean sensory scores of tomato powder incorporated control extrudates

Extrudate	Colour	Texture	Taste	Flavour	Overall acceptability
Control	7.40±0.51	8.267^{a}±0.45	7.67±0.49	6.47^{c}±0.52	7.53^{ab}±0.52
TP_1	7.87±0.74	7.53^{b}±0.83	7.33±0.98	7.47^{ab}±0.74	7.27^{ab}±0.45
TP_2	7.66 ±0.74	8.00^{ab}±0.65	7.73±0.70	7.13^{ab}±0.83	7.66^{a}±0.63
TP_3	7.73±1.03	7.65^{b}±0.74	7.27±0.96	7.67^{a}±0.81	7.07^{ab}±1.03
TP_4	7.60±0.73	6.87^{c}±0.99	7.07±0.96	7.07^{b}±0.88	7.00^{b}±1.13
Mean	7.64	7.63	7.41	7.16	7.29
CD	0.5681	0.5405	0.6370	0.5334	0.5358
SE	0.2836	0.2698	0.3180	0.2663	0.2675
CV (%)	10.16	9.69	11.74	10.18	10.44

Note : Values are expressed as mean ± standard deviation of three determinations. Means within the same column followed by a common letter do not differ significantly at $p\leq 0.05$

TP_1 : 5% TP incorporated extrudate TP_2 : 10% TP incorporated extrudate
TP_3 : 15% TP incorporated extrudate TP_4 : 20% TP incorporated extrudate

The mean sensory scores of tomato powder (TP) incorporated extrudates are reported in Table 1. The results showed that TP_2 at 10% incorporation had significantly highest scores for texture, taste and overall acceptability on 9 point hedonic scale.

In the present study showed that rice, refined wheat flour in combination with tomato powder can be effectively used to produce cold extruded products. The acceptable ready to cook products developed with rice and refined wheat flour of cavatelli prepared with 40% rice flour and 60% refined wheat flour was having high scores. Hence this combination was accepted for processing of tomato incorporated extrudates. The TP_2 at 10% incorporation was recorded significantly highest scores for texture, taste and overall acceptability on 9 point hedonic scale and was accepted by the panel members. Hence it can be concluded that extruded products that are usually prepared by a combination of cereals can be improved by addition of tomato powder. This will further enhance the flavour and nutritional quality without much affecting the physical quality and it can be suggested that the process can be referred for industrial production.

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Research note
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RESISTANT STARCH CONTENT OF PUFFED RICE PREPARED WITH NEWLY RELEASED VARIETIES (WGL44, WGL283 AND RNR2458) OF TELANGANA STATE

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Rice is the second most consumed cereal and has become the most important food source in Asian countries especially in south- east where it is an economic crop for many farmers (Arash, 2013). The cultivation of rice (*Oryza sativa*.L) by people began more than 10,000 years ago which led to development of rice culture over years, making it the staple crop for more than half of the world's population (Jerome *et. al*. 2008). Telangana (including Andhra Pradesh) is a surplus rice growing state, with cultivated area of 39.46 lakh ha and average productivity of 3352 kg ha^{-1} during 2007- 2008 (ANGRAU Annual Report, 2007-2008). Rice is grown in almost all parts of the Telangana State in all seasons all kinds of soils and is rightly called as "Annapurna state", "Rice bowl of India" and "Granary of south India". Rice is a dominant staple food for about 70 million people and a major source of livelihood for nearly 70 per cent of rural household and is consumed in many forms.

Lifestyle changes, food habits and urbanization have increased the demand of processed foods in India. Convenient snack foods like popcorn, popped and puffed rice, popped sorghum, popped wheat roasted and puffed soybean are very popular in India and worldwide (Jayabhae *et al*. 2014). Rice being major source of calorie consumption has been processed to develop instant rice products like puffed rice. The keeping quality of the rice can be increased in these products. The physical properties of puffed rice depends on the moisture content of the grain and is directly proportional to puffing quality (Basavaraj *et.al*. 2015).

Rice puffing includes parboiling, drying, milling and roasting. Traditionally paddy is parboiled or gelatinized by hydrothermal treatment before puffing. The hydrothermal treatment may include only hot water soaking and steaming or sand roasting of moistened grains (Hoke *et.al*. 2007). There are certain health benefits of processing the rice. For example the process of roasting where the rice starch gets damaged, gelatinized and subsequently a part of it is retrogradated, leads to the formation of resistant starch, making it a type of pre-biotic food apart from conventional and nutritious low cost product for low income masses (Kumar and Prasad, 2013). Resistant starch is the undigested starch that escapes digestion in the small intestine and on reaching the large intestine acts as dietary fibre. Dietary fibre has subtypes based on their digesting properties (Murphy *et.al*. 2008). As Telangana state is known to grow rice varieties that might be suitable for puffing process and taking into account the data shortage in a scientific literature in the variety specific area, the objective of the study was to determine the resistant starch content of puffed rice prepared with 3 varieties of rice.

The three varieties of rice for puffing were obtained from Rice Research Institute, Rajendranagar, Telangana. Standard traditional method of puffing was used to puff the rice varieties. Rice was cooked first using the traditional method, where rice was soaked in water for 30 minutes and boiled or steamed to obtain whole grain cooked rice. An equal amount of water was added to the milled rice, which was soaked at room temperature for two hours and then steamed at 18 psi pressure for 10 min. The water to rice ratio was controlled to prevent the cooked rice from becoming too sticky and soft. Heating was controlled to ensure gelatinization of the rice grain to the core without scorching. The cooked rice was dried to 10-12% moisture and fried in oil at 220° C (428° F) for 4-8 seconds in a deep fryer. Then, the puffed rice was packed. (Edmund and Lloys, 2002).

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The resistant starch content for WGL-44, WGL-283 and RNR-2458 puffed varieties of rice was evaluated using AOAC, 2002 method.

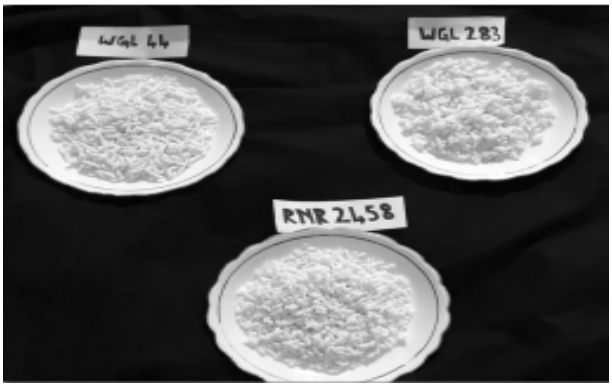

Figure 1. Puffed rice prepared from three varieties of rice

The resistant starch content of WGL-44 was 2.29 ± 0.01, WGL-283 was 2.23 ± 0.02 and RNR-2458 was 2.27 ± 0.01. (Table1) The highest amount of resistant starch was observed in WGL- 44 i.e. 2.29g and the lowest amount observed in WGL- 283 (2.23g). There was no significant difference (≥0.05%) between WGL-44 and WGL-283 and also WGL -283 and RNR-2458. Similar results were reported by Ruchi and Sheth (2011). The resistant starch of cereal based puffed products ranged 0.53 g to 2.09 g.

Rice contributes to be a major source of carbohydrate in the diet by supplying 60 per cent of total intake. Among many states in India, Telangana state has contributed largely to supply rice to the country. A variety of rice products are produced in order to enhance the storage capability, easy and instant cooking and to provide better nutritive value and flavour.

The results of the analysis showed that the resistant starch content in the three tested puffed rice varieties of Telangana state WGL-44, WGL-283 and RNR-2458 were 2.29, 2.23 and 2.27 g, respectively. There was a significant difference (≥0.05%) observed between the puffed rice varieties of WGL-44 and WGL-283. The results suggested that the highest amount of resistant starch was found to be in the puffed rice prepared with WGL-44 and the lowest with WGL-283.

Table 1. Resistant starch content in three varieties of puffed rice.

Rice Varieties	Resistant starch (g)
WGL 44	2.29^{ac} ± 0.01
WGL 283	2.23^{bc} ± 0.02
RNR 2458	2.27^{a} ± 0.01
Mean	2.26
CD	0.02
CV % value	0.39

NOTE: ● ± shows mean and standard deviation of triplicate value of each variety ● The supercripts shows the significance difference at d”0.05.

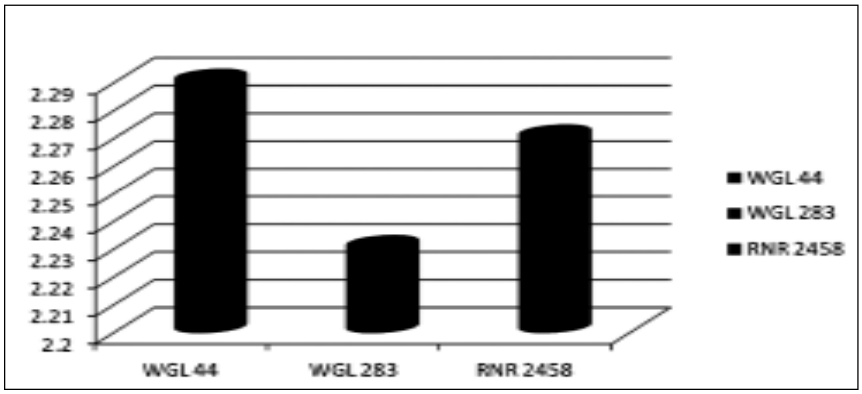

Fig. 2. Resistant starch content in puffed rice of different varieties

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Research note
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BUSINESS VIABILITY OF COOPERATIVE SUGAR FACTORY IN MAHARASHTRA STATE – A CASE STUDY ON SHREE VIGHNAHAR COOPERATIVE SUGAR FACTORY

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Sugar is one of the most important commodities produced and consumed around the world. Sugar is produced in over 123 countries worldwide but over 70 per cent of world sugar production is consumed domestically and the remaining is traded in the world. Since only a small proportion of world production is traded freely, sugar prices have been volatile in the world market.

In 2014-15, the world sugar production amounted to approximately 175.1 million MT. During this period, Asia was the largest sugar - producing region in the world, yielding approximately 66.12 million MT of sugar. India, China and Thailand were the region's top sugar producers.(*http://www.kpmg.com//indian sugar industry.pdf, 2015)*

The Indian Sugar Industry, with an annual productive capacity of over 25 million MT, stands out to be the second largest in the world after Brazil, accounting for around 15 per cent of the global sugar production. The country consumes approximately 22 MT of sugar annually, with Maharashtra contributing over 60 per cent of it, while the rest of the output come from states like Tamil Nadu, Karnataka, Uttar Pradesh and Madhya Pradesh. The sufficient and well distributed monsoon rains, rapid population growth and substantial increase in sugar production capacity have made India the largest consumer and second largest producer of sugar in the world. Highly fragmented with organized and unorganized players, the sector supports over 50 million farmers and their families, making significant contribution towards socio – economic development in the rural areas of the India.(http://dfpd.nic.in/sugar-division.htm)

The Co-operative sugar industry has been playing an important role in the development of rural Maharashtra. The selected sugar factory is one of the most reputed among the prevailing cooperative sugar factories in surrounding area and it also provides several backward linkages like the supply of credit, supply of inputs like improved seed materials, fertilizers, pesticides, agricultural implements etc. in addition to the forward linkages of processing and marketing.

The present study was conducted at Shree Vighnahar Cooperative Sugar Factory of Pune district during 2015-16. The data collected from various sources were analyzed in multiple stages. Various analytical tools were employed for analysis of collected data. Tabular analysis was done by working out simple averages and percentages. The business viability of the investment was assessed using NPV, IRR and BC Ratio.

1. Study on investment pattern, cost and returns, and financial feasibility of selected units

1.1 Investment pattern of Shree Vighnahar Cooperative Sugar Factory

The investment pattern of Shree Vighnahar Cooperative Sugar Factory gives an insight into the various capital investment factors and establishment cost to set up a sugar factory.

The sugar factory requires huge initial investment. It is seen from the Table 1.1 that the total fixed capital investment was Rs. 87,92,47,423.08 and the major investment items were land, building, machinery and equipment. The investment on land was Rs. 1,79,23,693 which accounts for 2.04 per cent of the total cost, whereas the investment on factory building and factory water supply structure worked out to Rs. 6,07,80,951 (6.91 %) and that of Rs. 54,11,31,056 (61.54 %) were invested on sugar production machinery. The investment on non-productive concerned contributed to 26.38 per cent to the total cost.

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Table 1.1 Capital Investment in the Shree Vighnahar Cooperative Sugar Factory

S.No.	Particulars	Cost (Rs.)	Cost in percentage
A)	**Capital Investment (Production concerned)**		
1.	Land and land development	17923693	2.04
2.	Factory building and factory water supply structure	60780951	6.91
3.	Sugar production machinery	541131056	61.54
4.	Workshop machinery	1618110	0.18
5.	Electrical substation and installation	3956115	0.44
6.	Weighbridge, weights and measurements	2131507	0.24
7.	Laboratory equipments and other implements	18390969	2.09
8.	R.C.C. Scrubber	1393481	0.16
	Sub Total (A)	**647325882**	**73.62**
B)	**Capital Investment (Non production concerned)**		
1.	Administrative office	25133976	2.86
2.	Vehicles	41021947	4.67
3.	other	165765618	18.85
	Sub Total (B)	**231921541**	**26.38**
	Total (A+B)	**879247423**	**100**

Shree Vighnahar Cooperative Sugar Factory, 2016

1.2 Costs and returns of the selected sugar cooperative

With a view to study the costs and returns from sugar production, an attempt was made to elicit necessary data from the sugar factory. All the costs incurred by the selected sugar cooperative are grouped under two broad heads, viz, fixed cost and variable cost which together constitutes the total cost and are depicted in Table 1.2 to 1.6

The fixed and variable cost incurred was estimated as Rs.89.73/qtl. and Rs. Rs.2375.84/qtl. respectively. The main component of fixed costs was interest on fixed capital about Rs. 8,79,24,742 constituting 77.34 per cent. The depreciation on fixed assets of production concern valued at Rs. 1,78,12,249 (15.67 %) and that of non-production concern was Rs. 79,40,909 (6.99 %).

Of the total variable cost in sugar processing, major cost component was purchase of sugarcane i.e., Rs. 2,28,70,13,030 (75.98 %). The next major cost incurred was interest on working capital, contributing about Rs. 34, 62, 72,607 (11.50 %). Of the total variable cost, the cost of chemicals and bags (Rs. 19,75,56,787) was the third major cost component which constituted about 6.56 per cent of the total storage cost. The cost incurred for wages, pay and allowances was Rs. 10,68,18,943, which constituted about 3.55 per cent of the total variable cost. In sugar processing, cost of losses during processing was accounted as a variable cost which adds to Rs. 2,28,70,130 (0.76 %). Cost of electricity and repairing of machinery and equipment account for 0.90 per cent and 0.74 per cent i.e., Rs. 2,72,20,587 and Rs. 2,21,55,968 respectively.

Details of the Fixed Cost of Processing

Table 1.2 Fixed Cost of Processing for the Selected Sugar Cooperative

S. No.	Cost Item	Cost (Rs.)	Cost in percentage
1	Depreciation on fixed capital of production concerned	1,78,12,249	15.67
2	Depreciation on fixed capital of non production concerned	79,40,909	6.99
3	Interest on fixed capital @ 10 per cent Per annum	8,79,24,742	77.34
	Total fixed cost	**11,36,77,900**	**100**

Table 1.3 Product Wise Fixed Cost for the Selected Sugar Cooperative

1.	**Sugar**	Total Fixed Cost for Sugar (86.39 per cent)	Rs.9,82,06,337
		Per Unit Fixed Cost (qtl)	**Rs.89.73**
2 .	**Bagasse**	Total Fixed Cost for Bagasse (9.30 per cent)	Rs.1,05,72,045
		Per Unit Fixed Cost (MT)	**Rs.41.34**
3 .	**Molasses**	Total Fixed Cost for Molasses (4.08 per cent)	Rs.46,38,058
		Per Unit Fixed Cost (MT)	**Rs.140.71**
4 .	**Press Mud**	Total Fixed Cost for Press Mud (0.23 per cent)	Rs.2,61,460
		Per Unit Fixed Cost (MT)	**Rs.7.45**

Table 1.4 Variable Cost of Processing for the Selected Sugar Cooperative

S. No.	Variable / Working capital	Amount (Rs.)	Cost in percentage
1.	Purchase of sugarcane	2,28,70,13,030	75.38
2.	Electricity	2,72,20,587	0.90
3.	Repairing of machinery and equipments	2,21,55,968	0.74
4.	Cost of chemicals and bags	19,75,56,787	6.56
5.	Wages, pay and allowances	10,68,18,943	3.55
6.	Loss in processing	2,28,70,130	0.76
	Interest on working capital @ 13 percent per annum	34,62,72,607	1.30
	Total variable cost	**3,00,99,08,053**	**100**

Table 1.5 Product wise Variable Cost of Processingfor the Selected Sugar Cooperative

1 .	**Sugar**	Total Variable Cost for Sugar (86.39 per cent)	Rs.2,60,02,59,567
		Per Unit Variable Cost (Qtl)	**Rs.2375.84**
2 .	**Bagasse**	Total Variable Cost for Bagasse (9.30 per cent)	Rs.27,99,21,449
		Per Unit Variable Cost (MT)	**Rs.1094.60**
3 .	**Molasses**	Total Variable Cost for Molasses (4.08 per cent)	Rs.12,28,04,248
		Per Unit Variable Cost (MT)	**Rs.3725.86**
4 .	**Press Mud**	Total Variable Cost for Press Mud (0.23 per cent)	Rs.69,22,789
		Per Unit Variable Cost (MT)	**Rs.197.21**

Table 1.6 presents data on break-up of cost of production of sugar per quintal for the financial year 2013-14, in respect of selected sugar factory in Pune district.

Table 1.6 Per Unit Cost of Processing for the Selected Sugar Cooperative

S.No.	Products	Fixed Cost (Rs.)	Variable Cost (Rs.)	Total Cost of Processing(Rs.)	Per Unit cost of Processing(Rs.)
1.	**Sugar**	9,82,06,337	2,60,02,59,567	2,69,84,65,904	**2,465.57 /Qtl**
		89.73	**2,375.84**		
2 .	**Bagasse**	1,05,72,045	27,99,21,449	29,04,93,494	**1,135.94 /MT**
		41.34	**1,094.60**		
3.	**Molasses**	46,38,058	12,28,04,248	12,74,42,306	**3,866.57 /MT**
		140.71	**3,725.86**		
4.	**Press Mud**	2,61,460	69,22,789	71,84,249	**204.66 /MT**
		7.45	**197.21**		

Returns of selected sugar cooperative

As shown in Table 1.6 the total cost of processing was Rs. 2,69,84,65,904 per year, the cost per qtl. worked out to Rs.2,465.57. The gross returns generated by the sugar was Rs. 3,16,60,75,777 per year and the share of returns by sugar is 86.39 per cent. The BC ratio was 1.12.

Table 1.7 Product wise returns structure of the selected cooperative sugar factory

S. No.	Product	Production	Selling Price (Rs.)	Gross Income (Rs.)	% Share of Product
1	Sugar(Qtl)	10,94,460	2,892.82	3,16,60,75,777	86.39
2	Bagasse(MT)	2,55,729.2	1,333.69	34,10,63,210	9.30
3	Molasses	32,960	4,540.91	14,96,68,393	4.08
4	Press Mud	35,103	225	78,98,175	0.23
Total				**3,66,47,05,555**	**100**

1.3 Business viability of selected sugar cooperative

Sugar processing units are long term investments. Once established continue to generate returns upto many years. The initial investment to establish a sugar processing factory depends on the capacity of the plant. The costs and returns are analyzed carefully to test the worthiness of investment in sugar factory. The techniques of project evaluation such as Net Present Value, Benefit-Cost Ratio and Internal Rate of Return were employed to assess the financial feasibility of investment on sugar factory. In analyzing the investment feasibility, the establishment costs, maintenance costs and gross returns from the sugar processing factory were discounted at 13 per cent discount rate since it represents the opportunity cost of the capital.

The stream of cost and returns of Shree Vighnahar Cooperative Sugar Factory were used for analysis purpose.

The Net Present Value (NPV) criterion helps to evaluate the benefits accrued and costs incurred during the project life. The advantage of NPV is that it gives an idea about surplus and varies with level of investment and discount rates. In this study, NPV was calculated to indicate the money that would be generated by a project at a given discount rate. It is an absolute measure by discounting the net cash inflows. The NPV of selected sugar cooperative at 13 per cent discount rate was Rs.98,57,24,703. The formal selection criterion of NPV is to accept all the projects with positive values. Applying this principle, the Net Present Value of sugar cooperative clearly indicates financial feasibility of investment (Ashwini *et al.* 2005).

Benefit-Cost (BC) Ratio is another tool for appraising the worthiness of investment and it helps to ascertain the profitability of an enterprise. For processing the sugarcane, initial investment was made to establish the sugar cooperative and maintenance costs incurred during subsequent years of establishment. The decision in BC Ratio frame work is to select the projects where the ratio is more than one. The BC ratio of the selected sugar cooperative confined to 1.12 at 13 per cent discount rate, which is more than unity indicating the worthiness of investment on these units.

Internal Rate of Return (IRR) is found to be very suitable measure for evaluating the profitability of investment on different projects. The IRR is the rate of discount at which the net present worth of project is zero or the discounted costs are equal to the discounted returns. It is superior over the other measures since it takes into consideration the reinvestment opportunities of enterprises during the life span. The formal selection criterion of IRR is to accept the projects with IRR more than the opportunity cost of capital. The Internal Rate of Return being 26.86 per cent for selected sugar cooperative which is higher than the interest rate at which the cooperative could borrow from lending agencies and invest on this processing unit. In other words, it is the average earning power of money invested on the selected sugar cooperative during its life span. Since IRR was more than the opportunity cost of capital, it clearly indicated that investment on the selected sugar cooperative is financially feasible and economically viable.

Since the BC Ratio, IRR and NPV are positive and encouraging, there is a lot of potential to set up such cooperatives so as to improve the socio economic situations of the farmers and the profitability of the business.

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Research note
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EFFECT OF DIETARY INCLUSION OF SOLVENT EXTRACTED AND DETOXIFIED KARANJ (*PONGAMIA GLABRA VENT*) CAKE ON COMMERCIAL LAYER PERFORMANCE

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Karanj cake is rich in protein and was advocated for incorporation in various types of poultry rations at very low levels partially replacing soyabean meal (Krishna Daida, 2013). However, the feeding value of karanj cake on poultry is limited due to presence of toxic principles i.e. karanjin furanoflavonoid, tannins, trypsin inhibitor (Natanam *et al.* 1989). Recent study revealed that alkali treatment with NaOH or $Ca(OH)_2$ of karanj cake reduced the karanjin content substantially. Present study was conducted to see the effect of dietary incorporation of solvent extracted karanj cake and detoxified karanj cake on body weight, body weight gain, feed consumption, hen day egg production, FCR (Feed intake/egg mass), feed intake per dozen eggs and egg mass per bird.

Processing of karanj cake: Raw solvent extracted karanj cake (SKC) was procured from Omex Agro Fertilizers Pvt. Ltd, Lathore, Maharashtra. About 10 kg of ground SKC was soaked in 15 litres of water (1:1, w:v) containing 200 g of NaOH to yield effective concentration of 2 % NaOH (w/w). The processed cakes were sun dried, ground and packed in gunny bags for incorporation into the experimental diet.

A total of 216 commercial layers (Lohmann) at the age of 45 weeks were procured, leg banded and weighed individually. The birds were distributed in 9 treatments with six replicates in each group and four birds in each replicate. The experiment was conducted in 3 laying periods, *viz.* first period (45- 48 weeks), second period (49-52 weeks) and third period (53-56 weeks). Efforts were made to detoxify karanj cake by chemical method such as acid treatment. At a concentration of 2% (w/w) NaOH was effective in reducing the karanjin concentration of solvent extracted karanj cake (SKC).The level of nutrients in all the diets was maintained similar (isocaloric and isonitrogenous).

Body weight, body weight gain, feed consumption and egg weight of each replicate was recorded at 28 days interval, on cumulative basis and hen day egg production, FCR (Feed intake/egg mass), feed intake per dozen eggs and egg mass per bird were arrived at the end. The feed conversion ratio (FCR) was calculated (feed intake/egg mass) considering mortality as and when it occurred to maintain accuracy in the data collection by weighing back the feed on the day of mortality in that particular group.

The feeding of processed or unprocessed karanj cake with supplementation of protease and liver tonic to layer chicken resulted in comparable body weight and body weight gain, which were statistically comparable among all the groups throughout the course of the experiment. Similar to these findings, Mandal and Banerjee 1982a reported that, inclusion of expeller pressed SKC at 10% level and Krishna Daida 2013 reported that at 3 and 6% inclusion of SKC, NaOH and $Ca(OH)_2$ treated SKC, there was no significant difference in body weight and body weight gain for commercial layers at 26 – 37 weeks.

The hen day egg production ranged from 83.04 to 88.04 per cent and there was no significant difference compared to control (87.89%). Similarly Krishna daida 2013 observed that inclusion of karanj cake at 6 percent did not affect hen day egg production and egg mass.

The feed consumption was not significantly ($P>0.05$) influenced during the cumulative feed

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Table 1. Production parameters in White Leghorn layers fed with detoxified *karanj* cake at 45 - 56 weeks

Treatment	SKC Level (%)	Hen day egg production (%)	Body weight (g)	Body weight gain (g)	Feed consumption (g/day)	FCR (Feed intake/egg mass)	Feed intake per dozen eggs (g)	Egg mass/bird (g)	Egg weight (g)
Control		87.89	1478	133.3	102.3	2.232	1400	1420	57.65
Control + Protease (4000U kg^{-1})	-	88.03	1420	130.3	101.3	2.314	1394	1405	56.89
Control + Liver Tonic (0.1%)	-	88.04	1444	156.3	100.9	2.233	1379	1415	57.44
SKC	10	83.43	1484	144.2	99.40	2.405	1443	1322	56.62
SKC +Protease (4000Ukg^{-1})	10	86.22	1450	126.4	100.8	2.325	1422	1396	57.84
SKC+ Liver Tonic (0.1%)	10	87.79	1426	126.5	99.50	2.318	1360	1367	55.55
NaOH treated SKC	10	87.55	1423	135.5	101.4	2.250	1390	1410	57.73
NaOH treated SKC+ Protease (4000Ukg^{-1})	10	87.81	1401	131.5	101.1	2.272	1402	1433	58.96
NaOH treated SKC + Liver Tonic (0.1%)	10	87.95	1493	152.2	103.3	2.308	1411	1390	56.38
n		6	24	24	6	6	6	6	6
P value		0.986	0.116	0.180	0.516	0.917	0.967	0.903	0.074
SEM		1.015	8.612	3.097	0.515	0.028	14.13	16.45	0.252

SKC - Solvent extracted karanj cake, Means bearing atleast one common superscript in a column do not differ significantly ($P<0.05$)

P_1 - period 1 (45-48 weeks),

P_2 - period 2 (49-52 weeks),

P_3 - period 3 (53-56 weeks)

* - cumulative body weight gain

consumption at 10% processed or unprocessed SKC supplementation with or without protease (4000 U/kg^{-1}) or liver tonic (0.1%). The FCR (Feed intake/egg mass) was significantly ($P<0.05$) higher in the raw SKC and NaOH treated SKC supplemented with liver tonic. Raju *et al*. 2014 reported that, feed intake was significantly ($P<0.01$) decreased in commercial layers fed diets at 9% and 12% SKC during 50 - 61 weeks of age. Krishna Daida 2013 reported that, the normal values were recorded for feed consumption at the inclusion of SKC up to 6% and Verma *et al.* 1984 reported poor feed consumption in layers fed at 10% karanj cake in the diet.

The feed intake per dozen eggs values of untreated (or) treated SKC ranged between 1360 to 1443g, which were comparable to control (1336 g). Egg mass/bird was significantly ($P<0.05$) higher in the NaOH treated SKC without supplementation of protease and liver tonic. Egg weight values of processed or unprocessed SKC range from 55.55 to 58.96 g. The results obtained with respect to the type of cake and level of inclusion are supported by the findings of Natanam *et al*. 1989 who observed that, inclusion of SKC in the diet at 10% did not result in any significant variation than the control diet, but birds fed on expeller pressed cake had depressed feed efficiency. Krishna Daida 2013 reported that, the levels of inclusion (3 and 6%) did not significantly affect FCR 1381 and 1361g in test groups and 1336 g in control.

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Research note
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COMBINING ABILITY ANALYSIS FOR YIELD AND YIELD COMPONENT CHARACTERS IN RICE (*Oryza sativa* L.)

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Rice (*Oryza sativa*) is one of the major staple food crop being grown worldwide. It is the staple food for more than half of the world's population. It is a nutritious cereal crop, provides 20 per cent of the calories and 15 per cent of protein consumed by world's population. Besides being the chief source of carbohydrate and protein in Asia, it also provides minerals and fibre.

The rising demand, saturation of cultivable field and low gross domestic production of rice are likely to cause shortage of rice in the near future. By the year 2025, about 785 million tones of paddy which is 70 per cent more than the current production will be required to meet the growing demand (Manonmani and Khan, 2003). Therefore improving the productivity of rice has become crucial (Subbaiah *et al.* 2011) in near future.

Combining ability analysis provides comprehensive information on performance of genotypes in series of crosses. This analysis helps in identiûcation of parents with high general combining ability (GCA) and parental combinations with high specific combining ability (SCA). The estimation of additive and non-additive gene action through this technique may be useful in determining the possibility of commercial exploitation of heterosis. Among the various mating designs, Line × Tester (Kempthorne, 1957) is the most widely used one to evaluate the general and specific combining abilities of various lines, hybrids and to estimate gene effects governing various quantitative traits.

The present investigation involving six lines *viz.,* RNR 11718, NDR 359, HKR-10-34, UPR-3831-10-1-1, HHZ 5-Y3-Y1-DT1, PSBRC 68 and four testers *viz.,* IR 64, NLR 34449, IR 72 and MTU 1001 were crossed in Line x Tester design to produce twenty four crosses at Rice Research Centre, Rajendranagar, Hyderabad during *Rabi* 2015-16. During *Kharif,* 2016, the complete set of ten parents and their twenty four hybrids along with two checks were grown for evaluation in a Randomized Block Design (RBD) with three replications. Each entry was planted in a single row with spacing of 20x15 cm. The data was generated on seven characters *viz.,* days to 50 per cent flowering, plant height (cm), number of effective tillers per plant, panicle length (cm), number of filled grains per panicle, 1000 grain weight (g) and grain yield per plant (g).

Analysis of variance of combining ability for yield and its component traits revealed the presence of sufficient variation in the experimental material for all the traits under study. Variance due to crosses was highly significant for all the traits except panicle length. Variance due to lines was highly significant for the traits plant height and panicle length. Variance due to testers was highly significant for all the traits except number of effective tillers per plant, panicle length and grain yield per plant. The interaction effects (lines x testers) were found to be significant for all the traits except plant height and panicle length (Table 1).

The analysis of variances showed that, the variances due to SCA were higher than those due to GCA for four characters *viz.,* days to 50 per cent flowering (Swamy *et al.* 2003, Malini *et al.* 2006 and Venkatesan *et al.* 2007), number of effective tillers per plant (Tiwari *et al.* 2011 and Utharasu and Ananda kumar, 2013), 1000 grain weight (Akter *et al.* 2010

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and Hasan *et al.* 2013) and grain yield per plant (Swamy *et al.* 2003 and Malini *et al.* 2006), whereas, for plant height (Akter *et al.* 2010 and Veeresha *et al.* 2013), panicle length and filled grains per panicle GCA variances were higher than SCA variances. The findings of present study revealed that non additive gene action played greater role than additive gene action for all the traits except plant height, panicle length and filled grains per panicle (Table 2).

The general combining ability effects of lines and testers are presented in the Table 3. Two lines *i.e.,* UPR-3831-10-1-1 and PSBRC 68 and the tester MTU 1001 expressed highly significant positive gca effects for grain yield per plant. The parents RNR 11718, HKR-10-34 and IR 72 were found to exhibit highest gca effects for plant height, while NDR 359 exhibited significant positive gca effects for days to 50 per cent flowering and 1000 grain weight. The line UPR-3831-10-1-1 had shown desirable gca effects for days to 50 per cent flowering, number of effective tillers/plant, panicle length, number of filled grains per panicle and grain yield per plant. Similarly IR 64 has desirable gca effects for days to 50 per cent flowering, number of effective tillers/plant and 1000 grain weight. While NLR 34449 had exhibited for days to 50 per cent flowering and number of filled grains per panicle and MTU 1001 for number of filled grains per panicle, 1000 grain weight and grain yield per plant.

The specific combining ability effects of hybrids for grain yield and component characters are presented in the Table 4. Out of twenty four crosses only six crosses PSBRC 68 x MTU 1001, HHZ 5-Y3-Y1-DT1 x MTU 1001, UPR-3831-10-1-1 x IR 72, RNR 11718 x MTU 1001, x IR 64 and NDR 359 x NLR 34449 exhibited significantly positive *sca* values for grain yield per plant. The *sca* value is an useful index to determine the usefulness of a particular cross combination for exploitation of heterosis. Among the crosses high *sca* values and *per se* performance for grain yield per plant was exhibited by PSBRC 68 x

Table 1. Analysis of variance of combining ability for yield and yield component characters

Source of variation	d.f.	Days to 60% flowering	Plant height (cm)	No. of effective tillers/ plant	Panic lelength (cm)	No. of filled grains/ panicle	1000 grain weight (g)	Grain yield/ plant (g)
Replications	2	8.72	59.76*	0.15	1.67	18.05	1.69	3.64
Crosses	23	100.55**	106.37**	6.73**	4.30	2592.46**	40.06**	95.66**
Lines	5	99.46	309.16**	3.07	13.55**	2658.23	31.81	164.70
Testers	3	254.09*	223.84**	6.45	3.76	10804.98**	108.10*	95.86
Line*Tester	15	70.20**	15.31	8.02**	1.32	928.01**	29.20**	72.60**
Error	46	5.93	15.31	1.08	2.80	358.19	1.28	8.26
Total	**71**	**36.67**	**46.06**	**2.89**	**3.25**	**1072.38**	**13.85**	**36.44**

* Significant at 5 % level, **Significant at 1 % level

Table 2. Estimates of general and specific combining ability variances for grain yield traits

Source of variation	Days to 50% flowering	Plant height	No. of effective tillers/ plant	Panicle length	No. of filled grains/ panicle	1000 grain weight	Grain yield/ plant
σ^2gca	11.27	16.75	0.26	0.41	427.16	4.58	8.17
σ^2sca	20.82	0.03	2.37	-0.39	201.25	9.33	21.67
σ^2gca / σ^2sca	0.54	496.55	0.11	-1.05	2.12	0.49	0.37

Table 3. General combining ability effects of parents for yield and yield component

Genotype	Days to 50% flowering	Plant height (cm)	No. of effective tillers /plant	Panicle length (cm)	No. of filled grains/ panicle	1000 grain weight (g)	Grain yield / plant (g)
RNR 11718	3.94**	-5.40**	-0.39	-1.42**	-1.98	-1.95**	-2.09*
NDR-359	-2.72**	5.64**	-0.53	0.84	-4.51	2.99**	0.20
HKR-10-34	-1.56	-6.27**	0.22	-0.33	-16.64**	-0.34	-4.88**
UPR-3831-10-1-1	-3.14**	5.08**	0.74*	1.52**	27.57**	-0.29	5.41**
HHZ 5-Y3-Y1-DT1	2.03*	1.55	-0.38	-0.69	2.03	0.23	-1.58
PSBRC 68	1.44	-0.60	0.34	0.07	-6.47	-0.62	2.93**
SE for lines	1.14	1.59	0.39	0.65	7.35	0.44	1.12
IR 64	-2.25**	-0.56	0.67**	0.65	-19.53**	3.05**	-0.34
NLR 34449	-2.19**	1.05	-0.65**	-0.36	24.15**	-2.71**	-0.97
IR 72	-1.14	-4.47**	-0.34	-0.03	-22.62**	-0.98**	-2.00**
MTU 1001	5.58**	3.96**	0.31	-0.22	18.01**	0.64*	3.31**
SE for testers	0.93	1.30	0.32	0.53	6.00	0.36	0.92

*** Significant at 5 % level, **Significant at 1 % level**

MTU 1001 which also showed high *sca* values for other yield contributing characters like number of effective tillers/plant and 1000 grain weight. The crosses RNR 11718 x MTU 1001 and HHZ 5-Y3-Y1-DT1 x IR 64 exhibited maximum positive *sca* value and *per se* performance for grain yield per plant but did not perform well for other yield attributing characters.

From this study it is observed that, parental lines UPR-3831-10-1-1 and PSBRC 68 among lines; MTU 1001 and NLR 34449 among testers and cross combinations; PSBRC 68 x MTU 1001, RNR 11718 x MTU 1001 and HHZ 5-Y3-Y1-DT1 x IR 64 could be exploited beneficially in future rice breeding programme by adopting appropriate breeding strategy in order to evolve high yielding hybrid varieties.

Table 4. Specific combining ability effects for yield and yield components

Genotype	Days to 50% flowering	Plant height (cm)	No. of effective tillers /plant	Panicle length (cm)	No. of filled grains/ panicle	1000 grain weight (g)	Grain yield / plant (g)
RNR -11718 x IR 64	-7.17**	0.98	-0.26	-1.02	-13.97	2.33**	-0.85
RNR -11718 x NLR 34449	5.79**	-4.57*	0.02	-0.08	2.64	-1.55*	-4.39**
RNR -11718 x IR 72	5.39**	0.09	-0.22	0.89	12.79	-0.67	-0.94
RNR -11718 x MTU 1001	-4.00*	3.50	0.47	0.22	-1.45	-0.12	6.18**
NDR - 359 x IR 64	0.17	0.14	-0.89	0.19	3.55	-0.91	-0.44
NDR - 359 x NLR 34449	-0.89	1.73	0.90	0.66	13.40	-0.80	4.23*
NDR - 359 x IR 72	-1.61	-0.75	0.19	-0.37	-14.09	2.73**	1.31
NDR - 359 x MTU 1001	2.33	-1.12	-0.19	-0.48	-2.86	-1.02	-5.11**
HKR - 10 -34 x IR 64	4.67**	-2.42	0.10	0.27	6.48	-0.50	1.77

Genotype	Days to 50% flowering	Plant height (cm)	No. of effective tillers /plant	Panicle length (cm)	No. of filled grains/ panicle	1000 grain weight (g)	Grain yield / plant (g)
UPR - 3831-10-1-1 x IR 64	-0.08	1.90	1.71**	0.13	-4.27	-2.31 **	2.76
UPR - 3831-10-1-1 x NLR 34449	1.59	1.55	-0.50	1.07	33.72**	-0.14	1.19
UPR -3831-10-1-1 x IR 72	0.47	0.21	0.99	-0.90	-14.64	1.69 **	4.28**
UPR -3831-10-1-1 x MTU1001	-1.92	-3.65	-2.19**	-0.30	-14.81	0.76	-8.22**
HHZ 5-Y3-Y1-DT1 x IR 64	6.75 ***	0.296	-0.57	0.13	6.42	-0.85	3.68*
HHZ 5-Y3-Y1-DT1 x NLR 34449	-5.31 **	1.02	-0.25	-0.65	-30.33**	0.56	-1.42
HHZ 5-Y3-Y1-DT1 x IR 72	-4.03 *	-1.06	-0.63	0.07	6.11	1.85 **	-5.74***
HHZ 5-Y3-Y1-DT1 x MTU 1001	2.58	-0.25	1.46*	0.45	17.81	-1.56 *	3.48*
PSBRC 68 x IR 64	-4.33 **	-0.89	-0.09	0.32	1.78	2.24 **	-6.94**
PSBRC 68 x NLR 34449	2.29	0.57	0.43	-0.63	-1.97	2.63 **	1.56
PSBRC 68 x IR 72	4.22 *	-0.97	-2.89**	-0.11	13.81	-8.58 **	-0.75
PSBRC 68 x MTU 1001	-2.17	1.30	2.54**	0.42	-13.67	3.71 **	6.13**
SE for crosses	2.27	3.18	0.78	1.29	14.70	0.89	2.25

*** Significant at 5 % level, **Significant at 1 % level**

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Research note
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DEVELOPMENT AND EVALUATION OF GERMINATED BROWN RICE IN CORPORATED NANKHATAI

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The demand for processed and convenience food is increasing constantly due to urbanization, changing lifestyle and food habits of the people (Sheereen, 2013). Development of fortified biscuits or other composite flour bakery products is the latest trend in bakery industry. The growing interest in these types of bakery products is due to their better nutritional properties and possibility of their use in feeding programs and in situations like starvation or earthquakes (Pratima and Yadava, 2000).

Germinated Brown Rice (GBR) is ordinary brown rice soaked in water in order to initiate budding (Komatsuzaki *et al.,* 2007). Hydrolytic enzymes are activated during germination process and high molecular weight polymers are broken down, therefore, oligosaccharides, amino acids and other bio-functional substances are formed. Gamma-aminobutyric acid (GABA), which has a significant role in neurotransmission, is one of the important bio-functional substances produced during germination.

Nankhatai is believed to have originated in Surat in the 16th century, the time when Dutch and Indians were the important spice traders. A Dutch couple set up a bakery in Surat then they handed over the bakery to an Iranian when they left India. With time, his experimentation with bread ultimately gave birth to Nankhatai.

Germination process: Paddy (*Oryza sativa*) variety RNR 15048 was procured from Rice section, ARI Rajendranagar, Hyderabad. Paddy was dehusked by a rubber roll huller at 14% moisture content. The mixture comprising brown rice and paddy was separated by a paddy separator. The brown rice was obtained from the paddy separator.

Preparation of GBR flour: The brown rice was germinated by soaking in warm water of 35–40°C for about 10–12hr, after that water was drained out and kept in moist condition for 48-52hr and during soaking period, changing the water every 3–4hr to prevent fermentation (which usually produces undesirable odour) and to maintain consistent water temperature.

Standardization and development of Nankhatai: Refined wheat flour and GBR flour were used in the preparation of nankhatai. The incorporated level of GBR was 10%, 20% and 30%. Control samples were prepared with refined wheat flour. The experimental samples were made with GBR in different proportions i.e. 10%, 20% and 30%.

Method of preparation: All the ingredients were weighed**.** Sugar and fat were creamed together until light and fluffy then the egg and essence were mixed. Flour and baking powder were mixed and added to the cream. The smooth dough was prepared and divided in to small portions and rounded. Then the balls were placed one inch apart on a greased and floured baking tray and chopped cashew nuts were sprinkled on top of each ball. The baking was done at 176.7^{0}C for 15-20min. The ingredients, processing conditions, process parameters were taken from the bakery laboratory manual.

Sensory evaluation of nankhatai:

Sensory analysis of nankhatai prepared by manual method with refined wheat flour and GBR were evaluated by ten semi-trained panelists at Post Graduate & Research Centre, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad using 9 point hedonic

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Preparation of Nankhatai

Table 1. Standardization of GBR incorporated Nankhatai

Ingredients	Control N	Rate of GBR flour incorporation		
		N_1 (10%)	N_2 (20%)	N_3 (30%)
Refine wheat flour(g)	140	126	112	98
GBR flour(g)	-	14	28	42
Sugar (g)	85	85	85	85
Butter (g)	115	115	115	115
Egg	½	½	½	½
Baking powder(tsp)	¼	¼	¼	¼
Cashew nuts(g)	25	25	25	25
Vanilla(drops)	2	2	2	2

Note:

- N- Control sample
- N1-10% GBR incorporated Nankhatai
- N2-20% GBR incorporated Nankhatai
- N3-30% GBR incorporated Nankhatai

scale and products were scored for colour, texture, flavor, taste and overall acceptability. Scores were based on a hedonic rating of 1 to 9 where: 1 is dislike extremely (very bad) and 9 is like extremely (excellent) as given by Meilgaard *et al.* (1999).

Sensory acceptability of nankhatai: The nankhatai prepared using refined wheat and GBR flours in the ratio of 10%, 20% and 30% were evaluated for sensory qualities like colour, texture, taste, flavor and overall acceptability. The sensory evaluation results were given in the Table 2.

Table 2. Mean sensory scores of Nankhatai

Product	Color	Texture	Taste	Flavor	Overall acceptability
N	8.05^{a}±0.76	8.14^{a}±0.57	8.09^{a}±0.57	7.90^{a}±0.74	7.79^{a}±0.63
N1	7.14^{b}±0.74	6.78^{c}±0.42	7.10^{b}±0.74	6.99^{b}±0.82	7.01^{b}±0.47
N2	7.21^{b}±0.63	7.55^{b}±0.50	6.81^{b}±0.43	7.20^{b}±0.42	$7.44^{a,b}$±0.68
N3	$7.58^{a,b}$±0.72	8.01^{a}±0.67	7.77^{a}±0.42	7.99^{a}±0.67	7.68^{a}±0.47
Mean	7.49	7.62	7.44	7.52	7.48
CD Value	0.5810	0.4386	0.4553	0.4924	0.3978

Note: Values are expressed as mean ± standard deviation of three determinations.

Mean values with similar superscripts within a row do not differ significantly (PÃ0.05).

N- Control sample N1-10% GBR incorporated Nankhatai

N2-20% GBR incorporated Nankhatai N3-30% GBR incorporated Nankhatai

Nankhatai prepared with refined wheat flour and with incorporation of germinated brown rice flour (the incorporation levels of GBR flour was 10% (N_1), 20% (N_2) and 30% (N_3).The sensory evaluation of nankhatai was done by semi trained panel of judges. The mean sensory evaluation for the nankhatai were given in Table 2.

Sensory rating of Nankhatai for color showed that control sample (8.05) ranked at top due to excellent appearance, followed by N_3 (7.58), N_2 (7.21) while minimum mean sensory score of color was observed for N_1 (7.14). The mean sensory score of color declined from 8.05 to 7.14 with increasing level of substitution of germinated brown rice flour.

Mean sensory scores for texture of nankhatai decreased from 8.14 to 6.78. Mean sensory score for texture showed in Table 2 revealed that the control sample had highest mean score for texture (8.14) followed by N_3 (8.01), N_2 (7.55) while N_1 (6.78) had least mean score for texture. Texture plays important role in baked products, texture should neither be very soft nor be hard.

Mean sensory score for taste of nankhatai varied from 8.09 to 6.81. Mean sensory score for taste as showed in Table 2 revealed that the control sample had highest mean score for taste (8.09) followed by N_3 (7.77), N_1 (7.10) while N_2 (6.81) had least mean score for taste.

Mean sensory score for flavor of nankhatai ranged from 7.99 to 6.99. Mean sensory score for flavor showed in Table 2 revealed that the mean sensory score for flavor in 30% incorporated germinated brown rice flour (N_3 7.99) at top position followed by control (7.90), N_2 (7.20) while N_1 (6.99) had least mean score for flavor.

Overall acceptability was determined on the basis of sensory quality scores obtained by the evaluation of color, flavor, taste and texture of the nankhatai. The mean sensory score regarding overall acceptability of nankhatai showed in Table 2 revealed that the mean overall acceptability in control was maximum, while 10% of GBR flour incorporating nankhatai had lowest mean acceptability when compared with other treatments. The decrease in mean overall acceptability was due to decrease in mean sensory score of color, flavor, texture and taste scores.

Statistically significant difference ($P<0.05$) was observed in mean color, texture, taste, flavor and overall acceptability scores of nankhatai prepared from refined wheat flour and with the addition of GBR flour (10%). However there was no significant difference among control, 20% and 30% GBR incorporated nankhatai.

The 30% GBR flour incorporated nankhatai had highest scores for all the sensory attributes (color, texture, flavor, taste and overall acceptability) when compared with other treatments. Basically nankhatai are also called as butter cookies while increasing the level of incorporation of GBR flour the acceptability of the product was not decreased, so we can add the GBR flour up to 30%.

From the present study, it is concluded that GBR has potential to become innovative rice by preserving all nutrients in the rice grain for human consumption in order to create the highest value from rice. The GBR technology can be transferred for empowerment of rural people, by transforming them into a successful entrepreneur by starting their own food (GBR) processing units and to contribute in the national development, health and nutritional security and improvement in the living standards. If successful on its generation and dissemination part, this technology will prove to be boon for the rice growers in India.

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Research note
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EFFECT OF SELECTED DEMOGRAPHIC CHARACTERS ON HEALTH RELATED QUALITY OF LIFE (HRQOL) IN TYPE 2 DIABETIC SUBJECTS OF HYDERABAD AND RANGAREDDY DISTRICTS OF TELANGANA STATE

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The prevalence of diabetes is swiftly increasing over the globe at an alarming rate. According to the International Federation of Diabetes, 415 million adults around the world are suffering from diabetes, and it is estimated that the numbers will reach around 642 million by 2040 (IDF, 2015). The first World Health Organization (WHO) global report on diabetes demonstrates that the number of adults living with diabetes has almost quadrupled since 1980 to 422 million adults (WHO, 2016).

India leads the world and stands at the second position after China, with 69 million persons affected by diabetes which poses a daunting challenge to the sustainable development of the nation as almost every tenth adult (9.3%) in India is estimated to be affected by diabetes (IDF, 2015). Type 2 diabetes mellitus (T2DM), affects a patient's general health and well-being in various ways such as, severe dietary restriction and daily self-administration of oral medications, or insulin may adversely affect an individual's health-related quality of life (HRQOL). At the same time, the disease and its complications cause a heavy economic burden for diabetic patients themselves, their families and society. In addition, the long-term complications of diabetes, such as nephropathy, neuropathy, heart disease and stroke, with their considerable impact on health, may also have a negative effect on quality of life. The impacts of T2DM are considerable: as a lifelong disease, it increases morbidity and mortality, and decreases the quality of life (Hoskote and Joshi, 2008).

WHO defines Quality of Life as individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns (Skevington *et al.* 2004). Diabetics mellitus (DM) can be negatively affect physical, mental and social well-being. Development of long-term complications leading to a significant drop in perceived quality of life and patient's ability to function independently may be impaired as well. Patients may become chronically frustrated, discouraged, enraged and helpless, begin feeling alone with diabetes, feeling different and unsupported, and believing that no one can understand what living with diabetes is really like. Quality of life assessment is therefore important for people with diabetes and their health care providers. This is because many people who suffer from diabetes and who have poor quality of life, often have less attention to their self-care and disease management. When self-care is diminished in diabetes, it in turn leads to poor glycaemic control and increased risk of complications. Thus, quality of life issues are crucially important because they may powerfully predict an individual's capacity to manage his/her disease and maintain long term health and wellbeing (Chasens *et al.* 2014).

Diabetes mellitus is a costly disease with an escalating prevalence which exerts significant burden on the physical, mental and social well-being of patients. To provide a more holistic management of DM. HRQOL outcomes are increasingly used to quantify the impact of chronic diseases such as DM.

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Despite the large body of literature on HRQOL issues in DM, few of these studies were performed in Asia and India (Thumboo *et al.* 2002; Alonso *et al.* 2004; Manjunath *et al.* 2014). Clearly, the volume of research activity does not match the magnitude of the problem that DM poses for India. Although India is expected to be at the forefront of an impending DM epidemic, our knowledge of the impact of DM on HRQOL among various states of India is lacking, especially when compared to the potential magnitude of this problem. In India, Hyderabad is known to be the diabetic capital of the country and there are no studies carried out in Hyderabad or the Telangana state as far as the published literature is concerned. In this context, a pilot study was planned to assess the HRQOL among Type 2 Diabetic subjects in Hyderabad and Rangareddy districts of Telangana state (Old districts of Telangana) so as to study the correlation between demographic characters of T2DM subjects with various domains of HRQOL, to contribute to the existing epidemiological data of the country.

The study was carried out in 384 subjects who were chosen from out patient / in patient departments in hospitals/clinics from Hyderabad and Rangareddy districts of Telangana State. A non-probability purposive sampling technique was used to select type 2 diabetic patients (based on inclusion and exclusion criteria).

Study tool: Quality of Life of the patients included in the study receiving allopathic / ayurvedic / life style modification treatment was assessed in line with QOLID (Quality of Life Instrument for Indian Diabetes Patients) in the following domains: Role limitation due to physical health, physical endurance, general health, treatment satisfaction, symptom botherness, financial worries, emotional / mental health, diet satisfaction (Nagpal *et al.* 2010). Before starting the interview, willingness to participate was sought and later verbal and written consent was taken from the subjects. Self administered questionnaires were provided and data was collected. Demographic characters of the population was expressed as percentages. Pearson's bivariate correlation test was used to calculate correlation coefficients between the selected demographic parameters and quality of life parameters.

Demographic profile of participants (N=384)

A study on Health related quality of life among type II diabetes subjects was carried out on 384 subjects in Hyderabad and Rangareddy districts of Telangana. The demographic characteristics of participants of the study are presented in table 1. The results showed that, 54.68% of the subjects were in the age group of 40 – 60 years (n=210); 23.43% of the subjects were in age group 60 – 80 years (n= 90); 20.57% of the subjects were in the age group of 20 – 40 years (n = 79) and 1.30% of subjects were above 80 years (n=5). The majority (54.68%) of participants from the study were middle aged (40-60 years). Among all the subjects participated in the study (n=384), 52.86% (n=203) were male and 47.13% were female (n=181). National health survey (2009) projected 1,052,00 adults with diabetes in middle age, 4,65,000 cases of diabetes in young aged adult and 3,90,000 cases in old aged population. Hence, it is increasingly becoming apparent that type 2 diabetes has become prevalent even among younger age groups, which could have long lasting effects on the health of the nation and its economy.

The results on type of education showed that educational qualification of majority of respondents 32. 29% (n=124) was undergraduation and above category, followed by primary education 26.56% (n=102), followed by secondary education 21.87% (n=84). There were 19.27% (74) without any kind of education. The figures give indication that education level among the diabetic respondents was high, and almost 310 subjects out of 384 subjects were either graduates or had primary or secondary education. Rayappa *et al.*1999 reported that education has a major effect on diabetes prognosis. The higher education among the respondents had early diagnosis of disease than the illiterates. The respondents with high education also had 44.4% less complication compared to illiterates (19.5%). He further indicated that level of education among respondents is important determinant for early diagnosis of diabetes.

Results on type of occupation showed that, 50% of the subjects were involved in moderate work (n=192); 43.22% in sedentary work (n=166) and 6.77% in heavy work (n=26). Shihabudheen *et al.* 2010

indicated the incidence of diabetes was only 26.6% among highly active individuals, who were mainly earning their living through daily wages. The incidence was up to 38.83% in case of moderately active and 34.46% in least active.

Table 1. Demographic profile of participants (N=384)

Subject characteristics	Number (%)
Age	
20-40 years	79 (20.57%)
40-60 years	210 (54.68%)
60-80 years	90 (23.43%)
>80 years	5 (1.30%)
Gender	
Males	203 (52.86%)
Females	181 (47.13%)
Education	
Primary	102 (26.56%)
Secondary	84 (21.87%)
College or higher	124 (32.29%)
No Education	74 (19.27%)
Occupation	
Sedentary	166 (43.22)
Moderate	192 (50)
Heavy	26 (6.77)
Marital status	
Married in partnership	284 (73.95)
Widowed	58 (15.10)
Divorced	9 (2.34)
Alone	33 (8.59)
Residence	
Own house	231 (60.15%)
Rented house	149 (38.8%)
Relatives	4 (1.04%)
Monthly income	
<10,000	166 (43.22%)
11,000-19,000	135 (35.15%)
20,000-29,000	54 (14.06%)
>30,000	29 (7.55%)

The results on marital status of the subjects showed that, 73.95% (n=284) were married in partnership; 15.10% of the subjects were widowed (n=58); 2.34% of the subjects were divorced (n=9) and 8.59% of the subjects were alone (n=33). The results about status of residence of the subjects indicated that, 60.15% (n=231) of subjects live in their own house; where as 38.8% of the subjects were living in rented house (n=149) and 1.04% of the subjects were living in their relatives houses (n=4). The place of residence of the patient also matters as it determines the availability of health care, specialist advice, education, therapy and the degree of patient adherence to medical recommendations.

Results of the monthly income status of the subjects showed that, a majority i.e., 43.22% (n=166) of them were having below 10,000 per month; 35.15% (n=135) had income between 11,000 to 19,000 income per month; 14.06% (n=54) had income between 20,000 to 29,000 per month and 7.55% (n=29) had income above 30,000 per month. A study by Rayappa *et al.* 1999, reported that people with high income group had likelihood of getting more adequate and proper medical care. The study also reported that greater care results into less diabetic complications. Multiple complications were 8.1% in diabetic patients of high income group compared to diabetic people with low socio-economic status (22%).

Demographic profile on disease related parameters

Information on disease related parameters were collected from all the 384 subjects. Information on disease related parameters was further subdivided into four components namely duration of diabetes, health status, treatment, diabetes related hospitalization and associated co-morbidities. The results obtained are given in table.2.

Table 2 . Demographic profile on disease related parameters

Subject characteristics	Number (%)
Duration of diabetes mellitus	
<6 months	6 (1.56%)
6-12 months	38 (9.89%)
1-5 years	234 (60.93%)
>5 years	106 (27.60%)
Health status	
Hypertension	300 (78.12%)
High cholesterol	66 (17.18%)
Poor eye vision	81 (21.09%)
Brain stroke	22 (5.72%)
Heart attack	77 (20.05)
Foot amputation	19 (4.94%)
Kidney dialysis	9 (2.34%)
Treatment	
No treatment	7 (1.82%)
Diet	13 (3.38%)
Exercise	4 (1.04%)
Diet & Exercise	43 (11.19%)
Combination therapy (medication + diet + exercise)	317 (82.55%)
Co-morbidities	
Diabetes related hospitalization in past year	78 (20.31%)
Cardiovascular co-morbidity	72 (18.75%)
Nephropathy co-morbidity	18 (4.68%)
Retinopathy co-morbidity	34 (8.85%)
Neuropathy co-morbidity	39 (10.15%)
Lower extremity lesions	5 (1.30%)

Responses about the duration of diabetes indicated that, 1.56% (n=6) subjects had onset of diabetes below 6 months (newly diagnosed), followed by 9.89 % (n=38) respondents with duration of diabetes between 6 to12 months. 60.93% (n=234) reported that the duration of diabetes was between 1 to 5 years and 27.60% (n=106) with duration of diabetes above 5 years. Results on health status regarding associated problems present along with diabetes in the subjects showed that 78.12% (n=300) had hypertension; 21.09% (n=81) had vision related problems; 20.05% (n=77) had heart attack; 17.18% (n=66) reported high cholesterol; 4.94% (n=19) had foot amputation and 2.34% (n=9) were undergoing kidney dialysis.

Liu *et al*. (2010) in their cross sectional hospital based survey in urban China on prevalence of chronic complications of type 2 diabetes mellitus in outpatients reported that, chronic complication is the outcome of type 2 diabetes and that at least one chronic complication was diagnosed in 52% of diabetic respondents, which increased with age. Our findings are in correlation with the findings of Liu *et al.,* (2010), where more than half of the respondents reported a chronic complication which was an outcome of type 2 diabetes.

Results on type of treatment among the study respondents showed that majority of them (82.55%, n=317) were on combination therapy (medication + diet + exercise), followed by 11.19% (n=43) on diet + exercise. 3.38% (n=13) of the respondents were on diet therapy only and 1.82% (n=7) of the respondents were managing their diabetes without any kind of treatment. A study by Harris, 1991 reported that the major environmental factors that lead to type II diabetes are sedentary lifestyle and over nutrition leading to obesity. Another study by Goodpaster *et al.* 2010, showed that regular exercise improves glycaemic control and insulin resistance in all forms of diabetes and that physical exercise is the best way to reduce insulin resistance.

Majority of the subjects who participated in our study reported one or more co-morbidities. Co-morbidity is defined as the occurrence of one or more chronic conditions in the same person with an index-disease, which occurs frequently among patients with diabetes. Currently, integrated diabetes care programs focus on diabetes-related co morbidities like cardiovascular diseases, retinopathy, nephropathy and neuropathy (Francesca *et al.* 2013). However, patients with diabetes do not only have diabetes-related co morbidity, but also have non diabetes-related co morbidity, such as depression and musculoskeletal diseases. With the on-going population aging in most of the societies, not only the number of patients with diabetes is expected to increase, but also the number of patients with diabetes with co morbidity. This implies that the current single disease management approach is not applicable to a large part of the patients with diabetes in the future (Yong *et al*. 2013). Co-morbidity among patients with diabetes is associated with considerable consequences for health care and related costs. Co-morbidity has been shown to intensify health care utilization and to increase medical care costs for patients with diabetes.

As per the results, 20.31% (n=78) of respondents reported diabetes related hospitalization in the past year (2014 to 2015). Results on associated co-morbidities showed that, 18.75% (n=72) had cardiovascular problems; 10.15% (n=39) had neuropathy; 8.85% (n=34) had retinopathy; 4.68% (n=68) respondents had nephropathy and 1.30% (n=5) had lower extremity lesions. Most adults with diabetes have at least 1 coexisting chronic condition (Druss *et al.* 2001) and approximately 40% have 3 or more (Wolff *et al.* 2002). As the number of comorbidities increases, the risks of poor patient outcomes (eg, unnecessary hospitalizations, adverse drug events, mortality) and healthcare costs also increase (Struijs *et al. 2006)*. Further, the types of co-morbidities impact diabetes care (Kerr *et al.* 2007).

Correlation between selected demographic characters of diabetes and Health related quality of life

Pearson correlation and intra class coefficient between selected demographic characteristics such as age, monthly income, duration of diabetes, were correlated with various domains of HRQOL and the results are presented in table 3. As per the results obtained, it was found that subjects in age the group of 20-40 had significant negative effect on physical endurance (P>0.05). Subjects in the age group of 40-60 years had a significant negative effect on all

Table 3. Pearson correlation and intra class correlation coefficient between selected demographic characters of diabetes and Health related quality of life

Parameters	Role Limitation Due to Physical Health	Physical Endurance	General Health	Symptom Botherness	Treatment Satisfaction	Financial Worries	Emotional Mental /Health	Diet Satisfaction
Age								
20-40	-0.139	-0.252*	-0.159	-0.117	-0.152	-0.076	-0.132	0.175
40-60	-0.206**	-0.326**	-0.378**	-0.293**	-0.200**	-0.201**	-0.175*	0.005
60-80	-0.103	-0.121	-0.239*	-0.101	-0.155	-0.129	-0.040	0.110
80+	0.384	0.224	-0.444	0.215	0.579	-0.102	-0.258	-0.218
Education								
Primary	-0.185	-0.010	-0.054	-0.142	-0.051	-0.140	-0.029	-0.113
Secondary	0.043	-0.164	-0.328	0.036	0.288**	0.068	0.084	-0.148
College	-0.045	0.005	0.008	-0.066	-0.009	0.069	-0.039	-0.094
No education	0.033	-0.087	-0.135	-0.072	-0.158	-0.018	-0.077	-0.192
Monthly income								
<10,000	0.093	0.226**	0.322**	0.146	0.246**	0.0896	0.132	0.089
11,000-19,000	0.191*	0.229**	0.311**	0.271**	0.287**	0.273**	0.241**	-0.119
20,000-29,000	0.108	0.162	0.068	-0.192	-0.086	-0.064	0.002	0,270
>30,000	-0.343	-0.968	-0.126	-0.115	-0.759	-0.025	0.132	0.170
Duration of Diabetes								
<6 months	-0.807	-0.603	-0.266	-0.432	0.603	-0.084	-0.429	-0.899*
6-12 months	-0.148	-0.056	-0.048	0.240	-0.0106	0.195	-0.038	-0.080
1-5 years	-0.409**	-0.457**	-0.443**	-0.423**	-0.460**	-0.333**	-0.385**	-0.027
>5 years	-0.068	-0.060	-0.202*	-0.238*	-0.141	-0.086	-0.092	0.019

Note: ** p value significant at 0.01 level, * p value significant at 0.05 level

aspects of HRQOL such as role limitation due to physical health (P>0.01), physical endurance (P>0.01), general health (P>0.01), symptom botherness (P>0.01), treatment satisfaction (P>0.01), financial worries (P>0.01), emotional / mental health (P>0.05). Subjects in the age group of 60 – 80 years had a statistically significant negative effect (P>0.05) on the general health indicating that as age advances, diabetes does have a negative impact on the quality of life. Age is an important parameter which has an effect on the HRQOL of diabetic patients (Song., 2012). Hanninen *et al*. 1998 reported that age has no effect on diabetic patient's HRQOL; however, another study reported that patients who are less than 40 years of age have significantly better QOL than other age groups (Al-Maskari *et al.* 2011). The results of our study found a negative correlation between age and HRQOL.

Results of our study indicate that diabetic complications had more impact on the quality of life in patients younger than 60 years old. A possible explanation is that complications are likely to have a greater impact on the health of this group because they have less co-morbidities and have not adjusted to the idea of accepting lesser health. The differences could also be explained by the fact that this younger subgroup has responsibilities such as work and family as well as relationship issues that are not found in the older subgroup. A Norwegian study by Solli *et al.* 2010 indicates similar results as the present study.

The results of correlation between level of education and HRQOL, showed that subjects who had secondary education only had a significant (P>0.01) impact on treatment satisfaction. All the other education levels among the subjects, did not have any statistically significant correlation with all domains of quality of life. The results of our study did not show statistically important impact of the level of education on the quality of life of patients with diabetes, which was not in accordance with a study conducted in Mexico (Martínez *et al.* 2008). Highly educated subjects with a strongly positive attitude had better opportunities of improving their results in the psychological domain and the domain of social relations (Martínez *et al.* 2008). Other studies have confirmed the linear correlation between the level of education and quality of life (Varghese *et al.* 2007; Nejhad *et al.* 2013; Esteban *et al.* 2010).

The results of correlation between monthly income and HRQOL indicated that subjects with lower monthly income levels ie., < Rs.10,000 and, Rs.11,000 to Rs.19,000 had significant (P>0.01) impact on physical endurance, general health, symptom botherness, treatment satisfaction, financial worries and emotional / mental health. Low socioeconomic status and patients with a high school education or less had a strong negative impact on HRQOL of diabetes patients especially in the younger age group (Eljedi *et al*. 2006; Wubben and Porterfield. 2005). A study by Ayman *et al*. 2014 reported that multivariate linear regression analysis indicated only economic status as independent risk factor for HRQOL in diabetes patients. The present study also found that patients with a low economic status had poor HRQOL outcome.

Correlation between duration of diabetes and HRQOL showed significant (P>0.01), negative impact on HRQOL domains such as role limitation due to physical health, physical endurance, general health, symptom botherness, treatment satisfaction, financial worries, emotional / mental health in subjects with duration of diabetes between 1-5 years. Subjects with duration of diabetes more than 5 years had a significant (P>0.05) negative impact on general health and symptom botherness. Many studies reported an association between increased duration of diabetes and poor HRQOL, in both types of diabetes (Glasgow *et al.* 2014; Redekop *et al.* 2002). On the other hand, there are also contradicting findings about the association between duration of diabetes and HRQOL. In this present study we found a negative association between diabetes duration and HRQOL. The longer duration of diabetes is associated with the poor HRQOL.

CONCLUSION

People with diabetes experience significant impairment in their health related quality of life, which is associated with a variety of clinical parameters. The presence of diabetic complications significantly affects few HRQOL domains. Health care providers such as medical practitioners and medical nutrition therapists should strive to understand the physical, emotional and social impacts of having chronic disease. Theoretically, such patient-centered knowledge can be incorporated into chronic disease treatment strategies designed to improve or enhance

function in everyday life and improve or enhance health-related quality of life (HRQOL). Strategies designed to diagnose HRQOL domains and their management may not only prevent diabetes related complications, but may also prevent irreversible deterioration of health related quality of life in diabetic patients. Patients in this study may not be representative of the large population of diabetics in our country, however, it throws light on certain determinants that can have a bearing on the quality of life. It can be concluded that a better quality of life would also mean improved confidence and a positive outlook, both of which will go a long way in the management of diabetes.

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