National Conference on Rural Livelihood Security through Innovative Agri-entrepreneurship

12-13 March 2016

Venue :
ICAR Central Potato Research Station
Patna, Bihar, India

Organized By :

Society for Upliftment of Rural Economy (SURE), Varanasi (U.P.) India
&
ICAR Central Potato Research Station, Patna, Bihar

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Message

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PATNA

Message

I am happy to note that society for upliftment of rural economy in collaboration with ICAR-Central Potato Research Station, Patna is organizing a two day National Conference on *"Rural Livelihood Security through Innovative Agri-entrepreneurship"* during 12-13 March,2016 at ICAR-CPRS , Patna.

More than 70 percent of total population of the country depends upon agriculture and allied sector for their livelihood security and most of them belong to the category of below poverty line. I congratulate the organizers for selecting a very relevant theme in which almost all the topic of *agri-entrepreneurship* has to be deliberated, discussed and documented during the conference for the benefit of various state holders.

I hope that this conference will provide the right platform to scientist, planners, professionals, policy makers, academicians and other stake holders for knowledge exchange and recommendations emerging from deliberation would give a new insight to *agri-entrepreneurship* sector which will help to further promote the agri and allied sector in Bihar.

I convey my best wishes for the success of the seminar.

(Nitish Kumar)

श्रवण कुमार

شروَن کمار

मंत्री
ग्रामीण विकास एवं संसदीय कार्य विभाग
बिहार सरकार

पत्रांक 536/ग्रा.वि. दिनांक 10/3/2016

शुभकामना संदेश

यह जानकर अत्यंत प्रसन्नता हो रही है कि ग्रामीण आर्थिक उत्थान संस्था एवं बिहार कृषि विश्वविद्यालय, सबौर के तत्वावधान में **'नावोन्मुखी कृषि आधारित उद्यम द्वारा ग्रामीण जीवकोपार्जन सुरक्षा'** विषय पर राष्ट्रीय संगोष्ठी का आयोजन किया जा रहा है।

ग्रामीण बाहुल्य भारत जैसे कृषि प्रधान देश में इस प्रकार की संगोष्ठी का अपना एक खास महत्व है। ग्रामीणों के स्तर को उन्नत बनाने हेतु बहुद्देशीय कार्यक्रमों के माध्यम से सरकार द्वारा कई योजनाएं संचालित की जा रही हैं। सरकार की इन योजनाओं के प्रचार-प्रसार तथा लाभूकों को समय पर सभी लाभ उपलब्ध कराने की दिशा में इस संगोष्ठी का एक महत्वपूर्ण स्थान है। राज्य की जनता खासकर ग्रामीण इससे काफी लाभान्वित होंगे तथा उनके आर्थिक स्थिति में सुधार का अवसर प्राप्त होगा।

मैं इस संगोष्ठी के सफलता की मंगलकामना करता हूँ।

(श्रवण कुमार)

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पत्रांक 269 दिनांक 11/03/16

शुभकामना संदेश

अत्यंत प्रसन्नता है कि सोसायटी फॉर अपलिफटमेंट ऑफ रूरल इकोनोमी, वाराणसी, बिहार कृषि विश्वविद्यालय, सबौर एवं बामेति द्वारा पटना में **'नवोन्मुखी कृषि आधारित उद्यम द्वारा ग्रामीण जीवकोपार्जन सुरक्षा'** विषय पर प्रथम राष्ट्रीय संगोष्ठी का आयोजन किया जा रहा है। साथ ही इस अवसर पर विषयाधारित स्मारिका भी प्रकाशित की जा रही है।

मुझे पूर्ण विश्वास है कि इस मंच से ऐसे विचार एवं मूर्त्त प्रस्ताव उभरकर आएंगे जो सहभागियों के लिए उपयोगी होंगे।

अतः सोसायटी द्वारा जनहित में आयोजित किये गये इस संगोष्ठी के लिए बधाई देता हूँ तथा इसकी सफलता के लिए मेरी हार्दिक शुभकामनायें।

(अवधेश कुमार सिंह)

सी० पी० सिन्हा
अध्यक्ष (मंत्री स्तर)
C. P. SINHA
CHAIRMAN (Minister Level)

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संदेश

मुझे जानकर अत्यंत प्रसन्नता हो रही है कि सोसायटी फॉर अपलिफटमेंट ऑफ रूरल इकोनोमी, वाराणसी, बिहार कृषि विश्वविद्यालय, सबौर एवं केन्द्रीय आलू अनुसंधान केन्द्र, पटना के तत्वावधान में दिनांक 12-13 मार्च, 2016 को केन्द्रीय आलू अनुसंधान केन्द्र, पटना में **'नावोन्मुखी कृषि आधारित उद्यम द्वारा ग्रामीण जीवकोपार्जन सुरक्षा'** विषय पर राष्ट्रीय संगोष्ठी का आयोजन किया जा रहा है। यह संगोष्ठी बिहार के परिप्रेक्ष्य पर काफी उपयोगी सिद्ध होगा। आयोजक मंडल द्वारा प्रकाशित पत्रिका के सफल प्रकाशन के साथ राष्ट्रीय संगोष्ठी की अपार सफलता के लिए अपना शुभकामना देता हूँ।

10.3.2016

(सी० पी० सिन्हा)
अध्यक्ष

डा0 रमेश चन्द्र श्रीवास्तव
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No. ...../RAU (VC)

Date ..10/03/2016....

Message

It is indeed a matter of great pleasure to learn that Society for Upliftment of Rural Economy, Varanasi, UP (INDIA) and ICAR-Central Potato research station, Patna are jointly organizing National Conference on "Rural Livelihood Security through Innovative Agri-entrepreneurship" during 12-13,2016 at ICAR-CPRS, Patna.

Agricultural sector in general and Livestock sector in particular is playing a very important role in ensuring food nutritional and livelihood security to the farmers. Livestock sector particularly contribute about 40 percent to agricultural GDP in Bihar.

Innovations are essential to further harness the potentials of agri-entrepreneurship sector particularly in Bihar. It is a matter of satisfaction to note that the organizers have identified a pertinent issue for organizing this conference at Patna.

I am sure it will bring together well acclaimed national level scientists, Professor, entrepreneurs farmers and policy makers to discuss the latest technology, development trends and their application in all spheres in agri and allied sector to find newer solution to achieve the goals of all stake holders.

I wish every success to this conference.

Srivastava

(R.C. Srivastava)

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Ref. ..... Date .....

Message

I am happy to know that the Society for Upliftment of Rural Economy (SURE), Varanasi is organising theNational Conference on "Rural Livelihood Security through Innovative Agri-entrepreneurship (RLSIAe)" at ICAR-CPRS Patna on 12-13 March, 2016.

Our country lives in village and rural economy has become a great concern for policy planners in this developing era. The society is devoted to work for rural magges and organizing such event halp developing a plan for future line of action in the area of livelihood security. The holding of conference is timely and will provide a platform to discuss the issues and will result in important recommendations.

I compliment the organizers and wish the event all success.

(Ajoy Kumar Singh)

BIHAR STATE MILK CO-OPERATIVE FEDERATION LTD.
बिहार स्टेट मिल्क को-ऑपरेटिव फेडरेशन लि0

SeemaTripathi
IAS
Managing Director

Message

I am extremely happy to know that Society for Upliftment of Rural Economy in collaboration with Bihar Agricultural University, Sabour and Central Potato Research Station, Patna is organizing a National Conference on "Rural Livelihood Security through Innovation Agri-entrepreneurship" during March 12 – 13, 2016 at Central Potato Research Station, Patna.

Dairying is an important component of Indian agriculture that offers viable alternative for ensuing livelihood security and improving rural household's economy where in about two-thirds of farming households are engaged. It is an important means of livelihood for millions of landless and small land holders and most of them belong to the category of below poverty line.

Bihar has witnessed a revolution in Dairying in recent past. Livestock sector contributes about 40% to agricultural GDP in Bihar. Innovations are essential to harness the potentials in agri-entrepreneurship particularly in Dairy sector. As a Managing Director, COMFED, I congratulate the organizers for selecting a very relevant theme that is to be deliberated, discussed and documented during the seminars for the benefits of scientist, academicians, policymakers, entrepreneurs etc.

I wish all success to this conference.

10/3/16.

(SeemaTripathi)
Managing Director
COMFED

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Joint Director (Academic)

संदर्भ सं./Ref. No. JDA (conf)/2015-16
दिनांक/Dated 10 March, 2016

Message

I am elated to learn that Society for Upliftment of Rural Economy in collaboration with Bihar Agricultural University, Sabour and Bihar Agricultural Management Training Institute, Patna is organizing National Conference on Rural Livelihood Security through Innovative Agri-entrepreneurship (Agri Search 2016) at Patna during March 12-13, 2016.

Agriculture will remain the mainstay of Indian economy in the future as well. India is managing 17.5 percent of world population on merely 2.4 percent of world land area. The growing population and diminishing land area pose a very challenging task of retaining agriculture as an economically viable livelihood source. The socio-economic and demographic changes taking place in the country coupled with global free market economy warrant that a good number of youth particularly the rural youth are turned into entrepreneurs to harness the benefits of new technologies and emerging market realities. For this to happen available human resources are to be equipped with adequate skills in agri-business which may not always be innate but can come through education and training. To this end the topics identified for deliberations during this conference are very relevant and synergize well with the government's 'Skill India' campaign. I am confident that the scientists, planners/policy makes, academicians and many other stakeholders who are going to participate will share their views and insights during the conference. I look forward to the organizers to come up with a very synthesis report containing relevant recommendations to guide the programmes and policies of the modern agriculture sector.

I wish this Conference a grand success.

(R.R.B. Singh)

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Date : .....

Message

It give me immense pleasure to learn that the Society for Upliftment of Rural Economy (SURE) Varanasi is organising the 1st National Conference on "Rural Livelihood Security through Innovative Agri-entrepreneurship (RLSIAe)" at Patna on 12-13 March, 2016.

Much emphasis has been placed on improving the quality life of rural people and enhancing productivity and quality of agricultural and dairy products. The livelihood security in agriculture has become a major concern with advancement of technologies and high degree of investment in agriculture apart from danger of climate change.

I hope that a large group of eminent researchers/academicians will deliberate on key issues pertaining to Rural Livelihood security and arrive at fruitful conclusion.

I wish the event a grand success.

9/3/2016

(Hare Ram Singh)

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DIRECTORATE OF EXTENSION EDUCATION
RAJENDRA AGRICULTURAL UNIVERSITY
PUSA- 848 125 (SAMASTIPUR), BIHAR

Dr. K. M. Singh
Director Extension Education

No. 23/DoEE
Date- 11.03.2016

Message

It is matter of great pleasure to learn that **Society for Upliftment of Rural Economy** in collaboration with Central Potato Research Station, Patna and Bihar Agricultural University, Sabour is organizing National Conference on ***"Rural Livelihood Security through Innovative agri-entrepreneurship"*** from March 12-13, 2016 at ICAR CPRS, Patna. I find the theme of the conference very relevant to the current situation particularly in the context of Bihar to ensure livelihood security among farmer through agri- entrepreneurship.

Bihar has witnessed a leading role in agriculture and allied sector particularly in dairying in recent past. Innovation are essential to exploit the potential of agri-entrepreneurship sector in Bihar and I appreciate the efforts of organizers who have meticulously chosen a very relevant topic and invited renowned scientists, academicians, policy-makers, entrepreneur and farmers to discuss different aspect of agri-entrepreneurship.

I wish the Conference a grand success.

(K. M. Singh)

सोसायटी फॉर अपलिफटमेंट ऑफ रूरल इकोनोमी

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श्रीमती मञ्जू लता सिंह

अध्यक्ष

Ref.: SURE/NC/042/2016 **Dated:**25.02.2016

संदेश

मुझे यह जानकर अत्यंत प्रसन्नता हो रही है कि सोसाइटी फार अपलिफ्टमेंट आफ रूरल इकोनोमीक वाराणसी, केंद्रीय आलु अनुसंधान केंद्र पटना एवं बिहार कृषि विश्वविद्यालय, सबौर के संयुक्त तत्वाधान में ''नवोन्मुखी कृषि–आधारित उद्यम द्वारा ग्रामीण जीविकोपार्जन सुरक्षा'' विषय पर राष्ट्रीय संगोष्ठी का आयोजन आईसीएआर, सीपीआरएस पटना में दिनांक 12–13 मार्च 2016 को आयोजित की जा रही है। बिहार विभाजन के बाद 80 प्रतिशत अधिक आबादी कृषि एवं संबंधित व्यवसाय पर सीधे या परोक्ष रूप से जीविकोपार्जन हेतु जुड़े हुए है। इसलिए उपरोक्त विषय पर की जा रही राष्ट्रीय संगोष्ठी बिहार में कृषि आधारित (जैविक खेती, बीजोत्पादन, बागवानी, डेयरी, मुर्गीपालन, मत्स्यपालन, बकरीपालन, मधुमक्खीपालन, वर्मी कंपोस्ट, खाद्य प्रसंस्करण तथा मुल्य संवर्द्धन) उद्यमों द्वारा जीविकोपार्जन को सुदृढ़ करने के साथ–साथ सामाजिक एवं आर्थिक उत्थान हेतु काफी उपयोगी सिद्ध होगा।

मैं उपरोक्त राष्ट्रीय संगोष्ठी के सफल आयोजन हेतु कामना करती हूँ।

Manju Lata Singh

(मञ्जू लता सिंह)

Rural Livelihood Security through Innovative Agri-entrepreneurship (RLSIAe)

March 12-13, 2016 ICAR Central Potato Research Station, Patna

Dr AK Singh
Organizing Secretary
Principal Scientist
ICAR RCER Patna

Message

I have immense pleasure to know that the Society for Upliftment of Rural Economy (SURE) Varanasi is organising the National Conference on "Rural Livelihood Security through Innovative Agri-entrepreneurship (RLSIAe)" at Patna on 12-13 March, 2016.

The society is doing appreciable work for rural people and organizing such events is further step which help in developing a concrete plan for future line of action which may be achieved through such gathering and deliberations of intellectuals at this platform.

Our country lives in villages and security of rural economy has become a great concern in the advanced and high investment oriented agriculture era. Moreover, global warming is also challenging the agriculture. The holding of conference is timely and will provide a platform to discuss the issues and will result in important recommendations to counter the challenges.

I wish a grand success to the event.

(Anil Kumar Singh)

Rural Livelihood Security through Innovative Agri-entrepreneurship (RLSIAe)

March 12-13, 2016 ICAR Central Potato Research Station, Patna

Dr. Sanjeev Kumar
Co-Organizing Secretary
Head cum Senior Scientist
KVK, Haranut, Nalanda, Bihar

Message

I am glad to know that 1st National Conference on "Rural Livelihood Security through Innovative Agri-entrepreneurship (RLSIAe)" at Patna on 12-13 March, 2016 is being organised by Society for Upliftment of Rural Economy (SURE) Varanasi with participants from different facets of agriculture across the country.

Such events provide an opportunity to the participants to share their experience and update the knowledge. I am sure this conference will synergize the efforts of research work being done in the field of agriculture to formulate future strategies.

I hope the deliberations of the conference would generate fresh perspective on various aspects covering critical issues related to Rural Livelihood Security.

I wish a grand success to the event.

(Sanjeev Kumar)

CONTENTS

Lead Papers

Agri-entrepreneurship : Key to Farmers' Prosperity

Naresh Chandra, A. K. Singh and R. C. Bharati
ICAR-RCER, Patna

Farmers' prosperity is a function of amount of money in their possession. They can have more money only when their occupation of agriculture becomes more productive and profitable. However, It is now widely believed and frequently expressed by the farming community and some non-farming communities as well at various fora that occupation of traditional agriculture is no longer that profitable and losing its charm. Therefore, farmers in general and rural youths in particular are not getting attracted and enthused to undertake farming. Rather, they are gradually getting disenchanted with this occupation, which used to be the mainstay of their livelihood earlier, because of its, *inter alia*, too low profitability and employment potential to meet their household requirements, and thus sustain their livelihood in a respectable manner.

In order to enhance agricultural productivity/ profitability, the option of adoption of modern agricultural technology is already there from the very beginning, and the same has got adequate, direct or indirect support of the Government, NGOs and other concerned agencies in various ways aimed at improving socio-economic conditions of the farmers. However, considering various types of constraints including those of labour and capital, risks and uncertainties confronted by farmers in food production and sale processes, having adverse impact on farm income, adoption of modern agricultural production technology as such, though claimed to be yield/income augmenting, is left with limited capacity to enhance farm income, if farmers choose to remain confined to their operation in agricultural production sector alone. This has resulted in their gradual relative marginalization, compelling them to leave this occupation and migrate to some other places in search of economically attractive avenues yielding greater returns needed to satisfy their increasingly growing needs, via exposure and demonstration effect, caused by techno-information led changing times of consumerism and materialism witnessing onslaught of flood of modern and fancy technological consumer goods in the market. This raises a very serious and pertinent question how working in agriculture sector can be made attractive, profitable, and employment augmenting so as to meet the rising aspirations of the farming community, and retain them in this very occupation of production of food required for their families and also for the growing population of the nation.

The answer lies in adoption of multi-pronged approach to deal with this problem of low agricultural profitability. These approaches should be adopted from both government and farmers' sides and these from both the sides should be considered equally important. However, the article focuses on those to be adopted from farmers' side, as sustainable development of an individual/economy is not a unilateral process. It is always a bilateral phenomenon, developer(government) and developee (farmer) being two parties, working together in symbiosis. Indifference from either side is detrimental to solution to the problem of low agricultural profitability. Therefore, farmers should not remain in confusion that it is only the government's responsibility to make agriculture profitable, but it is also their responsibility to make it profitable.

Adoption of, *inter alia*, agri-entrepreneurship in agriculture by farmers, may

prove effective in both development of agricultural economy in general and bringing about farmers' prosperity in particular. But before that to happen, first of all, the farmers, particularly youths, must learn and imbibe basics of entrepreneurship and factors affecting its development/inculcation. After that they must think of acquisition of gainful skill according to their taste and interest. For this, they should gear up themselves to attend some focused need-based training programmes, and the Government should also endeavour to provide them such training opportunity.

What is agri-entrepreneurship?

This refers to an individual's characteristic by virtue of which he has an intense desire and will power to achieve the goal of earning most benefit by undertaking innovative activities of agriculture (crop production) and allied enterprises (livestock, poultry, Fishery, duckery, bee keeping, horticulture, etc. together in symbiosis) including the work of agri-value addition in order to improve one's livelihood/ lifestyle by dint of actively engaging oneself in profitable and innovative agricultural enterprises warranting consistent hard work and adequate risk bearing ability.

How to bring about agri-entrepreneurship in agriculture?

There are many ways to bring about agri-entrepreneurship in agriculture. Broadly, three of them are given below.

1. Changing the method (do how) of agriculture: given below are a few ways

- Having will/commitment to change the method (do how) of agriculture.
- Learning of modern agricultural technologies: Kisan Diaries/publications of SAUs, KVKs, ICAR institutions, Trainings, visiting Kisan Melas, progressive farmers (neighbours, relatives, village leaders, etc), input dealers/traders, radio/TV talks, consulting line department officials, ATMA, etc.
- Use of learned modern agricultural technologies: Growing HYVs of crops, crop and soil management, input management, plant protection from pest and disease, modern agronomic practices, farm mechanization, etc.
- Undertaking market led agriculture: Growing that set of crops which can be sold easily at remunerative prices, i.e., the crop which has adequate demand in the market. If need be, entirely different crop suitable to the agro-climatic conditions of the farm may be taken, provided it is remunerative.
- Borrowing from institutional sources for necessary capital requirement to take up and continue the enterprise in a scientific way, followed by sincere repayment.
- Learning about and keeping/maintaining farm records (input-output records of agriculture), and calculating economics of various enterprises for self-appraisal and introspection so as to chalk out ameliorative strategies in future.

2. Changing the dimension of agriculture: given below are a few ways

- **Crop diversification**

  Crop diversification refers to the addition of new crops or cropping systems to agricultural production on a particular farm taking into account the different returns from value-added crops with complementary marketing opportunities. This gives individuals and households more capabilities to improve livelihood security and to raise living standards.

- **Farm diversification**

  Farm diversification consists of taking up of multiple agricultural production enterprises together, such as crop, horticulture, livestock, poultry, fishery, bee keeping, etc, on a piece of land, allocating suitable separate area for each enterprise, so that the output of one enterprise acts as input for the other one, as far as possible. In fact, such kind of symbiotic combination of agricultural production enterprises is not a new practice, but the same has already been practised by our farming community since time immemorial depending upon their need, interest, culture and capability. The question always remains with the farmer about the enterprise combination to

be taken up by him, given the natural resources (quantity and types of land, soil, topography, rainfall, status of surface and ground irrigation water availability, climatic condition, energy, etc) he is blessed with, and also his other strengths, weaknesses, opportunities and threats (SWOT), which is normally unique for a particular farm/farmer. There are many literatures/reports advocating IFS as agricultural technology capable to significantly enhance farm income in general, and small farm income in particular.

- **Occupational/Role diversification**

Presently, majority of farmers are normally acting in and confined to one role, i.e., producer only. They sell their produce to middlemen reportedly at unremunerative price resulting in low/no profit. Undertaking different diversified roles by farmers, such as producer, processor, value adder and marketer may be referred to as occupational/role diversification. Farmers rue that though they are the real producers of the farm produce, it is the middlemen who take away the maximum benefit in the process of movement of farm produce from point of production to that of consumption, and they are left high and dry with only little benefit. By involving themselves in various roles of value addition and marketing of the farm produce or value added products to the nearest point of final consumers as far as possible, farmers can help create a lot of employment opportunities and enhance income for themselves and also for others. For this, farmers should learn skill sets of production, processing and marketing, and practise them gainfully, either locally or outside.

Types of value addition

- **Time value addition**: selling farm produce not at harvest time when there is glut in the market, but in times of relative scarcity to obtain a premium price.
- **Place value addition**: selling farm produce at a place where a premium price can be obtained.
- **Form value addition**: transforming the farm produce into different product of consumer preference (processing) to obtain premium price.
- **Possession value addition**: advertising the product as if being in the possession/use of the popular and trustworthy celebrity to obtain premium price.

3. **Changing the mindset/attitude (self reform) of agriculturists: given below are a few ways**

- Developing/Creating an intense urge to earn more and more by dint of consistent hard work.
- Minute observation of activities of those who remained successful in their lives and learning from and emulating them, and also learning factors of failure from those who could not succeed in their endeavour.
- Breaking one's socio-psychological and personal barrier to undertaking any profitable enterprise irrespective of its apparent social recognition/non- recognition.
- Learning and inculcation of characteristics of entrepreneurship in oneself.
- Building self help group (SHG) for a common cause, going ahead singly is difficult.
- Inculcating belief in participatory/collective development rather than individual standalone development.

Points to ponder before and after making self help group (SHG)

- Members should have similar views, attitude, level of motivation, achievement target, and affinity among themselves.
- Prevalence of a sense of equality and broadmindedness among all the members.
- Anyone may be free to enter and exit the group.
- The group must have a goal and sub-goals--economic, social, etc.
- The goal/sub-goals should be democratically well thought out.
- The group should be committed to achieve the goal.
- The group should hold meetings at regular intervals and discuss openly various concerned issues in a democratic way, and maintain proceedings of the meeting.
- All the members should make equal amount of

periodic contribution to group fund.

- There should be transparency in financial transactions/handling and management of common group fund.
- In case of any conflict, members should resolve this following principles of transparency, equity and justice.
- A very large group should be avoided, as it is rightly said that too many cooks spoil the food.

Characteristics of an agri-entrepreneur

There are many characteristics of an agri-entrepreneur, which are certainly not that easy to inculcate and possess. Even partial inculcation can serve a lot. However, if one wants to earn money following agri-entrepreneurship, improve livelihood and bring about farm prosperity, one has to be loaded with these characteristics, as much as possible. As a matter of fact, a number of characteristics of a good entrepreneur are those of a good human being. In other words, if an individual is not filled with characteristics of a good human being, he cannot think of becoming a good entrepreneur. Perfection in entrepreneurship is a myth, but as far as possible, one should try to imbibe those characteristics in order to bring about prosperity by working in the field of agriculture sector. Given below is an exhaustive list of characteristics of a perfect entrepreneur.

Health conscious (health is wealth), goal setter, and goal committed, right user of time, money and energy (TME), laborious, hard working, risk bearer, courageous, willing to work, work enjoyer, enthusiastic, service-motivated to society, focused, self confident, market led, determined, well behaved, Non-aggressive in nature, but aggressive in work, innovative, aware, active, opportunity seeker, passionate, persistent, persevering, patient, polite, punctual, progressive, pluralistic, pragmatic, positive, planner, professional, far-sighted (dreamer), optimistic, disciplined, honest, competitive, non-quarrelsome, frugal, saver investor, good fund manager, non-superstitious, tolerant, open minded with sharing attitude, help seeker and giver, non-blaming, tendency to learn (knowledge and skill, etc) and implement it in life profitably, occupationally, spatially and attitudinally mobile, temperamentally flexible, receptive and adjusting/accommodative, non-defeatist, belief in and capable of team work, social, but not over-emotional, over- social and over-religious, no intoxication habit, which is time and money consuming, infectious, debilitating, health damaging, socially and environmentally unfriendly, no hesitation in borrowing for undertaking gainful enterprise, but also a sincere loan repayer (non-defaulter), harnesser of women power, family planner, i.e., Short family (two children only irrespective of sex, proper spacing between children, marriage at appropriate age i.e. after 25 or attaining economic independence), good family manager ensuring that family aspirations are also taken care of, and it remains free from conflict.

Barriers to agri-entrepreneurship development

There are a few barriers to agri-entrepreneurship development by farmers. These must be overcome by them as far as possible to venture into arena of agri-entrepreneurship. These may be classified as follows.

- **Physical**: Problem of farmers' and their families' health, and that of rural infrastructure such as connectivity, electricity, irrigation/water facility, etc.
- **Individual/personal**: Laziness and unwillingness to do unconventional work of profit, lack of risk and responsibility bearing capacity.
- **Family**: lack of support/encouragement from family to take up some enterprise beyond production sector.
- **Social**: There is lack of support/ encouragement from the society, which the entrepreneur is associated with, to take up some enterprise. Many times, following entrepreneurship is considered forbidden for individual, as per societal protocol.
- **Economic**: Lack of capital for initial fixed investment and meeting operational

expenditure.

- **Religious/cultural**: Religious/cultural restriction to take up some enterprise.
- **Educational**: Lack of education reduces risk and responsibility bearing capacity, self-confidence/ faith to take up some enterprise.

Conclusions

Agri-entrepreneurship refers to an individual's characteristic by virtue of which he has an intense desire and will power to achieve the goal of earning most benefit by undertaking innovative activities of agriculture (crop production) and allied enterprises (livestock, poultry, Fishery, duckery, bee keeping, horticulture, etc. together in symbiosis) including the work of agri-value addition in order to improve one's livelihood/ lifestyle by dint of actively engaging oneself in profitable and innovative agricultural enterprises warranting consistent hard work and adequate risk bearing ability. Adoption of, *inter alia*, agri-entrepreneurship in agriculture by farmers, may prove effective in both development of agricultural economy in general and bringing about farmers' prosperity in particular. But before that to happen, first of all, the farmers, particularly youths, must learn and imbibe basics of entrepreneurship and factors affecting its development/inculcation. After that they must think of acquisition of gainful skill according to their taste and interest. For this, they should gear up themselves to attend some focused need-based training programmes aimed at inculcation of characteristics of agri-entrepreneurship, and the Government should also endeavour to provide them such kind of training opportunity to improve their entrepreneurial capacity building. For bringing about agri-entrepreneurship, farmers must adopt strategies such as (1) changing the method (do how) of agriculture, (2) changing the dimension of agriculture, and (3) changing their mindset/attitude (self reform). However, there are a few barriers to agri-entrepreneurship development, such as physical, individual/ personal, family, social, economic, religious/ cultural, educational, etc., which must be overcome as far as possible to bring about farm prosperity.

A Profitable Enterprise - Oyster Mushroom Cultivation : An Alternative Source of Income

Rashmi Shukla
Scientist, JNKVV, Jabalpur

KVK, Narsinghpur introduced the FLD on oyster mushroom cultivation. Similarly training programme on oyster mushroom cultivation was organized for Rural youth, farm women, farmers. Necessary technical literature was provided to the farmers. Training programme was arranged to create awareness and interest among the farmers for mushroom cultivation. KVK is instrumental is imparting training to the farmers and farm women.

Details of the technology:

Raw material requirement for mushroom cultivation:

(i)	Wheat straw	(ii)	Polythene bags
(iii)	Spawn	(iv)	Plastic Tub
(v)	Farmiline	(vi)	Bavistine
(vii)	Iron racks	(viii)	Sprayer
(ix)	Plastic sheet	(x)	Water
(xi)	Ventilated hut/room		

Soaking:

Wheat straw
↓
Soaking in clean cold water for 12-16 hrs
↓
Draining excess water
↓
Pasteurization of the straw pieces in boiled water at temp. 70-800 C for 45 minutes to 1hr.
↓
Draining of excess water & dry in shade to get 65% moisture.

Laying of bed & spawning:

Filling in the polythene bag (65cm X 35cm) with sterilized straw bits (6" ht)
↓
Sprinkling of ¼ part of spawn over it at the periphery only.
↓
Again covering with sterilized straw pieces to another 6" ht.
↓
Repeat spreading of straw pieces and spawn for 4th time.
↓
Covering the top layer with thin layer of straw & tie the polythene bag at the top & making 20 to 25 holes for exchange of gas & keeping it in dark room.

Spawn running :

Removing the polythene cover after 16th day.
Arranging the beds on the sika, leaving a space of 6” between the bed.
↓
Sprinkling of water twice a day as per the weather to keep the bed moist.

Orissa Review * May-June - 2010

Harvesting of mushroom :

Harvesting fresh mushrooms after 7 days by twisting carefully when the edges starts upward curling.

1st flush - 1 kg
7 days after 2nd flush - 250 gm.
↓
7 days after 3rd flush - 250 gm

Result and Discussion

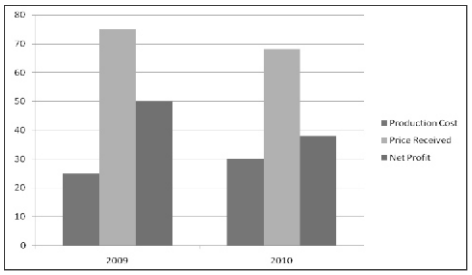
KVK Narsinghpur made the farmers aware about mushroom cultivation and conducted on campus vocational training/awareness 2009 to 2012 programme for the farmers. They were trained for the mushroom cultivation, which not only improved their technical knowledge regarding mushroom cultivation but also awakened their interest for making it their own business for livelihood.

After attending training on mushroom cultivation some of them started their own business at their home without heavy investment, and limited area. They are earning approximate 4000 to 5000/- per month, which is higher then their previous occupation profit.

Inspired by the easy method of cultivation, good yield and economy of production and being exposed to extension interventions made by KVK, sum farmers have started practicing oyster mushroom. Cultivation in small scale under the guidance of scientists of KVK. One Kg dry wheet straw blocks yielded 8oo to 900 Gram fresh mushroom, which can be sold in market at the rate of Rs 70/- per kg against Rs 30/- cost of input (fig-1) . Oyester mushroom can be esily dried in the day sunlight in white cotton clothe and make powder when not sold in the market , this dry mushroom reduces 10 times as compared to fresh mushroom (Jandaik and Goyal 1995). Kokate et al (2010) clearly indicated that there have been increased in its cost of production from Rs. 20 to 30 per Kg, yet with increase in price received the profitability have been maintained. It was seen that when mushroom directly sold to consumer, obtained more unit price in comparison to sold through commission agent/ other agencies.

Total processing cost of mushroom cultivation

Cost as produce (cost of input) - 30-00 Rs/ kg
Selling price - 70.00 Rs/kg
Net profit - 40.00Rs./kg



(Fig-1) Cost and return from Mushroom production (in Rs/Kg)

1.1 Farmers reaction and feedback :

Table A: Impact of training on the dissemination of mushroom production technology.

Year	No of trainees (basis of land holding)		
	Marginal	Small	Large
2009	4	14	12
2010	7	16	7
2011	7	19	4
2012	6	21	3
Total	**24**	**70**	**26**

Table B:

Year	Horizontal spread of mushroom production tech.		
	Marginal	Small	Large
2009	-	-	-
2010	17	51	3
2011	44	68	11
2012	82	79	6
Total	**143**	**198**	**20**

The farm women of the village were surprised with the success of mushroom cultivation. They could not just believe such a good amount of net profit in less than a month period. Now they are interested to take up mushroom cultivation as a major income generating activity throughout the year due to its heavy demand in his village area.

KVK Narsinghpur provided technical guidance timely and motivated them to participate district/state level exbhitions also. The impact of the training can be assessed from the fact that 40-50% of the trainees in his village adopted this venture after seeing his success.

1.2 Follow-up action:

KVK, Narsinghpur has documented the success and has developed plan to promote this technology. KVK has planned for further expansion of technology in Narsinghpur. Apart from this KVK printed literature TV coverage of the technology has been organized for wider dissemination of the technology.

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Constraints as Perceived by Women Self Help Groups Entrepreneurs

Anuradha Ranjan Kumari, Shamsher Singh , Kamlesh Meena and Neeraj Singh[1]
Krishi Vigyan Kendra (ICAR-IIVR) Malhana Deoria UP.
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Introduction

Self-Help-Groups (SHGs) as a basis for the social and economic empowerment of deprived and disadvantaged women has been found to be a successful mechanism for the organization, mobilization and self development of women. These groups can facilitate the process of economic empowerment through thrift and savings, training and skill up gradation and access to credit and other productive resources. According to Wikipedia, “a self-help group (SHG) is a community/village-based financial intermediary usually composed of 10-20 local men/women. Most self-help groups are located in India, South Asia and Southeast Asia.

Empowerment is a multi-faceted, multi-dimensional and multi-layered concept. Women's empowerment is a process in which women gain greater share of control over resources - material, human and intellectual [knowledge, information, ideas] and financial resources and control over decision-making in the home, community, society, nation and to gain `power' (Sharma, 2011). Members make small regular savings and contributions over a few months until there is enough capital in the group to begin lending. SHG may be registered or unregistered. It typically comprises a group of micro-entrepreneurs having homogenous social and economic backgrounds; all voluntarily coming together to save regular small sums of money, mutually agreeing to contribute to a common fund and to meet their emergency needs on the basis of mutual help.

The problems of unemployment and poverty have assumed alarming dimensions in India especially in the state of Uttar Pradesh. The SHGs based entrepreneurship is almost non-existent in Uttar Pradesh, although much has been done for SHGs members to overcome the barriers and meet the challenges. The SHGs member entrepreneurs need a lot of encouragement, help and support of Government. It is obvious that their problems and difficulties are likely to have wider significance. Accordingly, the study was undertaken with the objective to study perceived constraints faced by women SHG entrepreneurs.

Methodology

The present investigation was carried out in Deoria district of Uttar Pradesh in 2014-15. There were sixteen blocks in Deoria district, out of which two blocks namely i.e. Salempur and Bhatparrani were selected purposively because these blocks were having highest number of SHGs in comparison to other blocks. From each block four villages i.e. Jiraso, Malhana, Laxmanchak, Chatrapura from Salempur block and Dharamkhorkaran, Chapiya, Jamuniadih, Khampar from Bhatparrani block were selected purposively for this study. Each village two SHGs were selected through proportionate random sampling technique. The list of SHGs which are successfully functioning for the last 3 to 5 years in entrepreneurial activity was prepared from each village. Among each village 20 women Self Help Groups members were selected from each village (10 women from each SHG). A total number of 160 SHGs women members

were selected on the basis of dairy enterprises using proportionate random sampling from eight villages (16 SHGs). The data collection was done with the help of well structured interview schedule. The interview schedule was prepared by keeping the objectives of the study in mind. The necessary care was taken to collect the unbiased and correct data. The data were collected, tabulated and analyzed to find out the findings and drawing the conclusion. The statistical tools Frequency, percentage and rank were employed to analyze the data.

Results and Discussion

Constraints refer to the factors that are working as barriers faced by women SHGs members. The constraints faced by women SHGs members were grouped into six categories namely personal constraints, lack of knowledge, bank-SHG coordination, social constraints, feeling of discrimination and institutional constraints.

Table 1. Distribution of the SHGs members according to their personal constraints.

N=160

Statement	Frequ-ency	Perce-ntage	Rank
Lack of education among women	111	69.37	I
Women face drudgery and thus do more hard work and less time for self empowerment	89	55.62	IV
Lack of confidence women usually suffer from inferiority complex	95	59.37	III
Lack of pertinent knowledge about new innovations	101	63.12	II
Lack of awareness	54	33.75	VI
Poor decision making ability	34	21.25	VII
Highly engagement in house hold work	80	50.00	V

The data presented in Table 1 indicated that the rank order of personal barriers as perceived by majority of SHG members. Lack of education among women (69.39%) was ranked I, because the rural families were poor and they want to educate their children. 'Lack of pertinent knowledge about new innovation' (63.12%) was ranked II, as the social media and internet connectivity is not available in the villages and they are also not much educated. 'Lack of confidence women usually suffer from inferiority complex (59.37%)' ranked III. The women have not find time for their self management an account of burden of kitchen, child care, care of old family members and involved in other activities.

Table 2. Distribution of the SHGs members according to Knowledge constraints.

(N=160)

Statement	Frequ-ency	Perce-ntage	Rank
Lack of awareness of available opportunities	93	58.12	I
Lack of information about the changing market scenario	69	43.12	III
Lack of marketing strategy	81	50.62	II

Table 2 indicated that majority of the SHG members faced the constraint of lack of awareness of opportunities available (58.12%) followed by lack of marketing strategy (50.62%) and lack of information on the changing market scenario (43.12%). This finding is in conformity with the findings of Suriyanarayanan and Tamilselvi (2007). Lack of awareness is one of the important constraints in any activity. Enterprise development is one such activity where the players should update themselves on regular basis to be successful. The respondents have expressed their concerns regarding the lack of awareness.

Table 3. Distribution of the SHGs members according to bank SHG coordination constraints.

N=160

Statement	Frequ-ency	Perce-ntage	Rank
Poor perception about SHG by bank officials	61	38.12	I
Over dependence on intermediations	53	33.12	IV
Unfavorable attitude of bank officials	73	45.62	I
Lack of coordination among SHG members	42	26.25	VI
Lack of recovery	57	35.62	III
Poor records keeping	48	30.00	V

Table 3 revealed that the majority (45.62%) of respondents faced constraints unfavourable attitude of bank officials was ranked I followed by poor perception about SHG by bank officials (38.12%) ranked II, Lack of recovery (35.62%) ranked III, over-dependence on intermediations (33.12%) ranked IV, poor records keeping (30.00%) ranked V and lack of coordination among SHG members (26.25%) got last ranked.

Table 4. Distribution of the SHGs members according to their Social constraints.

(N=160)

Statement	Frequ-ency	Perce-ntage	Rank
Negative social attitude about women role outside the home	98	61.25	I
Due to “parada system” women are restricted within home boundaries	78	48.75	III
Unequal distribution of households work	41	25.62	VII
Lack of social competition with men as well as women	69	43.12	IV
Lack of social security to rural women	61	38.12	V
Women are overlooked in decision making process	54	33.75	VI
Tendency of other to under estimate a women's capability	89	55.62	II

The data in Table 4 indicated that the rank order of social barriers faced by overwhelming majority of SHG members. Negative social attitude about women role outside the home' ranked I. 'Tendency of others to under estimate a women's capability' ranked II. 'Due to parda system women are restricted with in home boundaries' ranked III. Rural family head usually believing that women should work only within the house boundaries and men are meant for outside house work. As nature has made physically and mentally poor the women in comparison to men but women should always try to do best. In some villages it was found that the women want to go outside the villages but they cannot do so because of complicated attitude of society.

Table 5. Distribution of the SHGs members according to perceived discrimination constraints.

(N=160)

Statement	Frequ-ency	Perce-ntage	Rank
Caste based discrimina-tion	65	40.62	I
Gender based discrimin-ation	78	48.75	I
Education based discrim-ination	52	32.50	IV
Religion based discrimin-ation	72	45.00	II

The data presented in Table 5 clearly showed that the feeling of discrimination on the basis of gender has emerged as the most important constraint followed by religion, caste and education constraints in rank II, III and IV respectively.

Table 6. Distribution of the SHGs members according to institutional constraints.

(N=160)

Statement	Frequ ency	Perce ntage	Rank
Lack of technical skilled labours	25	15.00	XI
Labour scarcity	63	39.37	V
Inadequate water supply during summer	71	44.37	IV
Absence of marketing of SHG products	38	23.75	IX
Lack of mobility	49	30.62	VII

Lack of transport facility	30	18.75	X
Distant location of market	85	53.12	II
Fluctuation in market price	79	49.37	III
Financial constraints	57	35.62	VI
Non visit of SHG members to developed SHG	43	26.87	VIII
Lack of visionary management body	92	57.50	I

Table 6 revealed that the perceived constraints in rank I were lack of visionary management body (57.50%) followed by distant location of market (53.12%) was ranked II, fluctuation in market price(49.37%) was ranked III, inadequate water supply during summer (44.37%) was ranked IV, labour scarcity (39.37%) was ranked V, financial constraints (35.62%) was ranked VI, lack of mobility (30.62%) was ranked VII, non-visit of SHG members to developed SHG (26.87%) was ranked VIII, absence of marketing of SHG products (23.75%) was ranked IX, lack of transport facility(18.75%) was ranked X and lack of technical skilled labours was last ranked. These findings are in consonance with findings of Ramkumar (1997).

Table 7. Distribution of the SHGs members according to overall constraints.

(N=160)

Statement	Frequency	Percentage
Low	37	23.12
Medium	91	56.87
High	32	20.00

Table 7 indicated that most of the SHGs members perceived medium level of constraints (56.87 %) followed by low level (23.12 %) and high level (20.00 %). Similar findings were reported of Samantaray et al. (2009).

Table 8. Constraints as perceived by women members in formation of SHGs.

N=160

Statement	Frequency	Percentage	Rank
Lack of cooperation among women.	44	27.50	II
Illiteracy among women	59	36.87	I
Lack of mutual understanding among women	39	24.37	III
Lack of belief on others	32	20.00	IV
Lack of money for sharing in group account	25	12.50	V

Table 8 indicated the constraints in group formation faced by the majority of SHG members as 'illiteracy among women was (36.87%)' ranked I. Illiterate women are tough to understand the process of group formation as they hardly understand the how and why a group formed. 'Lack of cooperation among women was (27.50%)' ranked II. Rural women usually show competition with each other which is not well in view of growth. 'Lack of mutual understanding among women was (36.87%)' ranked III. Usually, the group members are having different mind so their way of thinking may be different to each other but there is a need of utilizing common understanding of the group members. 'Lack of belief on others was (20.00)' ranked IV. In villages the women had found different socio-economic capacities hence a common trust can be developed in forms of formation of SHG members. 'Lack of money for sharing in group account was (12.50%)' ranked V. Basically the control of family economy remains in hand of men rather than women in rural areas therefore, they are unable to do large share in group account.

Table 9. Constraints as perceived by women members in functioning of SHGs.

N=160

Statement	Frequency	Percentage	Rank
Lack of leadership among women.	87	54.37	I
Lack of working ability of members	53	33.12	II

Table 9 indicated that women SHG members faced the barriers in functioning of SHG and reported 'lack of leadership among members was (54.37%)' as the most severe constraint. It is very important and responsible job to handle the group so no any member wants to take the extra burden of leadership. 'Lack of working ability of members was (33.12%)' ranked II. Most of the time the rural women remain engaged with family work therefore, they shows lack of working ability in groups.

Table 10. Constraints as perceived by women members in Bank transation.

N=160

Statement	Frequ-ency	Perce-ntage	Rank
Lack of information about banking procedures	82	51.25	I
Rules and regulations which the women cannot fulfill	75	46.87	II
Banks branches are distantly located	57	35.62	IV
No special arrangement for women in banks	63	39.37	III

Table 10 further revealed that majority of SHG members faced the barriers in bank transaction and reported as 'lack of information about banking procedures was (51.25%)' ranked I. Nationalized bank has made complicated procedures as it is tough task to illiterates and less educated members. 'Rules and regulations which the women cannot fulfill was (46.87%)' ranked II. Rules and regulations are tough to handle a bank account of SHG members hence, separate rules and regulations should be for rural women those are easier them. Chatterjee (2003) pointed out that due to complex banking rules and regulations the SHG members were suffering. He also recommended for some flexibility in banking rules so that poor people can be benefited.

Conclusion

The present investigation concluded that a majority of SHG women faced constraints as lack of education, lack of awareness of available opportunities, the unfavorable attitude of bank officials, negative social attitude about women role's outside the home, gender based discrimination, lack of visionary management body, Illiteracy among women and lack of information about banking procedure which must be supported by family members, friends and society. For improving the rural women status as whole, training programmes should be arranged to acquire new knowledge, skills, attitude and confidence methods about formation of SHG and about among rural women interested in dairy enterprise. The government and other financial institutions should enhance support lending activities to these women through single window systems and camps should be conducted**.** The women self help groups entrepreneurs need to reorient their attitude and promote leadership qualities. The problems are multi-dimensional and need to be solved by coordinated and sincere efforts of entrepreneurs, promotional agencies, and government assistance, incentives and concessions. Entrepreneurship in women SHGs members can be promoted and explored through suitable training programmes. There is absolute need for occupational diversification.

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Micro-enterprise Approach for Improving Livelihood of SHGs through Vermi-compost

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Introduction

Agriculture and allied activities support livelihoods of nearly 70 per cent of India's rural population (Hiremath, 2007). Land-based livelihoods of small and marginal farmers are increasingly becoming unsustainable, due to which there is increased need to look for alternative means for supplementing their livelihoods. The allied agricultural activities are gaining importance as the proportion of income coming from agriculture are going down and households became increasingly dependent on other sources of income (Deb et al. 2002). Heavy use of agrochemicals increased food productivity at the cost of environment & society, killing the beneficial soil organisms, destroying their natural fertility. With the extensive use of chemical fertilizer and improper irrigation, productivity of the soil is getting reduced The permanent and cheapest solution to overcome the dangerous effects of modernized agriculture is to develop a farming system which is economically productive and long-lasting in sustainable farming or natural farming by simple and inexpensive practices like vermin biotechnology. Thus the old agricultural systems *viz.,* biological, organic, ecological, regenerative, natural, biodynamic and low input agriculture are being reconsidered for their sustainability

Vermi-compost is the excreta of earthworm, which are capable of improving soil health and nutrient status. Vermiculture is a process by which all types of biodegradable wastes such as farm wastes, kitchen wastes, market wastes, bio-wastes of agro based industries, livestock wastes etc. gets converted while passing through the worm-gut to nutrient rich vermi-compost. Vermi worms are used here act as biological agents to consume those wastes and to deposit excreta in the process called vermi-compost. It is a simple biotechnological process of composting, in which certain species of earthworms are used to enhance the process of waste conversion and produce a better product. Vermi-composting differs from composting in several ways (Cresent, 2003). It is a mesophilic process that utilizes microorganisms and earthworms that are active at 10°C to 32°C, the process faster than composting as the material passes through the earthworm gut, a significant transformation takes place, resulting in earthworm castings which are rich in microbial activity and plant growth regulators, transforming waste into “gold” (Gandhi,*et.al*. 1997). Vermi-compost, apart from supplying nutrients and growth enhancing hormones to plants, improves the soil structure leading to increase in water and nutrient holding capacities of soil. Chemical fertilizer in moderate doses can go along with vermi-composting. The cost of production of compost works out to about Rs. 1.5 per kg, and is quite profitable to sell the compost even at Rs. 2.50 per kg.

Earthworms live in the soil and feed on decaying organic material. 5-10% of the organic matter is digested by the cells and rest undigested material moves through the alimentary canal of the earthworm, a thin layer of oil is deposited on the castings. This layer erodes over a period of 2 months. Although the plant nutrients are immediately available, they are slowly released to last longer. The process in the alimentary canal of the earthworm transforms organic waste to natural fertilizer. The chemical changes that organic wastes undergo include deodorizing and neutralizing. The worm castings also contain bacteria, so the process is continued in the soil, and microbiological activity is promoted. *Vermi-*

composting is the process of turning organic debris into worm castings. The worm castings are very important to the fertility of the soil. The castings contain high amounts of nitrogen, potassium, phosphorus, calcium, and magnesium. Castings contain 5 times the available nitrogen, 7 times the available potash, and 1½ times more calcium than found in good topsoil.

Methodology

The process of composting crop residues and agri wastes using earthworms comprise spreading the agricultural wastes and cow dung in gradually built up shallow layers. The pits are kept shallow to avoid heat built-up that could kill earthworms. To enable earthworms to transform the material relatively faster a temperature of around 30^{o}C is maintained. The final product generated by this process is called vermi-compost which essentially consists of the casts made by earthworms eating the raw organic materials. One earthworm reaching reproductive age of about six weeks lays one egg capsule (containing 7 embryos) every 7-10 days. Three to seven worms emerge out of each capsule. Thus, the multiplication of worms under optimum growth conditions is very fast. The worm lives for about 2 years. Vermi-compost is ready for harvest when it contains few-to-no scraps of uneaten food or bedding. For commercial production, the beds can be prepared with 15m length, 1.5m width and 0.6m height spread equally below and above the ground. While the length of the beds can be made as per convenience, the width and height cannot be increased as an increased width affects the ease of operation and an increased height on conversion rate due to heat built up. Cow dung and farm waste can be placed in layers @ 350 worms per m3 of bed volume that weighs nearly one Kg. The beds are maintained at about 40-50% moisture content and a temperature of 20-30^{o}C by sprinkling water over the beds. Vermi-compost also increases water-holding capacity of the soil, promotes crop growth, helps produce more, and improves food and fodder quality (Nagavallemma et al. 2004).

The vocational trainings on vermiculture were started at the Krishi Vigyan Kendra in December 2007-08. After training the interest level of trained farmers was determined through feedback sessions. On the basis of feedback the interested farmers were supplied earthworm species *Eudrilus eugeniae* (African earthworm) to the beginners along with technical knowhow to start production of compost. The units established were closely monitored by visiting at regular interval. At initial phase close monitoring was kept by KVK at every stage of production. Slowly the message of organic farming and vermin-composting was spread among the farming community and their importance was highlighted during exhibitions and Kisan melas. The three main products of vermi-composting, i.e., vermi-compost, vermi-wash and worms were highlighted and importance of worms and their contribution towards the bulk of the income was explained in detail.

Result and Discussion

With the spread of knowledge there was spread in establishment of vermi-compost units in the district. In year 2008-09, 305 units of vermi-compost was established producing 54,240q of compost, giving income of Rs. 85.40 lakh (@ Rs 350/q) from sale of compost and 9.15 lakh from worm sale (@ Rs200/ 1000) with total income of 94.55 lakh. Similarly in next year i.e., in 2010-11 the number of vermi-compost unit reached 638 units, with production of 54,240 q compost and income of 189.84 lakh (@ Rs. 350/q.) and 101.70 lakhs from sale of earthworm (15000/year per unit) (Table-1). By 2011-12, the number of vermin-compost unit were 1103 in district with production of 88,240 q compost and income of Rs.308.84 lakhs from compost and 33.09 lakh from sale of earthworms. This increase in knowledge and skill of farmers encouraged them to form SHG for easy marketing. One such SHG was formed by farmers of Rajapakar of Vaishali district with more than 50 members named *'Panchmukhi SHG'*. This SHG was involved in large scale production of vermi-compost. They started marketing their compost as *'Panchmukhi Jaivik compost'* in local markets at

the beginning. With increase in production this group started looking for new marketing avenues and in this endeavor they started supplying their bulk vermi-compost to tea gardens of N-E. Besides these farmers are also using vermi-compost in their own field of vegetables and orchards.

Conclusion

"Vermiculture Movement" is going on in India with multiple objectives of community waste management and economical way of crop production, which replaces the costly chemical fertilizers. Vermi-composting to a non-professional simply means making of compost by worms by utilizing worm's innate behavior. Vermi-composting process improves soil aeration and thereby promotes the survival and dispersal of the useful bacterium within such systems, which is slowly becoming clear day by day. Vermi-composts could be prepared from the kitchen waste, farm waste, market waste, even from biodegradable city waste. The most effective uses of earthworms are organic waste management and supplement of readily available plant nutrients and they also play a vital role in improving the soil health. Farmers need a sustainable alternative to chemical fertilizer which should be both economical and productive while also maintaining soil health & fertility. The new concept is "Ecological Agriculture", endorsed by UN which emphasizes on total protection of food, farm and human ecosystems while improving soil fertility and acting as a secondary source of income for the farmers. Vermiculture provides the best answer for ecological agriculture, which is synonymous with "sustainable agriculture". Micro-enterprises are effective, informal, low costs, local business hubs for livelihood security of small and marginal farmers. There is increased role of micro-enterprise in promoting rural livelihoods and the associated increase in the proportion of household income derived from these activities and vermi-composting can play a very important role as a successful micro-enterprise.

Table 1: **Progressive increase of vermi-compost units in Vaishali**

Particulars	**YEAR**		
	2009-10	**2010-11**	**2011-12**
No. of units established	**305**	**678**	**1103**
Total production of vermi-compost per year in q.	**24400**	**54240**	**88240**
Income from sale of vermi-compost (Rs. in Lakhs @ Rs. 350/q.)	**85.40**	**189.84**	**308.84**
Number of earthworm sold in lakhs (15000/year per unit)	**45.75**	**101.70**	**165.45**
Income from sale of worms (Rs. in lakhs @ Rs. 200/thousand)	**9.15**	**20.24**	**33.09**
Total income(3+5) (Rs. in lakhs)	**94.55**	**210.08**	**341.93**

Production of vermi-compost - 20 q./cycle/unit.

Total production in a year (with 4 cycles in a year, 20X4) - 80q./unit/year.

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Rural livelihood Improvement through Promotion of Lac Cultivation in Jharkhand

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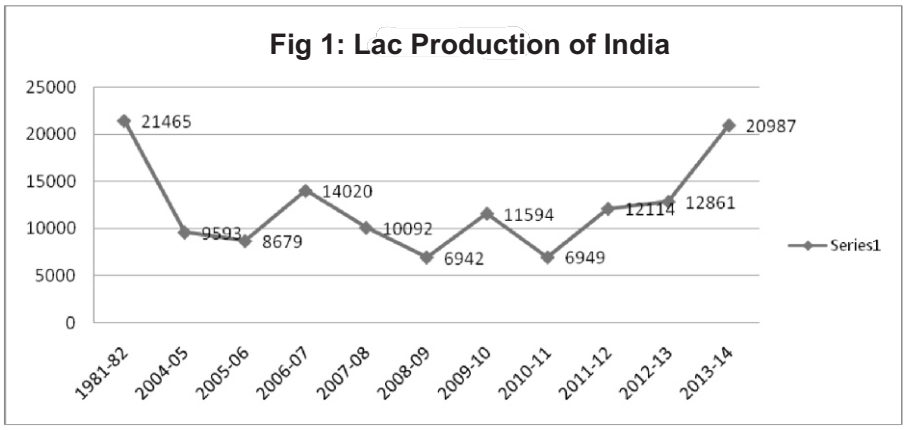
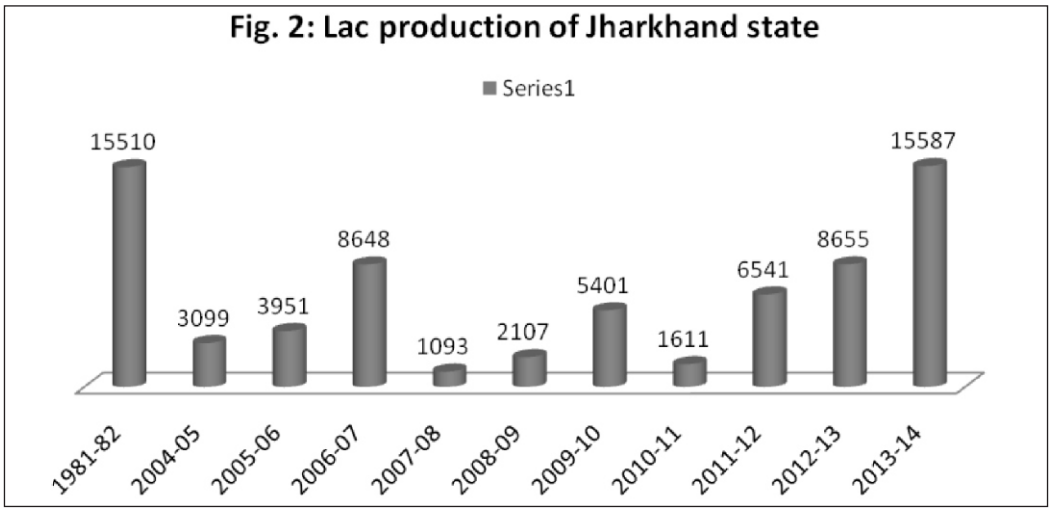
Introduction

Lac insect namely *Kerria lacca* belongs to super family: Coccoidea order: Hemiptera. The family known for commonly scale insects and about 2000 insect species found all over the world. Since Vedic period, it is being cultivated and used in India. Lac is currently cultivated in India, Myanmar, Thailand, Malaya, Lao and Yuan province of China. Scale insects range from almost microscopic size to more than 2.5 cm. The lac insects thrive and feed on certain species of the tropical trees. Lac is a resinous exudation from the body of female insect. Globally India and Thailand are main lac production countries. India is the leading lac producing country in the world contributing about 80% (Ramani, 2002) and it continues to maintain its leadership in lac export despite the fluctuations in production. In India about 90% lac produced share is of Jharkhand, Chhattisgarh, Madhya Pradesh, West Bengal, Maharashtra and Odisa. Jharkhand state is predominated with lac host plants *viz. Palash* (*Butea monosperma*), *Kusum* (*Schleichera oleosa*) and *Ber* (*Zizyphus mauritiana*) existing in forest and forest fringe villages which favours lac insect rearing in the state by the farmers. The cultivation of lac is mainly done by economically poor farmers living in forest or forest fringe villages. The farmers cultivating lac are mostly tribals. Historically they suffered from challenges like uncultivable barren land, low asset base, lack of irrigation facilities, small landholding, poor linkages with the market and their own low risk-bearing capacity. Thus, they are unable to cultivate agricultural or horticultural crop. In these forest fringes tribal are dependent on forest and forest produces viz. *lac, tasar* rearing*, honey, medicinal plants*, collection of *mahua* and *karanj* seeds etc. Among this lac has been traditionally very economical source of livelihood of thousands of tribal families living in the forest fringes of Jharkhand. More than 75 % forest fringe farmers of tribal community are involved in lac cultivation and it contributes a major part of livelihood of the tribal farmers. While, due to illiteracy and lack of knowledge of scientific method of lac cultivation, host plant management, unavailability of healthy brood lac and ultra left extremism farmers are unable to get maximum lac production. National lac production was gradually fluctuating downwards from 2006-07 to 2010-11 (Fig. 1) and also of Jharkhand state (Fig 2).



In view of the economic returns to the growers and global interest for safe natural lac production, the production scenario needs to be improved. Thus, to uplift the rural livelihood and lac production in the state and country scientific method of lac cultivation needs to be promoted. To overcome the uncertainty of quality brood lac production at the village level needs to be encouraged. With the aim uplift the farmer's livelihood through increase in lac production with community participation a UNDP and ICFRE supported programme was launched from 2010-14 by the Institute of Forest Productivity, Ranchi in Khunti district of Jharkhand state.



Methodology

Problem identification

Jharkhand state is the major lac producing state of India and Khunti district was the maximum lac producing district. This district was maximum number of natural lac host tree, market, processing units but from last one decades, lac production of this district was gradually declining. To find out the problem behind decreasing lac production, a scientific team of IFP Ranchi had visited to many villages of Khunti district *viz*. Jiuri, Bari, Kilahatu, Kotna, Ulahatu, Rutadih, Janumpiri, Kudapurti, Kudda, Anirdih and Torpa and had many rounds discussions with the villagers in presence of village head “PAHAN”. Additionally, survey was done of natural lac host plants present in these villages and following major problems were identified:

1. Unavailability of farmers and researches network
2. Unawareness about the importance of lac, demand and uses.
3. Unawareness about the scientific lac cultivation prectices.
4. Unawareness about the conservation and proper utilization of natural lac host plants.
5. Unawareness about the management of natural host plant for lac cultivation.
6. Unawareness about the alternate lac host plants.
7. Unavailability of village level lac farming expert
8. Unavailability of timely brood lac

STRATEGIES ADAPTED FOR PROMOTION FOR LAC CULTIVATION

After getting the gaps among farmers of Khuanti district, the Institute of Forest Productivity, Ranchi (Jharkhand) has launched a programme for farmers to improve their livelihood under UNDP and ICFRE sponsored project from 2010-2014. In this programme total eleven tribal villages of Khunti district of Jharkhand were targeted. These all villages were tribal 'Munda' community dominated villages. In these villages lac cultivation slowly decreasing since, one decade. Following strategies were adopted to revive the lac cultivation and improve the source of livelihood of these tribal communities.

1. ***Farmers and master trainer's training:*** Farmers were trained at the village level by

demonstration and active involvement for host tree pruning, brood lac shorting and cutting, brood lac inoculation, pest identification and their management, methods of pesticide spray preparation and spray in addition to class room training through audiovisual. In this continuation youths of the villages were especially targeted as a master trainer/ motivator and facilitator master trainers were also developed in each village so that they can assist to the farmers at each and every step of the cultivation practices. The master trainer were additionally trained for searching of brood lac availability in the area, host plant selection, pruning method, identification of healthy brood lac, selection of suitable pesticide, arrangement of suitable pesticide for farmers, preparation of pesticide solution with effective doses, method of pesticide application, method of brood inoculation, identification of lac maturity and harvesting. Training was also provided to SHG's and village mahila sangathan on initial processing of lac with aim to develop some cottage industry at block level, so that the farmers can get more income from processed lac in place of sale of unprocessed lac.

2. ***Awareness about demand and use of lac:*** In the lac producing states it found that most of the farmers do not know the importance of lac or its importance in Indian economy. The farmers were don't know that lac being used in their day to day use. They are unaware that our country is the largest lac producer in the world. Thus, during the training and we made them aware of the vast use and scope of the lac being produced by them internationally and nationally by exposing them to exhibition, museum visit and through audio visual ads.
3. ***Awareness creation about scientific cultivation:*** Most of the farmers were un-aware about the proper scientific technique of lac cultivation. Farmers were not following the right method of cultivation and management practice. The farmers were using continuous lac inoculation on the same plant without giving rest to the host plant resulting in plants becoming very weak and poorer and are unable to produce sufficient succulent nutritious branches for the insects' leading to serious lac yield loss. They were unaware of disease and insect pest infestation upon lac and were using infested brood lac for inoculation. This way due to disease and insect pest and up to 40 % yield loss has been noticed. The harvesting process was also very unsatisfactory. They were partially harvesting and doing self inoculation which is scientifically very harmful. In lac rearing time schedule of different practices is very important starting from the brood inoculation. These schedules were not being followed by the farmers' *viz.* time of host plant pruning, lac inoculation time, application of insect pest management practice and harvesting. The farmers were advised to follow cultural activity schedule as per table 1.

Table 1: Practices in scientific method of lac cultivation

SL	Activity	Improved technique
1.	**Pruning of the**	**Lac host plant/trees**
	Palash	In the month of March & April
	Kusum	In the month of January – February or June – July
	Ber	In the month of February
2.	**Selection of brood lac**	• Brood should not be insect infested or disease infected • Brood should be fully matured • Brood should not be old harvested

3.	**Inoculation of brood lac**	• Brood lac must be inoculated at proper time of insect emergence. • Broodlac must be inoculated cutting and filling in 60 mes by tied on branches net never by naked hanging • Brood should be inoculated in proper amount • Brood must be proper distributed in the branches
4.	**Phunki Removal**	After 3–4 weeks of brood lac inoculation it should be removed from the branches.
5.	**Application of insecticides & pesticides**	There should be application of insecticides /pesticides 21, 40 and 60 days interval or as per need at least 23 times.
6.	**Harvesting**	Transfer of the advance/ready lac at the appropriate time
7.	**Coupe system**	To secure the brood for next, we should follow the coupe system
• Regular monitoring is very important in lac cultivation and problem observed in the field must be removed timely.		

4. ***Conservation and proper utilization of natural lac host plants:*** Lac host plants were naturally available in lac growing regions of Khunti, Jharkhand. Initially a survey of the project areas was done to identify the natural lac host plants and it was found that, Khaunti district was naturally full of traditional lac host plants *viz*. *Palash, Kusum* and *Ber.* , In the all ten villages' total 691 kusum trees, 144800 plash tree and 27290 ber trees were recorded (Table 2). But, only in some of the regions lac host plants were being utilized properly for lac cultivation and mostly were remaining unutilized and farmers were used to cut them for fuel wood. After the survey it was estimated that only 5-10 % *Kusum* and *Ber* plants and *Palash* only 1% plant were being utilized for lac cultivation. Thus, farmers were made aware about the benefits of precious natural host plants available with them and their conservation proper utilization for lac cultivation (Table 2).

Table 2: Village vise lac host plant distribution in Khunti district Jharkhand

Sl.No.	Name of the villages	Lac host plants distribution		
		Kusum	Palash	Ber
1.	Bari	90	27000	1600
2.	Rutadih	20	900	430
3.	Jiwri	76	30000	6000
4.	Gutuhatu	150	10000	1260
5.	Janumpiri	90	3000	1000
6.	Kudapurti	175	30000	6000
7.	Kudda	30	3900	5000
8.	Kitahatu	10	20000	3000
9.	Kotna	40	10000	2500
10	Anirhdih	10	10000	500
Total		**691**	**144800**	**27290**

5. ***Management of natural host plant:*** Most of the farmers were not aware about the benefits of host plant pruning and they were use to cultivate lac on same host plant periodically

without giving them rest and also without pruning. Pruning of plants is necessary to rejuvenate the host plant growth with new succulent shoots. Some farmers were use to prune the trees, but they were not aware about the proper time of tree pruning, resulting in adversely affecting the growth. Thus, the farmers were trained by demonstration of pruning and about schedule of pruning. So that lac host plant can be easily managed and the growth of succulent shoots could be promoted.

6. ***Introduction of Flemingia spp. for lac cultivation*:** Lac cultivation in the regions was being done on traditional lac host plants *viz. Palsh (Butea monosperma*), *Kusum (Schleichera oleosa*), and *Ber (Zizyphus mauritiana*). While, these host plant were not available with all the interested farmers. Though, these host plants were very good lac host but growth nature is very slow and they take about 8, 10 and 6 years, respectively for lac inoculation. Additionally, the management of these plants was also labour intensive and risky. Thus very suitable *kusmi* lac host plant namely, Ban Cholla *(Flemingia semialata)* and Bhalia *(F. macrophylla)* can be planted for Kusmi lac cultivation. Both the plant species takes only one year for growth and after one year lac can be inoculated. Height of these species is only 3-4 m which makes them easy to manage for lac cultivation in addition to following advantages mentioned in table 3.

Table 3: Advantages with lac host plant *Flemingia* spp.

Easy to propagate	Flemingia can be easily propagated through seed and stem culling. New seedling can be raised within only three month.
One year for growth	Flemingia is takes only one year for proper growth to get ready for lac inoculation. While other host takes at least 5-10 years.
Short height	The height of Flemingia is only 3-4 m which suitable for management.
Nitrogen fixing	Flemingia plant is belongs to family Leguminosae which has nitrogen fixing ability in the soil. Thus this plant enriches the soil with fixing atmospheric nitrogen to the soil and improves soil fertility.
Lac cultivation easy	Flemingia has the ability of easy propagation, fast growth, short height and easy management. Thus lac inoculation, phunki removal, insecticide spray, monitoring of development and harvesting of lac could be easily done even by childhood and female members.

7. ***Promotion of community lac brood farm*:** Brood lac is major constant in lac production. About two decade back state forest department and Research Institute were managing more than 200 brood lac farms in different regions. Farmers were getting proper brood lac from these farms and they were totally dependent on the supply through forest department. But, in present scenario the department has no such active farms in true sense. Thus, farmers were not getting healthy brood lac supply at proper time and farmers were bound to switch over to other source of livelihood and migration in search of livelihood. Some middle-man took advantage and became active to supply the brood lac and started supply of brood lac bringing from other state *viz.* Chhattisgarh and West Bengal. This imported brood lac is not accepting new and changed environmental condition and survival percent is very less. During long transportation of live insect material (brood lac) a lot of mortality was occurring and farmers were not getting desired quality of brood lac. To make sure timely availability of good quality of healthy local brood lac to the farmers the

Institute of Forest Productivity, Ranchi helped in establishing community brood lac farms at village level including farmer's plants. Therefore, farmers were motivated and SHG/Mahila sangathan were created at village level to build-up brood lac farm again, under the supervision and technical support of the scientists of Institute of Forest Productivity. For the motivation task a NGO namely SPAR was actively involved. This community brood lac farms has ensured timely supply of healthy insect and disease free brood of local standard which is environmentally suitable. The four farms were made with A- 410 plants, B-579 plants, C-700 plants and D-1100 plants of palash lac host plant available on community land and belongs to the community. This model of community brood lac farm helped to farmers to become independent in brood lac production, utilization and also ability to supply in nearby villages.

8. ***Facilitation of lac working network:*** Network among the producer farmers, researchers, processors, factory owner and policy maker is not properly established. The problem of the farmers is not reaching to the researchers. Similarly, the policy makers are not properly attached with the farmers and processors. The policies are not properly addressed with the real problems of farmer and processors.

Results

SUCCESS AND FINANCIAL BENEFIT

Capacity building through multiple training:

After motivation and agreement with the villagers for active participation and scientific lac cultivation, multiple trainings were conducted to the farmers. Different forms of training like class room training, field training for host plant pruning, lac inoculation, insect pest identification, management and proper time of harvesting knowledge were provided. Additionally, the exposure of basic processing of lac and its utilization were also provided to the farmers. In this programme till March 2012 a total 1135 farmers along with nine master trainers were trained in continuation of promotion of lac cultivation in the region. After the capacity building of the farmers through participatory training, farmers have started performing cultivation practices as per the scientific method.

Rangeeni strain based lac cultivation with community brood lac farm concept:

In continuation of establishment of community brood lac farm the year 2010 the site at Bari Sarna sthal (Sacred grove) a patch of 410 *Palash* trees were pruned by the village community. After 6 months of its pruning 200 kg of healthy broodlac was brought from nearby farm named *Silli*. In the month of October, 2012 @ 50-60 gms per plant of broodlac was inoculated. After one month *Phunki* was removed and total 37.5 Kg of lac collected and sold in the local market worth Rs.7500/- which was spend for purchase of pesticides and other all maintenance activities by the community. All the lac management and maintenance activities were done in the supervision of IFP's scientists. After eight months of inoculation 529 Kg brood matured lac was harvested worth Rs. 1,58,700 from these 410 palas trees.

The lac produced above was again inoculated on the village and 579 *Palash* trees belongs to of 58 poorer farmers were inoculated as community brood lac farm (total 464 kg free). Rest of the brood lac was sold @ 300/- kg in *Kotna, Gutuhatu, Gutuhatu, Chundiburu* and *Bari* villages. After maturity total 1564 kg of lac was harvested worth rupees 4,69,200 @ 300 per kg.

To maintain the brood lac cycle, another farm-C a group of 700 *Palash* trees were pruned in *Jiwri* village in the month of April 2011 and 320 kg brood lac was inoculated in the month of October, 2011. Six month after partial harvesting was done and a total 140 kg lac was obtained worth 49,000 rupees. While at final harvesting 1100 kg lac was harvested this way a total 1240 kg lac was produced from 700 plants. Another farms-D having 1100 *palas* trees were pruned and in these brood lac farms 410 kg brood lac was inoculated in the month of October, 2012 and lac production was obtained 1920 kg at final harvesting (table 4).

Table 4: Palash tree based rangeeni community brood lac farms input and production detail

Brood lac farm	No. of tree	Inoculation of brood lac (kg)	Brood lac production (kg)
Farm A	410	200	529
Farm B	579	464	1564
Farm C	700	320	1240
Farm D	1100	410	1920
Total	2789	1394	5253

Kusumi strain based lac cultivation:

In the 140 kusum plans of village *Gutuhatu, Bari and Jiwri* were identified for further Kusmi strain brood lac cultivation and were pruned scientifically in the month of February, 2011 which has been inoculation with 2520 kg (15-20kg /plant) lac in January 2012. After six month of inoculation, 20160 kg (120-180 kg/plant) brood lac was harvested by the community. After six month a farmer Dero Munda of Bari village earned approximately Rs. 40000 per *kusum* tree with lac cultivation.

Some farmers were not having natural lac host plant and the farmers having spared land were promoted to plant *Flemingia semialata* for lac cultivation. *Flemingia semialata* plants were planted on total 49 farmers of five villages. Initially only about 55 per cent plants were inoculated with lac. Village vise details of the planting and lac production is discussed bellow as detailed in table 5.

Village Kitahatu: In the year 2010 total 8000 Flemingia semialata plants were planted on seven farmer's field. After one year only 1500 plants were inoculated with brood lac and lac was produced 280. Similarly, in the year 2013 again 4000 plant were planted on four farmer's field and after one year 1750 plants were inoculated with brood lac and 60 kg lac was produced after six month.

Jiwri Village: In the year 2011 a total 16595 Flemingia semialata plants were planted on nine farmer's field. After one year of planting 8500 plants were inoculated with 210 kg of brood lac. After six months of brood inoculation total 1300 kg lac was harvested. In the year 2012 a total 13000 *Flemingia semialata* plants were planted on seven farmer's field. After one year of planting, 7500 plants were inoculated with 120 kg of brood lac. After six months of brood inoculation total 728 kg lac was harvested. Similarly, in the year 2013 a total 2000 *Flemingia semialata* plants were planted on two farmer's field and after one year 2000 plants were inoculated with 40 kg of brood lac. After six months of brood inoculation total 275 kg lac was harvested. In 2013 a farmer namely Soto Manki has harvested 215 kg brood lac from his total 1600 *Flemingia semialata* plants and was sold wroth 2,15,000 rupees.

Saiko Village: In the year 2012 a total 8850 *Flemingia semialata* plants were planted on eight farmer's field. After one year 2000 plants were inoculated with 50 kg of brood lac and after six months of brood inoculation a total 363 kg lac was harvested. Similarly, in the year 2013 a total 7600 *Flemingia semialata* plants were planted on nine farmer's field and after one year 7000 plants were inoculated with 230 kg of brood lac. After six months of brood inoculation total 1147 kg lac was harvested.

Digri Village: In the year 2013 a total 2000 *Flemingia semialata* plants were planted on two farmer's field and after one year total 2000 plants were inoculated with 40 kg of brood lac. After six months of brood inoculation total 255 kg lac was harvested.

Torpa Village: In the year 2013 a total 5000 *Flemingia semialata* plants were planted on a farmer's field and after one year 5000 plants were inoculated with 140 kg of brood lac. After six months of brood inoculation total 710 kg lac was harvested.

Table 5: Flemingia based lac cultivation and lac production

Village	Year of planting	No. of farmers involved	No. of plant planted	No. of plants inoculated	Brood lac inoculated (Kg)	First lac production (Kg)
Kitahatu	2010	7	8000	1500	45	280
	2013	4	4000	1750	60	425
Jiwri	2011	9	16595	8500	210	1300
	2012	7	13000	7500	120	728
	2013	2	2000	2000	40	275
Saiko	2012	8	8850	2000	50	363
	2013	9	7600	7000	230	1147
Digri	2013	2	2000	2000	40	255
Torpa	2013	1	5000	5000	140	710
	Total	**49**	**67045**	**37250**	**935**	**5483**

Conclusion

Lac cultivation is one of a very effective source of livelihood in the rural areas because of ample availability of quality natural resources as a host plant. For its effective implementation SHG/*Gram Sabha/Mahila sangathan* of these villages supported and proactively made efforts. The community which had given earlier the causes of failure of lac cultivation in their areas due to various reasons e.g. monetary loss, lack of brood lac, climatic conditions etc. now with this initiative, farmer are now enthusiastic to opt once again their tradition asset of lac cultivation in their areas. The young generations are also taking interest in lac production as one of the very profitable agri-business practice, requiring less capital, less labour, improved technique and provides good opportunity for income generation. A short term field training and periodic supervision from the institute was very effective in increasing lac production and farmers interest as well. Establishment of community brood lac farm at village level has directly supported the promotion for lac cultivation among the farmers. Additionally, introduction of *Flemingia semialata* has provided another livelihood support to the farmers in addition to their traditional source. In present scenario utilization of natural host plant resources is increased drastically. This way after only engagement of 50 % traditional host plants for lac cultivation and an additional inclusion of Flemingia sp. can uplift more than 20 times income of the farmers from lac cultivation only.

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Impact Analysis of Kharif Onion Demonstration in Nalanda

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Abstract

A study was conducted on cultivation of kharif season variety of onion, **Agrifound Dark Red** by NCOH, Noorsarai, Nalanda. During study the college mainly focus on comparative analysis between traditional cultivar (Local) and ADR. Having studied on various facts it was found that ADR has better yield capacity in comparison with the traditional/local cultivar. The study was comprised of survey, field visit and focus group discussions. Since the college had demonstrated ADR over a large number of Farmers in district Nalanda, therefore the study was conducted in easy manner. The major findings after the study was – considerable increase in significant yield between traditional/local and ADR variety of Onion.

Introduction

More than twenty villages of Nalanda District have better place in Onion cultivation in Bihar. Farmer belonging to these villages cultivates onion in two seasons at commercial level. Over 70% farmers in this area are small and marginal who insure their livelihoods by adopting well farm planning with modern technologies of vegetable cultivation especially for onion. Since all above villages are adjacent to district head quarters. Therefore market is easily accessible for them.

During last year, we are felt that there is a need to adopt scientific technology/approach for onion cultivation, recommended by research institutions. It was also felt that the said technologies can definitely be a major cause behind higher production of onion. It was an affirmative aspect that various programmes on National Horticulture Mission (NHM) were being implemented in Nalanda District by ATMA.

During the month of June – 2013 demonstration of ADR was ensured with 06 farmers in Sohdih village of Nalanda District. The farmers were provided seeds and inputs by ATMA, Nalanda. Scientists from NCOH, Noorsarai visited in the area in continuous manner and assist the farmers technically. Farmers get interested in this innovative approach and enjoyed better significant yield of ADR as compared to traditional cultivar of onion. After 7 months i.e. in the month of January-2014, a study was done on ADR variety. This study was undertaken to find out the comparative analysis between traditional and ADR variety of onion.

Selection of farmers for ADR Demonstration

Selected area for ADR demonstration is situated near to district head quarters. This area is comprised of small and marginal farmers who are engaged in Onion cultivation. Majority of Onion cultivators belongs to BC, EBC and SC classes. These classes are absolutely depending on vegetable farming especially on onion. Following table shows a clear description about farmers and land used.

Methodology –

1. **Orientation and capacity building of selected farmers**

   Firstly, we oriented the farmers which were selected for demonstration of ADR var. of Onion. Scientists made them aware and acquainted them following points regarding ADR cultivation.

   - Nursery raising techniques
   - Land preparation
   - Transplanting & nutrient management
   - Irrigation & weeding
   - Disease & pest management
   - Harvesting & Post harvest management
   - Marketing

Sr. No.	Farmers Name	Full Address	Area (ha.)	Qualification	Category	Gender & Age	Remark
1	Smt-Shushma Devi	Vill-Sohdih, Block-Soohsarai, NALANDA	0.5	Nil	E.B.C	F/ 39	
2	Shri-Sanjay Prasad	Vill-Sohdih, Block-Soohsarai, NALANDA	0.5	5th	B.C	M/48	
3	Shri-Nand Lal Prasad	Vill-Sohdih, Block-Soohsarai, NALANDA	0.5	5th	S.C	M/46	
4	Shri-Prashant Kumar	Vill-Sohdih, Block-Soohsarai, NALANDA	0.5	8TH	B.C	M/38	
5	Shri-Naveen Kumar	Vill-Sohdih, Block-Soohsarai, NALANDA	0.5	12th	B.C	M/30	
6	Shri-Sanjeev Kumar	Vill-Sohdih, Block-Soohsarai, NALANDA	0.5	10th	E.B.C	M/22	
		Total=	**3.0**				

2. Continuous visit of scientist in the area

Scientists visited in the area in continuous manner. They made proper interaction with farmers and solved their problems. During the season (June – January) total 57 farmers maid them known about their problems related to crop protection

3. Providing inputs to selected farmers

Under the demonstration programme farmers were provided with following Inputs by ATMA, Nalanda –

Yield of ADR –

Sr. no.	Fertilizer/Disease & insect pest	Inputs	Dose	Water used for spray solution	Time of application	No. of applications
1	Water soluble fertilizers	Polyfeed 19:19:19 Multi-K 13:0:45	10gm/lit 10gm/lit	500lit/ha. 500lit/ha.	1st spray at 30DAP, 2nd spray at 45 DAP 1st spray at 60 DAP, 2nd spray at 75 DAP	2 2
2	Organic sea weeds extract. for boosting growth of crops	Bioalgeen	2 ml/lit.	500lit/ha	1st spray at 15 DAP, 2 nd spray at 30 DAP	2
3	Damping off & Basal rot, White rot.	Tricoderma viridi	10 kg/ha.	Soil application	Apply @ 4 kg/acre at the time of transplanting	1
4	Seedling treatment	Thiram	2gm/lit.	500lit/ha	Drenching 2 time at 15 & 30 days of sowing in nursery	2
5	Thrips	Delta traps	5 pairs/ha	Field application	At the time of Thrips appearance	1

An analysis was done to draw authentic sketch regarding the yield of ADR. Apart from it, we also analyzed input and output of ADR and traditional cultivar of Onion.

1. Analysis of yield– It has earlier been mentioned that in village Sohdih total 6 farmers were selected for the said demonstrations, study reveals that –

There were two farmers who cultivated 200-250 qtl./ha ADR whereas in case of traditional/local cultivar the yield was maximum up to 150 qtl./ha. During field day on above experiment more than 50 farmers of the area experienced a significant increase as compared to traditional cultivar.

Many farmers were deprived of getting better yield due improper crop management i.e. Flat bed having no proper drainage facility. They faced Severe attack of rains over their crops hence their yield was ranged between 80 to 100 qtl./ha.

Major findings, obtained after study was –

Majority of selected farmers experienced tremendous yield of ADR they obtained 200-240 qtl./ha. While in case of traditional and local cultivars they produced up 100-125 qtl/ha. Therefore, they have a considerable increase i.e. 100-115 qtl/ha.

Many farmers of above area who are using local varieties and traditional system of cultivation, was in between 100-115 qtl/ha only.

Significance of ADR as stated by farmers

- It has better yield as compared to other/traditional/local
- Size of ADR bulb are about 5 to 7cm, it is just double from local cultivar
- It can be cultivated two time in off season i.e. kharif and late kharif
- It is a good option of income generation during off season (Spring)
- There is less incidence of pest and disease as compared to *Rabi* season
- Farmers got better price (Rs.25/Kg) in market as compared to local (Rs.15/Kg)
- Colour, shape, size and quality of ADR is much more better and attractive as compared to local
- No need of storage because prices of onion is always hike in off season
- Marketing is very easy due to scarcity of onion in market

Problem faced by farmers

It was found during the study that nursery of kharif onion get affected with damping off during rainy season. To overcome these problem farmers discussed with NCOH scientists. We are recommended and demonstrated them the raised bed low tunnel technology of nursery production. Farmers did the same and got better result.

Management of Post-harvest Losses in Betel (Piper betel L.) Leaves by Various Techniques

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Abstract:

Fresh leaves of betel vine (*Piper betel* L.) popularly known as *Paan* in India are consumed by millions on daily basis. The leaves possess a particular aroma with pungent and sharp taste. The demand is also increasing in overseas including European countries. But, there is a tremendous amount of post-harvest loss of leaves particularly during transportation and storage. Owing to the highly perishable nature, these leaves undergo quick spoilage due to dehydration, fungal infections, discoloration. Wastage may be minimized by drying the leaves for further value-addition. Other than curing, few attempts are also being made to reduce losses by chemical treatments, beneficially modifying the storage conditions, adopting better packaging techniques. Such wastage may also be reduced by extracting essential oils from the leaves which remains unsold in the market. This essential oil has reported of remarkable medicinal and aromatic properties which indicate a promising industrial future. Therefore, if appropriate post-harvest technologies are made, the betel leaves will rightly be the "Green gold" for our country.

***Keywords*:** Betel leaves; Piper betel; Post-harvest loss; Essential oil

Introduction:

Piper betle L. (betel vine, Paan) an indigenous medicinal plant, has a folk (Siddha and Ayurveda) reputation in the rural areas of India, a member of the piperaceae. The plant is dioeciously, shade loving perennial root climber (Singh *et al.,* 2013). There are about 125 to 150 cultivars of betel vine in India (Singh *et al.,* 2013, Verma *et al*., 2004). Significance of *P. betle* leaves have been explains in relation to each and every plethora of human life from the dawn of civilization. These leaves are traditionally used for chewing in their natural raw condition which a product is called 'paan'. The significance of leaves has been explained in relation to every sphere of human life including social, cultural, religious and even day-to-day life, which is very much relevant even these days. For example, a well-prepared betel quid is still regarded as an excellent mouth freshener and mild vitalizer, routinely served on the social, cultural and religious occasions like marriage, *Puja* (religious festivals), *Sraddha* ceremony (religious function performed after cremation) etc. It is also used as a special item offered to the guests in order to show respect and for such traditional use of betel leaf in the Indian society, the leaf really stands alone without any parallel even today (Guha, 1997; Mehrotra, 1981). Betel leaves are traditionally used for chewing in their natural raw condition along with many other ingredients like sliced areca nut, slaked lime, coriander, aniseed, clove, cardamom, sweetener, coconut scrapings, ashes of diamond, pearl, gold and silver (Ayurvedic preparations), jelly, pepper mint, flavouring agent, fruit pulp etc. (CSIR, 1969).

Fresh leaves of betel vine are consumed by 15-20 million people in India and the major contributor towards the production is West Bengal which is about 66% (Guha, 2006).The leaves possess a particular aroma with pungent and sharp taste. The demand for fresh paan leaves is not only limited to Nepal, Canada and Gulf countries but also there is tremendous demand from the European countries (Balasubramanian *et al.,* 2010). But there is an alarming problem of post-harvest losses mainly during the transportation and storage. Owing to the

perishable nature, it undergoes spoilage rapidly. Spoilage may occur due to some infectious diseases, pest attack or dehydration and discoloration. The spoilage of betel leaves accounts for the post-harvest losses in the ranges between 35-75% during transportation and storage (Rao and Narasimham, 1997).

Wastage may be minimized by drying the leaves for further value addition. Other than curing, few attempts are also being made to reduce losses by chemical treatments, beneficially modifying the storage conditions and by adopting better packaging techniques. Such wastage may also be reduced by extracting essential oils from the leaves which remains unsold in the market. This essential oil has reported of remarkable medicinal and aromatic properties which indicate a promising industrial future (Guha, 2006). Some of the preservation techniques are discussed in the following sections.

Minimizing the post-harvest losses:

Post harvest losses is minimizing since time memorial through depetiolation by betel growers. Depetiolation is removal of the petioles from the leaves and thus, about 10-25% weight of leaves are reduced beside 10-40% reduction in length of leaves. It helps in delaying senescence (Mishra and Gaur, 1972). Imam and Pariari (2012) revealed that the keeping quality under different seasons and methods of storage to suggest that December-January i.e; winter season was the best for longer storage of betel leaves in any form and method. Among method of storage, zero energy cool chamber was the best for longest period of storage followed by packing with banana leaves in bamboo basket. Depetiolated condition was always better than petiolated condition for enhancing storage life. Chlorophyll degradation was found minimum in petiolated condition either in packing with banana leaves or in treatment with Benzylaminopurine (BA) @ 30 ppm compared to depetiolated condition. Ascorbic acid content was more in sterilized paddy straw packing and in hessian cloth lined with mustard seed and ice pieces compared to other treatments. Another practice, follows commonly is drying of betel leaf. Drying is preservation process of any product by lowering the amount of moisture content in the materials (Drouzas and Schubert, 1996). Ramalakshimi *et al*. (2002) have studies the impact of drying on quality of betel leaves and found that solar drying produced better results compared shade drying, mechanical drying and microwave drying since in the latter methods there was substantial losses of volatile oil which is responsible for improving organoleptic qualities of the leaves. According to current research of drying of betel leaves, shorter drying times need to preserve the quality (Pin *et al*., 2009) and under vacuum drying green colour of betel leaf is preserved at 50°C (Wahida *et al*., 2012).

Since ages, solar drying of leaves has been practiced as an essential tool for preservation in various parts of the country. But, prolonged exposure to the solar radiation leads to negative changes in colour, flavour, texture, contamination from soil and other foreign matter (Adom *et al*. 1997; Midilli, 2001). Another method which is practiced is shade-drying but the issue with such practice is that it is very time consuming. Because of these reasons, modern and well-equipped hot air dryers seems inevitable for drying to improve the quality of the final product (Doymaz and Pala, 2002; Ertekin and Yaldiz, 2004).There is very few research reported for the preservation of betel leaves through dehydration and hence modern drying should be promoted for beneficiary outcomes (Balasubramanian *et al*., 2010). Attempts are also being made to reduce wastage by controlling senescence (Mishra and Gaur, 1972) by chemical treatments, manipulation of storage temperature, adopting better packaging materials and methods (Guha, 2004; Rao and Narasimham, 1997) besides curing and bleaching of the leaves (Dastane, 1958; Sengupta, 1996).

The storage of the betel leaves could be extended by including a mixture of sodium bicarbonate and tartaric acid in the packaging. Before packaging, the packing material could be disinfected with sodium hypochlorite as it reduces the spore load and development of yellow colour.

Ventilation was found to be most important as no aeration leads to moist discolouration and fermentation and too much aeration leads to dry discolouration. For prolonged storage and distant transport, the betel leaves treated with benzyl adenine (BA) had less chlorophyll destruction with greater build up of carotenoids and yellowing was delayed about 3 days. Betel leaves packed in traditional packaging subjected to heat treatment for 1hour at 45 ^{0}C had as extended storage life. Storage life of betel leaves was extended by 5 days with acceptable qualities by keeping in cold chamber; Storing betel leaves for 10 days at 200^{0}C under modified atmosphere packing had better retention of chlorophyll which could be an alternative for retail handling and storage which is at present done by ice boxes and gunny bags. (Bhuvaneswari and Narayana, 2014).The curing process for betel leaves was probably first invented as Varanasi, India where the techniques was traditionally used for making Banarasi paan (cured betel leaf). The green leaves are treated with smoke, high temperature and pressure for improving organoleptic qualities and ultimately the green leaves are converted to white or yellowish white colour leaves. Betelvine Research Centre, Islampur under Bihar Agricultural University, Sabour took initiation in the studied of curing of betelvine and constructed two paan bhati at the centre. It also facilitates the training to betel growers coming from different parts of the state. The method of curing the betel leaves are alternate heating of 6 hours at 50-60 °C and cooling of 12 hours, two to three time following aeration of leaves by turning and stored under dark condition. It takes 15-20 days for making complete white or yellowish from green betel leaves. In this process, the shelf life of betel leaves is extended up to one months and curing imparts softness and sweet taste in betel leaves. It is also suitable for packaging (Kumar and Pandey, 2014).

Surplus leaves which remain unsold in the market can be utilized through extraction of essential oil. The constituents present in the oil may vary with the variety, soil and agro-climatic conditions followed to raise the crop like any other essential oil yielding crop (Sankar *et al*. 1996; Sharma *et al*., 1981). According to Khanra (1997), these constituents are the sources of the medicinal, aromatic, stimulant, tonic and various other useful properties found in the leaves. Two bioactive phytochemicals that found in betel leaves are hydroxychavicol (HC) and eugenol (EU) contribute to the beneficial bioactivity of betel leaves (Rathee *et al*. 2006; Mazura *et al*., 2007; Nalina and Rahim, 2007). The industrial use of such range indicates promising future for betel leaves. IIT, Kharagpur design and develop an apparatus for extraction of essential oil from betel leaves that recovered essential oil 16.2 % more as compared to Clevenger Apparatus (Guha, 2010). The essential oil extracted with this apparatus clearly revealed the Meetha, Bangala and Sanch varieties of betel leaves contained about 2.0%, 1.7% and 0.8% essential oil respectively, on dry weight basis. Essential oil of Bangala variety contained a mixture of about twenty-one different compounds of which eugenol was chief ingredients (29.5%) (Guha, 2003). Post-harvest dipping of betelvine leaves for 6 h in solutions of 25 ppm benzyladenine (BA) and 50 ppm kinetin and packed in vented polythene bags stored under refrigerated conditions prolonged the shelf life of the leaves. Leaves packed in baskets and stored at room temperature could keep up to 40 days. De-petiolation and de-midribbing increased the shelf life of leaves. A combined treatment of de-petiolation, de-midribbing and dipping in 25 ppm of BA for 6 h resulted in the further increase of shelf life by about 10 days. In these treatments, spoilage due to yellowing was negligible. From a commercial point of view, matured harvested leaves, after de-petiolation, treated with 5 mg/l of BA for 6 h and stored in conventional packing was observed to be best suited to prolong the shelf life of betelvine leaves (Bhuvaneswari and Narayana, 2014). Betel leaf has many unique properties including those of its essential oil besides medicinal ones which can be utilized for development of Novel food and non-food products. Accordingly at IIT, Kharakpur a few novel food product like cup cake, suji halwa, Ice cream, Chocolate and Biscuit have been developed with using essential oil of betel leaves ranging from 0.01 to 0.5% (Guha, 2014). One other hand, as far as non-edible products are

concerned, developed an herbal Shampoo with very low concentration of essential oil of betel leaf which was found to be beneficial against Dandruff with very pleasant smell and smooth feeling in hair without addition of hair conditioner or oil. Formation of betel leaf powered is also an alternative method of preservation and value addition. The optimum spray drying process was developed by Tee *et al*. (2012) using different parameters including inlet air temperature; pump flow rate and aspirator rate of spray drying of betel leaves extract on powder quality. The spray-dried powder was analyzed for its HC content, moisture content, particle size distribution, powder yield and hygroscopicity.

As a raw material, it can be used for the manufacturing of tooth-pastes, skin emollients, tooth-powders, *paan masala*, de-odorants, mouth fresheners, facial creams, antiseptic lotions, cold-drinks, chocolates, appetizers, carminative mixtures, digestive agents, tonics, medicines etc (Guha, 2000). Therefore, for exploitation of the unique qualities of the crop, there is a tremendous requirement for research on developing new products from betel leaves and essential oil. This would definitely be helpful for minimizing the menace of post-harvest losses of the leaves. Unfortunately, there are very few reports available on the preservation of betel leaves and hence more of such research inputs are required in this area.

Medicinal properties of betel leaves:

In Ayurvedic medicines, there have been reports of usage of betel leaf for the treatments of various diseases. Traditionally, it is known to be useful for the treatment of various diseases like bad-breath, boils and abscesses, conjunctivitis, constipation, headache, hysteria, itches, mastitis, mastoiditis, leucorrhoea, otorrhoea, ringworm, swelling of gum, rheumatism, abrasion, cuts and injuries etc as folk medicine while the root is known for its female contraceptive effects (Chopra *et al*. 1956; Singh *et al.,* 2013; Khanra, 1997).

The extracted essential oil also poses anti-fungal and anti-bacterial properties. This indicates that essential oil is the powerful inhibitor of pathogens causing cholera, typhoid, tuberculosis etc (CSIR, 1969). Betel leaves serves as a cheap source of medicine which is also easily available in the market. Mastication of betel leaves produces a sense of freshness, alertness, salivation, energetic feeling with enhanced mental and physical response of the human body (Guha, 2006). Rich in phenols and terpenes in betel leaves have been reported to exhibit antioxidant, antiinflammatory, immunomodulatory and antitumor activities (Kumar, 2010). The leaves of *Piper betel* are a reservoir of phenolics with antimutagenic, antitumor and antioxidant activities. Recently, an anticancer property of betel leaf extract has identified. Oral feeding of betel leaf extract (BLE) significantly inhibited the growth of human prostate xenografts implanted in nude mice compared with vehicle-fed controls (Paranjpi *et al*., 2013).

Impact on the country's economy:

The economic potentiality of the crop can be imagined by the fact that around 20 million people consume betel leaves in India on a regular basis (Jana, 1996). It can generate national employment by providing the livelihood to millions of the people engaged with this works. At present, around 20 million workers derives their livelihood, partly or fully, right from the production till its consumption (Jana, 1995). In this way, the crop provides a national income to the tune of Rs 6000-7000 million every year. Leaves worth about Rs 30-40 million are exported to the countries like Bahrain, Canada, Great Britain, Hong Kong, Italy, Kuwait, Nepal, Pakistan, Saudi Arab and many other European countries (Jana, 1996; Singh *et al*. 1990). This clearly indicates that this crop has a tremendous potentiality in earning the foreign exchange which will strengthen the nation in many ways. Though a “Betel leaf oil extractor” is been developed by IIT, Kharagpur, more of such research and technology inputs are required in this area.

Conclusion:

Considering the huge commercial potentiality of betel leaf in India and overseas, it can be truly called as “Green Gold of India”. If the agronomic practices are linked with the scientific research and technology, there would be a tremendous magnification in the revenue

generation. In spite of potentiality of such calibre, it still remains a neglected particularly by the scientists, technologists, administrators and policy makers. The research and technology inputs are still lacking in this area and more of such research should be funded and encouraged in the country. A well-coordinated effort by the farmers, traders, scientists, technologists and policy makers will definitely boost the national economy and also generate huge employment opportunities for the people and thereafter it will truly be a "Green Gold" for the country.

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Integrated Farming Systems in Changing Agricultural Scenario

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Abstract
The emergence of Integrated Farming Systems has enabled us to develop a framework for an alternative development model to improve the feasibility of small sized farming operations in relation to larger ones. IFS works on the principle of system of systems. Integrated farming system refers to agricultural systems that integrate livestock and crop production or integrate fish and livestock and may sometimes be known as Integrated Biosystems. In this system an inter-related set of enterprises used so that the "waste" from one component becomes an input for another part of the system, which reduces cost and improves production and/or income. Integrated farming systems seem to be the possible solution to the continuous increase of demand for food and nutrition, income stability and livelihood upliftment particularly for small and marginal farmers with little resources. In India, out of 115 million operational holdings more than 80 percent are marginal and small farmers. To fulfil basic needs of these farm families including food (cereal, pulses, oilseeds, milk, fruit, honey, meat etc.), feed fodder, fibre and fuel warrant an attention about Integrated Farming System (IFS). Based on the research works conducted all over the country it is clear that crop cultivation alone can't fulfil the demand of food and nutritional requirement of the country and we have to focus on multi-component farming as it is the only way of efficient resource recycling within the system with increased economic profitability, economic stability, enhanced soil sustainability, and preserving environmental quality and maintaining biological diversity and ecological stability.

Key words: Farming system, sustainability, employment, livelihood improvement, productivity

Introduction

The livestock revolution is stretching the capacity of existing production, but it is also exacerbating environmental problems. Therefore, while it is necessary to satisfy consumer demand, improve nutrition and direct income growth opportunities to those who need them most, it is also necessary to alleviate environmental stress. Conventional agriculture is known to cause soil and pasture degradation because it involves intensive tillage, in particular if practised in areas of marginal productivity.

Because of declining per capita availability of land in India, there is hardly any scope for horizontal expansion of land for food production. Only vertical expansion is possible by integrating appropriate farming components that require lesser space and time to ensure periodic income to the farmer. Further, modest increments in land productivity are no longer sufficient for the resource-poor farmers. Hence, intelligent management of available resources, including optimum allocation of resources, is important to alleviate the risk related to land sustainability. Moreover, proper understanding of interactions and linkages between the components would improve food security, employment generation as well as nutritional security. This approach can be transformed into a farming system that integrate crops with enterprises such as – agro forestry; horticulture; cow, sheep and goat rearing; fishery; poultry and pigeon rearing; mushroom production; sericulture; and biogas production – to increase the income and improve the standard of living of small and marginal farmers. The challenge of such an integrated farming system

(IFS) is to upgrade technological and social disciplines on a continuous basis and integrate these disciplines to suit the region and the farm families in a manner that will ensure increased production with stability, ecological sustainability and equitability (Varughese and Mathew, 2009).

The increasing pressure on land and the growing demand for livestock products makes it more and more important to ensure the effective use of feed resources, including crop residues. An integrated farming system consists of a range of resource-saving practices that aim to achieve acceptable profits and high and sustained production levels, while minimizing the negative effects of intensive farming and preserving the environment.

IFS Concept

IFS systems combine livestock, aquaculture, agriculture and agro-industry in an expanded symbiotic or synergistic system, so that the wastes of one process become the input for other processes, with or without treatment to provide the means of production, such as energy, fertilizer, and feed for optimum productivity at minimum costs. The concepts associated with IFS are practiced by numerous farmers throughout the globe. A common characteristic of these systems is that they have a combination of crop and livestock enterprises and in some cases may include combinations of aquaculture and trees. It is a component of farming systems which takes into account the concepts of minimizing risk, increasing total production and profits by lowering external inputs through recycling and improving the utilization of organic wastes and crop residues. In this respect integration usually occurs when outputs (usually by-products) of one enterprise are used as inputs by another within the context of the farming systems.

Integrated Farming System: Benefits

Ever increasing concentration of green house gases in the atmosphere resulting in global warming is likely to have serious repercussions for human beings, animals, plants, microbes and environment. As per NSSO, 40% farmers want to quit agriculture and the young generation is no more interested in farming profession. Diversification into farming system mode of agriculture on small land holding can provide proofing for predicted climate change related risk in agriculture. This can also help in obtaining food and nutritional security at farm level and can also generate rural employment, thus preventing excessive migration to urban areas, which is a common problem in developing economies (Singh, 2012).

Integrated Farming System: Scope

Farming enterprises include crop, livestock, poultry, fish, tree crops, plantation crops, etc. A combination of one or more enterprises with cropping, when carefully chosen, planned and executed, gives greater dividends than a single enterprise, especially for small and marginal farmers. Farm as a unit is to be considered and planned for effective integration of the enterprises to be combined with crop production activity

In the context of India, there are a number of situations and conditions that can be alleviated by an Integrated Farming System. The following situations are ideal for the introduction of Integrated Farming Systems:

- The farmer wishes to improve the soil quality
- The farm household is struggling to buy food or below the poverty line
- Water is stored on-farm in ponds or river-charged overflow areas
- Fertilizers are expensive or the recommended blend is unavailable
- Soil salinity has increased as a result of inorganic fertilizer use
- The farmer is seeking to maximize profits on existing holding
- The farm is being eroded by wind or water
- The farmer is looking to reduce chemical control methods
- The farmer wants to reduce pollution or waste disposal costs

Efficient Nutrient Recycling

Efficient nutrient recycling within the system is an

integral part of any farming system research. An ideal nutrient interactions expected in an integrated farming system from the nutrient pool is depicted in Fig.1. Removal from the nutrient pool includes primarily uptake by the trees and crops which becomes either locked up in the vegetative parts or exported through harvested produce. Nutrient removal through harvested produce is compensated by nutrient input through manures, fertilizers, recycled crop residues and tree nutrient cycling processes. The tree components by virtue of their deep roots intercept absorb and recycle nutrients that would have been otherwise lost by leaching. A dynamic equilibrium can be expected with respect of organic matter and plant nutrients in the soil due to continuous addition of leaf litter, other plant residues and animal wastes and its continuous removal through decomposition.

Important findings from different IFS model across the country Hilly region

IFS is a multidisciplinary whole farm approach and very effective in solving the problems of small and marginal farmers. The approach aims at increasing income and employment from small-holding by integrating various farm enterprises and recycling crop residues and byproducts within the farm itself (Behra and Mahapatra, 1999, Singh et al, 2006). Goswami and Meenakshisundaram, 1997 attempted to develop optimum farm plans for the Garo hill areas where shifting cultivation was practiced for augmenting the incomes of the hill farmers, by eliminating shifting cultivation. He used linear programming model to maximize farm business income under the prevailing level of resources, with capital borrowing and simultaneous hiring of capital and human labour. He indicated that the systematic farm planning was a paying proposition under the existing technology and with the existing resource base on the hill farms. Rapid destruction of forest due to shifting cultivation appears to be the prime cause of degradation of land mass in NEH Region. A micro-watershed based agro-pastoral system in a hilly slop holds promise for small and marginal farmers for sustaining their family and soil fertility on low input basis.

In a study conducted at Umiam, Meghalaya on an area of 0.50 ha having slope of 32 % which was converted into 60 numbers terraces and perennial grass species planted on terrace risers and combined with live stock (two number of cows and their calves). The 1500 m^2 lower terraced area was assigned with rice – toria - frenchbean, middle area for maize – mung – toria (1200 m^2) and groundnut – toria (300 m^2) while upper terraced area ginger + cucumber (500 m^2), ginger + bottle gourd (500 m^2) and turmeric + bottle gourd (1000 m^2) were planted. The terraced risers of 3700 running meter (rm) area was planted guinea grass (2500 rm) and broom grass (1200 rm). He found that integration of these crop sequences with animal component improved the system profitability in totality as maintaining milch cow on small farm of 0.50 ha was one of the important components, which contributed more than 55 % of the total farm income and make the system more remunerative. The inclusion of animal component in the system had set a positive link on sustainability by generating cash income, improving family nutrition and recycling crop residues and livestock refuse into valuable nutrient source for crops (Panwar**,** 2014).

Development of optional modules of integrated farming system in Uttarakhand with introduction of new enterprises like poultry, fisheries, papaya and cucurbits cultivation, gap filling, balanced fertilization and insect- pest management in existing orchards, etc. provided additional returns of Rs. 2766 and Rs. 3800 per household for marginal and small farmers, respectively. Under the livestock module interventions of providing mineral mixture to milching animal, deworming of abdominal worms through drugs, proper nutrition and sanitation increased the gross returns of marginal farmers from Rs. 75307 to Rs. 84834 and of small farmers from Rs. 83129 to Rs. 94216 (Singh *et al*., 2014).

Southern India

Chandrashekar *et al* (2001) listed production constraints faced by growers in Integrated Farming System in the order of

importance. They were lacking in technical guidance, more pests and diseases, high cost of fertilizers, high cost of plant protection chemicals, non availability of seed materials and non-availability of fertilizer in time.

Varughese and Mathew (2009) also reported from their experiments in Kerala that Integrated farming involving aquaculture has great relevance to the coastal rice lands such as Kuttanad, Kole and Pokkali/Kaippad. In lowland rice the entire food chain and vast amount of fertilized water can be fully utilized by integrating rice and fish. The rice- based farming involving fish will not only reserve the present trend of non-utilizing and under utilization of rice field but also make rice farming more attractive, consequent of such a farming system, it can sustain food security. This system of farming could trigger a process of change whereby the income and economic prosperity of people living in these areas will increase leading to economic resurgence. Jyanti *et al*. (2004), based on field experimentation at Coimbatore on farming in lowlands reported that integration of cropping with fish, poultry, pigeon and goat resulted in three fold higher productivity per unit of land over cropping alone as use of manures from the linked allied enterprises helped in increasing productivity of crops. Channabasavanna *et al*. (2002) observed from their integrated farming system studies at Sirupura that rice-fish-poultry combinations gave highest net income (> 1,57,000/ha) with an improvement in soil health.

In North Telangana zone, farming system with agriculture and dairy generated more than 200% additional employment over agriculture alone. The net returns were higher in agriculture and dairy followed by agriculture and poultry and agriculture and sheep (Reddy, 2005). In Tungabhadra project area of Karnataka integration of crop with fish, poultry and goat resulted in higher productivity than adoption of conventional rice-rice alone. Integrated farming system approach recorded 26.3 and 32.3 per cent higher productivity and profitability, respectively over conventional rice-rice system. Among the components evaluated, the highest net returns was obtained from crop (63.8 %), followed by goat (30.9 %), fish (4.0 %) and poultry (1.3 %), respectively (Channabasavanna *et al.,* 2009).

Kulkarni *et al* (2014) conducted IFS in farmers' field of Raichur in Karnataka and found that integration of various components improved farm income in a sustainable manner besides reduction in cost of cultivation by adopting low cost and eco-friendly technologies. *Bajra* followed by groundnut was common cropping practice followed by the farmer. By adoption and integration of various components like vegetable (tomato, brinjal, chilli, bottlegoard, ridgegoard, coriander, menthi, etc), cow, poultry birds, fishery, vermicomposting etc. There was sustainable increase in net returns *i.e*., 243.3 per cent over *Bajra* – groundnut cropping system *(*Rs 23450). There was also drastic reduction in cost of cultivation besides generating more employment *i.e.,* 245 man days in IFS demonstration as against 80 man days in normal practice.

Northern India

Northern part of India comprises of fertile land, rivers, dams, canals, hilly and plateau land with sub-humid to temperate climatic condition and considered as basket for temperate fruits like apple, almonds, pear, scented rice and wheat etc. In the pilot area of model Watershed, Rendhar, Jalaun, U.P., India under financial assistance of Ministry of Water Resources, Government of India carried out by one descript breed of buffalo 'Murrah' which was provided under each system. The seven selected sesame based cropping systems were diversified with companion crops of *rabi* season. Further, each sequence was integrated with one 'Murrah' buffalo for maintaining cash flow of resource poor farm families of Bundelkhand reeling below poverty line (BPL). Among the tested integrated farming systems, the maximum net income (Rs. 65819/ha) was obtained from sesame-lentil + mustard + one 'Murrah' buffalo and was closely followed by sesame-lentil + linseed+ one 'Murrah' buffalo (Rs. 64,004/ha) in ravines degraded soils of Bundelkhand. The lowest net returns of Rs

35,999/ha was recorded from sesame-wheat + mustard + one 'Murrah' buffalo farming (Singh *et al.*, 2010).

Singh *et al.*(2012) had undertaken Integrated farming system comprising the components like crop, dairy, fishery, horticulture and apiary rearing at the Project Directorate on Farming System Research, Modipuram, Meerut, Uttar Pradesh during 2004-05 to 2009-10. The Integrated farming system approach recorded higher productivity, profitability and employment generation. Among the components evaluated, the relative share of different component in the order of merit were from dairy (48%), crop (41%), horticulture (6%) followed by fish (3.0%) and apiary (2%) The net returns obtained from different components were Rs.87029, Rs.74435, Rs.10263, Rs.4947, Rs. 4204, respectively of which total return from IFS unit per year (1.4 ha) was Rs.135826. The employment generation mandays $ha^{-1}year^{-1}$ through crop, dairy, horticulture, fishery and apiary was to the tune of 315, 189, 100, 42 and 38, respectively resulting employment generation of 684 mandays $year^{-1}$. Efficient nutrient recycling made the model sustainable and eco-friendly.

An Integrated Fish Farming model involving fishery, poultry and vegetable farming was developed and evaluated by Bisht, 2011, for two consecutive years on participatory approach at farmer's field in Indian Central Himalaya region. Fast growing hybrid *layer* broiler were housed beside fish pond (264 m^2) at 3000 birds/ ha. Fingerlings of Chinese carps (30,000/ha) and combination of silver carp 45%, grass carp 35% and common carp 20% were stocked. On an average 98 gm dropping/bird/day was recycled into the pond. After one year composite carp culture yielded an average of 120 kg, which corresponded to 4545 kg/ha/yr. Average egg production per female bird was 143 eggs/bird/year and an average of 118.5 kg chicken (live weight) was obtained annually. Besides, 2115 kg vegetables were produced annually on the associated fields (600 m^2), generating handsome amount of Rs 20,958/-. Beside protein rich food for household consumption, an average net gain of Rs 36,823 was obtained annually from IFS with investment of Rs 11,925 by the farmer. Economic analysis of technology clearly showed advantage over conventional system of cropping under rainfed conditions.

Eastern India

Agriculture is the mainstay of economy in eastern states of India since 82 percent population lives in rural areas and more than 80 percent of farmers falls under small and marginal category with an average holding size of 0.32- 0.42 ha. Sarma *et al*. (2011) studied the impact of training on aquaculture under DBT's Women Bio-resource Complex in terms of extent of adoption of Integrated rice-fish farming practices by women farmers. A total sample of 150 women farmers, consisting of 75 trained and 75 untrained, was selected for the study. The purposive cum proportionate random sampling method was followed for selecting the respondents. The findings indicate that only few of the trained respondents had adopted the recommended practices. None of the untrained respondents were found to adopt the recommended practices. Study further revealed that majority of the adopter women had medium level of adoption of recommended practices. The findings of the correlation analysis revealed that extent of adoption of recommended practices had positive and significant relationship with operational land holding, mass media exposure and availability of fish pond, while in case of age, educational level and contact with project staff, it was positive but not significant.

ICAR Research Complex for Eastern region, Patna has developed seven integrated farming systems for efficient utilization of available farm resources and to increase the income per unit of land, different combinations of crop, animal, fish and bird were evaluated at three locations of Eastern India, *viz*. Patna, Vaishali and Munger districts, to sustain productivity, profitability, employment generation and nutrient recycling for lowland situations from 2007- 2008

to 2009-10. Among the tested different Integrated Farming System (IFS) models, crop + fish +cattle model recorded higher rice grain equivalent yield (RGEY) (18.76 t/ha) than any other combinations, but in terms of economics and employment generation, crop + fish + duck + goat model supersedes over all other combinations. The highest average net returns of Rs. 1,64810 (USD 2655/yr) only were recorded from crop + fish + duck + goat system over all other systems tested here. Higher average employment of 752 man-days/ year were also recorded from crop + fish + duck + goat system because of better involvement of farm family labours throughout the year (Fig. 2) . Based on a sustainability index (SI) derived from different models, crop + fish + duck + goat system was found superior with a maximum sustainability for net returns (83.9 %), apart from the addition of appreciable quality of nitrogen, phosphorus and potassium into the system in the form of recycled animal and plant wastes (Table 2).

The wastes/by- products of crop /animals were used as input for another component to increase the nutrient efficiency at the farm level through nutrient recycling. Results on integration of different components with crop depending upon sustainability and preferences were found encouraging, and to enhance the productivity, economic returns, generating employment for farm families and maintaining soil health of the farm, the crop + fish + duck + goat combination could be adopted in the eastern part of India than cultivating the crop alone on the same piece of land under irrigated conditions. Addition of organic residues in the form of animal and plant wastes could also help in improving the soil – health and thereby productivity over a longer period of time with lesser environmental hazards (Kumar *et al*., 2012).

In rice based production system at Orissa, in situ conservation of rain water by optimum wear height, conserving excess water in the refuges constructed at the downstream of rice field and rearing of fish in the refuges in the medium land enhanced the total productivity (James *et al*., 2005). Livelihood models were developed for marginal rainfed, small farmers near water harvesting bunds & check dams and small farmers with assured irrigation for both Sonbhadra and Mirzapur districts in Vindhyan region. By adopting crop (0.7 ha) + goat (5+1) + backyard poultry (10), marginal farm households under rainfed condition can earn household income of Rs 51,769 and Rs 39,438, respectively.

Western Region

In the West coast region, Goa the marginal uplands with shallow soils are predominated by cashew crop while the low lying areas are dominated by rice and rice based cropping systems. Singh *et al* (2014), developed two Integrated farming system models in Goa, one each for upland (plantation crop based) and lowland (rice based) with the feasible cropping systems and their integration with allied agri-enterprises. In the upland model Cashew (variety Bhaskara) + Pine apple (Variety Giant Kew) system in the upper elevation; local coconut cultivar intercropped with elephant foot yam / papaya (local selection) as well as Noni (*Citrus morinifolia*) in middle elevation and high yielding arecanut variety Mangala with intercrop of tissue cultured banana in lowlying areas and their integration with poultry, piggery and vermicomposting. This model yielded a productivity of 901 kg/ha cashew nuts with a mean nut yield of 3.2 kg nuts/ tree and 4.8 t/ha of banana fruits per year. While from lowland IFS model, (with ½ acre under protective irrigation + ½ acre under residual moisture) a net return of Rs.5890/month was obtained by following half acre Rice –Sweet corn (Naveen - Sugar 75 Hybrid) and half acre Rice- Cowpea (Naveen-local selection) + Dairy (1 milch cow) with heifer as bonus. Further, with the involvement of family labour for the management of integrated enterprises one can get enhanced sustained profits even with a marginal holding of one acre with protective irrigation even for part of the holding. Major Prevailing and potential farming system in different Agro- climatic zones, reported

by Rai Mangla (2005) has been presented in table 1.

Conclusion

Integrated farming system approach advocates a change in the farming techniques for maximum production in the cropping pattern and takes care of optimal utilization of resources. The farm wastes are better recycled for productive purpose in the integrated system. Farm as a unit is to be considered and planned for effective integration of all enterprises. The future of Indian agriculture depends heavily on the development of appropriate farming system as it fits to resource poor farm families of different agro ecological zones. The endowment of abundant sunshine, long growing season, responsive soil type and combination of surface water, ground water and seasonal rains and above all a progressive peasantry offer vast scope for an intensive farming system through multiple cropping and diversified farming including animal husbandry, forestry, sericulture, fisheries and the like. The challenge is to upgrade technological and social disciplines on a continuous basis and integrate these disciplines to suit the region and the farm families in a manner that may ensure increased production with stability, ecological sustainability, nutritional security and equitability.

Planning ahead

- Development of ecologically stable, environmentally sound and location specific low cost viable IFS modules for different holding sizes which are socially acceptable is required.
- On –farm testing and refinement of the developed modules according to the farmers, need and requirement as it is a continuous process i.e. addition of profitable components and replacement of less profitable components with time, choice of the farmers and availability of market.
- Need to study the sustainability of the developed or identified farming systems under different agro- climatic situations in the long run including high value crops.
- Need to study the nutrient dynamics of soil, accumulation of carbon and carbon sequestration with continuous cropping and recycling of organic resources in form of plant or animal wastes with different systems over time.
- Development of indigenous technology know how (ITK) of IFS existing in the farming community and its scientific validation.
- Need to identify the constraints in adoption of identified integrated farming systems for particular area or locality.

Agro- climatic Zone Wise Farming system:

Table 1. Prevailing and potential farming system in different Agro- climatic zones

Sl. No.	Agro- climatic Regions	Prevailing Farming System	Potential Farming System	Total area (000, ha) under F.S.
1.	Western Himalayan Region	-Crop based farming system -Horticulture based farming system	-Dairy based farming system -Vegetable based farming system	106.8 (10%)
2.	Eastern Himalayan Region	Rice- rice- rice	Rice + Fish + Horticulture + Vegetable	59.04 (3 %)
3.	Lower Gangetic Plain Region	Jute- rice- mustard	Crops + Horticulture + Fish + Dairy + Duck	108.03 (5%)
4.	Middle Gangetic Plain Region	Rice -Wheat	Crop + Dairy + Fishery + Mushroom	146.43 (3%)

5.	Upper Gangetic Plain Region	Crop + Dairy	Crop + Dairy + Fishery + Bee Keeping + Horticulture	283.05 (5%)
6.	Trans Gangetic Plain Region	Rice/ sorghum -wheat + Dairy	-Fishery + piggery -Crop + Dairy (cross bred) -Crop + Dairy + Vegetable -Crop + Dairy + Poultry -Crop + Dairy + Fishery + Piggery	988.56 (18%)
7.	Eastern Plateau & hill Region	-Crops + Horticulture Crops + Fish / Poultry + Dairy	-Crops + Horticulture +Dairy Crops + Dairy + Poultry + Fishery + horticulture + Duck	309.10 (5%)
8.	Central Plateau & hill Region	-Crops + Livestock -Maize-Potato- Wheat -Soybean- maize-wheat	-Crops + Livestock + Fishery -Crops + Dairy + Vegetables -Crops + Dairy	972.29 (11%)
9.	Western Plateau & hill Region	-Crop based	-Crops + Dairy + Sericulture -Crops + Dairy -Crops + Dairy + Poultry	816.28 (%)
10.	Southern Plateau & hill Region	-Crops alone -Rice/ maize based cropping system	-Crops + Orchard + Goat -Crops + Poultry + Fishery -Crops + Fishery + Pigeon -Crops + Fishery + Goat -Crops + Fishery + Poultry + Mushroom	480.40 (11%)
11.	East cost plain & Ghat Region	-Rice-rice-fallow-pulses	-Rice-rice-rice-cotton+ maize and duck cum fish -Rice-rice-rice-cotton+ maize and Poultry cum fish -Crops + Poultry Fish + Horticulture + Coconut + Poultry	400.77 (9%)
12.	Western plain & hill Region	Rice- rice -Rice + Fishery - Cashew/ Coconut + Rice	- Rice + fish - Rice+ fish + Poultry - Rice – fish (in rotation)	86.21 (11%)
13.	Gujarat plain & hill Region	Crops + dairy (Local breed)	-Crops + dairy (Cross bred) -Crops + Poultry	345.88 (13 %)
14.	Western dry Region	-Crops, cereals and millets -Crops, millets and pulses	-Crops + Dairy + Horticulture -Agri-Pasture System	333.84 (6%)
	Total			5361.99 (8.36%)

Source: PDCSR, Modipuram, 2005 (Presented by Rai, Mangla, 2005)
Note: (Figures given in parenthesis are percent of cropped area)

Table 2: Economics and income sustainability indices of different farming systems models (mean value of five years)

Farming Systems	RGEY (t/ha)	Capital cost (Rs./ha)	Depreciation cost/year	Production cost (Rs./ha)	Total Production cost (Rs./ha)	Net return (Rs./ha)	Net return/ day (Rs.)	ISI
Crop alone	10.01	---	---	58,337	58,337	60063	164	39.4
Crop+fish+poultry	17.04	1,10,000	9,600	91,120	1,00,720	1,03,388	283	79.8
Crop+fish+Duck	13.72	1,00,625	10,408	76,580	86,988	77,845	213	56.1
Crop+Fish+goat	16.65	1,13,500	11,056	85,472	96,528	1,02,256	280	78.7
Crop+fish+duck+goat	18.20	1,35,125	14,158	95,972	1,10,130	1,07,828	295	83.9
Crop+fish+cow	18.60	1,45,000	14,555	1,25,813	1,40,963	84,197	231	62.0
Crop+fish+mushroom	13.38	1,04,000	10,250	71,290	81,149	80,211	220	58.3
Mean	15.37	1,01,178	11,453	86,702	96,447	87,934	241	65
SD	3.10	19,939	1,946	21,224	25,034	17,349	48	
CV (%)	20.1	16.9	17.0	24.5	25.9	19.7	19.7	

Note: ISI: Income sustainability index

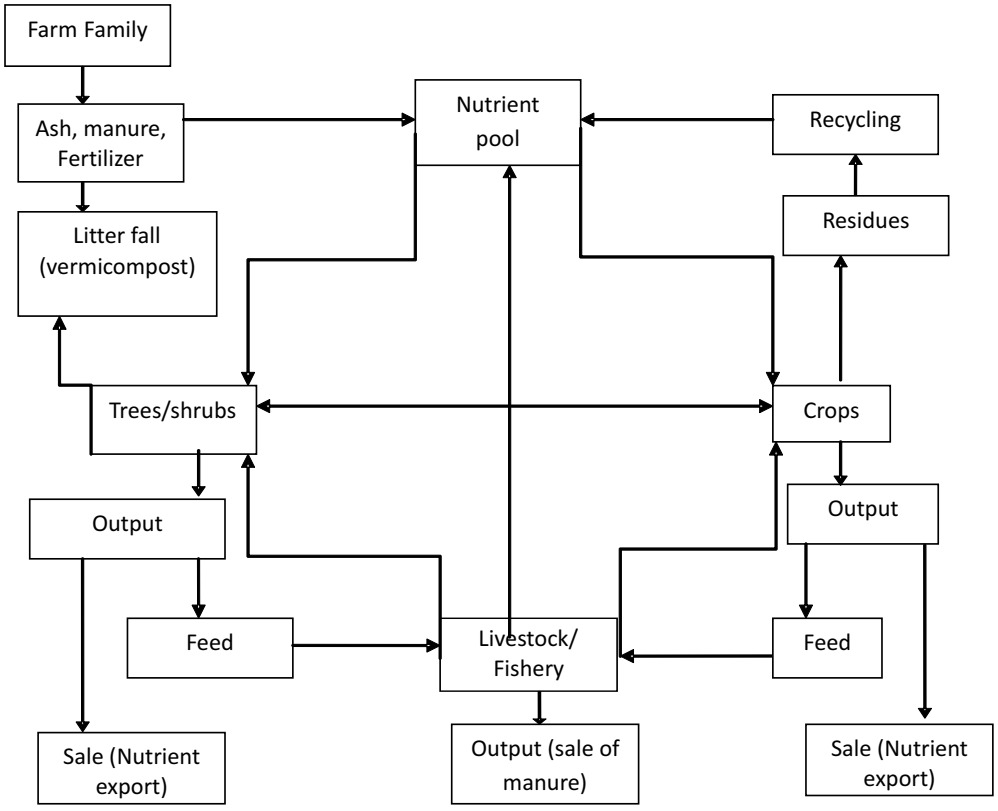

Fig.1. Nutrient dynamics under integrated farming system model

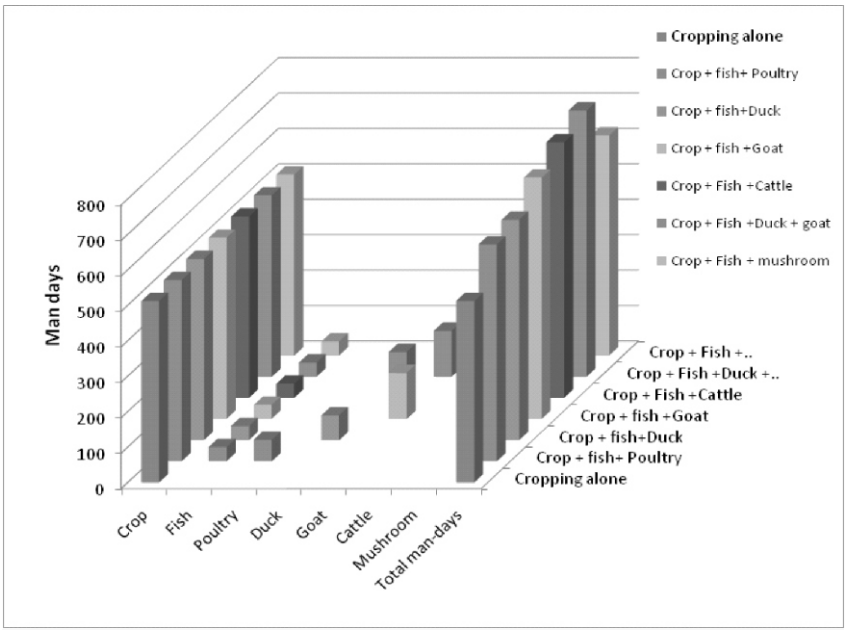

Fig. 2: Man-days requirement under different IFS system

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Integrated Water Management Under Limited Water Supply

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Abstract
Water is one of the most important inputs in agriculture. In order to feed ever increasing population of India, there is dire need to increase food production from available limited land and water resources. Since land and water are finite resources and diminishing due to indiscriminate and unscrupulous exploitation, it is required to adopt an integrated approach towards efficient utilization of natural resources keeping in view long term sustainability. It is possible if available knowledge is changed into information and along with this suitable technologies and management practices are adopted. Timeliness, quantity, quality and management aspects are given due attention and need based technologies/ policies are implemented in participatory mode with full cooperation of farmers and other stakeholders. It has been observed that integrated water management technologies/strategies are available but their suitability, accessibility and affordability are posing challenges to researchers, planners and policy makers. In this paper, review of available water management technologies has been presented and suitability has been discussed. Some recent water management technologies developed in the Institute and elsewhere have also been presented to impart updated information.

Introduction

Water is a crucial input for augmenting agricultural production towards sustainability in agriculture. Therefore, expansion of irrigation resource was given top priority in five years plans leading to creation of a cumulative irrigation potential of 101 Mha by 99-2000 out of a ultimate potential of 140 Mha. This is an achievement without parallel in the history of agricultural development anywhere in the world. No other country has attached so much attention to irrigation development as India in recent years.

Irrigated agriculture has been the ultimate choice to increase food production. But introduction of irrigation is not without problems. Water loss in conveyance and distribution has been found to be as high as 50-70 per cent and losses in water courses alone are estimated to be about 20 per cent of water delivered at canal outlet, figures far greater than what was originally envisaged. Water losses at the farm are substantial depending upon the texture and other soil characteristics, irrigation method and cropping pattern etc..Indiscriminate irrigation in several commands had led to water logging and salinity problems. In most of the canal commands, water supply is supply-driven rather than demand-driven. It has been reported that water supply is inadequate, irregular, unpredictable and untimely, resulting in wide gap between supply and demand of water. Due to this either water users don't get adequate quantity of water at appropriate time or they get water more than their requirement. Both the situations of water scarcity or water abundance create adverse impact on agricultural production.

Our country is blessed with fairly rich rainwater resource (about 115 cm per annum), but agricultural productivity of rainfed areas continues to be low and unstable. Management of rainwater assumes significance, both in low as well as high rainfall areas, for preventing rain-induced degradation and enhancing on-site and off-site agricultural productivity.

This needs sufficient attention to be paid to

adopt the cost effective, efficient and integrated water management including water management practices/technologies/strategies suiting to soil-crop-climate-socioeconomic status of the study area.

What Is Integrated Water Management

Integrated Water Management may be defined as: a process which promotes the co-ordinated development and management of water, land and other inputs in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. It is a comprehensive approach to the development and management of water, addressing its management both as a resource and the framework for provision of water services.

The term 'management' is defined as "a skilled handling of something; the executive function of planning, organizing, coordinating, directing, controlling any project or activity with responsibility for results; and judicious use of means to accomplish an end. On the basis of this definition of management, integrated water management for agriculture could therefore be interpreted to imply skilled and responsible handling of water and judicious use of it for sustainable agriculture production purpose. Sustainable agriculture includes successful management of natural resources to satisfy changing human needs while maintaining and enhancing quality of environment and conserving the resources.

Under the situation of declining per capita water availability and quality degradation, integrated water management assumes a great importance. Researchers are trying to answer questions like: how to irrigate? when to irrigate? how much to irrigate? and how to improve the water use efficiency so that with limited water resources more area can be brought under irrigation and achieve sustainable production.

HOW TO IRRIGATE?

From time immemorial it has been realized that water is just like blood to crop. Excess or much lower application of water are detrimental to crop and if water stress persists for a longer time the crop may die, so planning about methods through which water can be applied to crop becomes very important. Besides technical, physical, economic and social considerations influence the selection of irrigation system.

Irrigation Methods

There are various irrigation methods like surface irrigation methods (From traditional Border, Check-basin and furrow irrigation to Cablegation and Surge irrigation), and pressurized irrigation methods (from sprinkler, micro-sprinkler, drip, to Low Energy Precision Application (LEPA) and Low Energy Water Application (LEWA) methods). All the methods have their capabilities and limitations and can be recommended after taking into account physical, economic and social considerations.

In case of Border irrigation, depending on soil type, slope and inflow rate border dimensions have been standardized under Indian conditions. Similarly, recommended values of the area of the check basin for different type of soils and inflow streams have also been computed after experimentation. Furrow irrigation is suitable for areas with water scarcity. The size and shape of the furrows depends on the crop grown, soil type, equipment to be used and spacing between crop rows. The size and shape of the furrows can be modified widely to suit the crop planting, irrigation system, and management of saline soils and use of saline water. The crop planting on the side of the ridge gives better results for vegetable crops. The planting on the top of the ridge is preferred in high rainfall regions and planting at the bottom of the furrow is preferred in low rainfall regions.

Surge irrigation

Surge irrigation is the recent development in surface irrigation methods. Under surge irrigation, water is applied in the border intermittently and not in continuous basis. It increases the advance rate. It has been introduced and evaluated for field use. Extensive experiments covering a wide range of long furrow specifications, inflow discharges, cycle ratio and number of surges with different test crops, like

maize, sunflower, sorghum, groundnut have established the supremacy of surge irrigation over continuous flow. Palanisami (2005) reported that Surge irrigation was found to be discernible with 40 per cent water saving, 25 percent yield increase, 20 percent land saving, 40 percent labour saving (for irrigation), ease for the labour in night hours and saving of Rs. 1250 ha^{-1} on tillage. The cost increase is only marginal. The water use efficiency was highest (8.23 & 13.13 kg ha^{-1} cm^{-1}) under surge irrigation than check basin, short strip and long furrow with continuous flow.

Cablegation

The cablegation system is an advanced, automated surface irrigation method that can be easily adapted for many different types of field crops, orchards and trees. It is designed to automatically apply a predetermined quantity of water to field at a declining rate. The water application rate is designed to closely match the infiltration characteristics of soil to minimize deep percolation and run off losses. Compared to blocked-furrow irrigation method, atleast more than 50 percent water savings can be achieved. Properly designed cablegation systems can attain water application efficiencies of over 80 percent. The system requires a person to turn on the water supply and control the rate into the stilling tank. This may take about an hour. Once started, the cablegation system will irrigate the entire field automatically. Once the plug reaches the end of the pipe, the irrigation water supply is stopped. The plug is un-hooked and the rope is wound manually. Both these operations could be carried out by the farmer eliminating the need for additional labour to irrigate the field. Loam to clay-loam soils that have low infiltration rates are most appropriate for this system. The soils that reach their basic intake rate in less than 15 – 20 minutes are more suitable for this method of irrigation. The system could also be installed in soils having higher infiltration rates provided the furrow lengths are shorter than 50 m. The land slope and water flow rate to each furrow will determine the maximum length of the furrow for the particular type of soil. The aim is to minimize deep percolation losses. Cost per acre is also less (annualized cost is Rs 2500). Land that has a gentle slope between 0.1 to 0.5 per cent is more suitable. Land with higher slope can be used after the furrows are formed on benched terraces having gentle slopes.

Pressurized Irrigation Systems

Under pressurized irrigation systems, in sprinkler and micro-sprinkler irrigation, water is delivered through a pressurized pipe network to sprinklers, nozzles or jets, which spray the water into the air, to fall to the soil in an artificial “rain”. These systems, when properly spaced, give a relatively uniform application of water over the irrigated area. These systems are usually (there are some exceptions) designed to apply water at a lower rate than the soil infiltration rate, so that the amount of water infiltrated at any point depends upon the application rate and time of application, but not the soil infiltration rate. The sprinkler and micro-sprinkler works well at right operating pressure recommended by the manufacturer. The uniformity of water distribution is affected if the system is operated at higher or lower pressure and under windy conditions.

Sprinkler and micro-sprinkler irrigation systems can be used for almost all crops (except rice and jute), particularly close growing crops and on most of the soils. It is however, not suitable for fine textured soils and particularly suitable for sandy soils and undulating topography. Compared to gravity fed irrigation method water saving in Sprinkler irrigation is of the order of 20-30%. Some of the limitations of the sprinkler irrigation are high initial cost, high power requirement, clean water, stable power and water supply, and high winds, which distort the water distribution pattern.

Trickle irrigation, which may be considered as revised form of pitcher irrigation is the slow, frequent application of water to the soil though emitters placed along a water delivery line. The term trickle irrigation is general, and includes several more specific methods. In drip irrigation system the water is conveyed under pressure through pipes to the field where it drips slowly onto

the soil surface through emitters or droppers, located close to the plants.

Drip irrigation is best suited for tree, vine, and row crops. The main limitation is the cost of the system, which can be quite high for closely-spaced crops. Complete cover crops, such as grains or pasture cannot be economically irrigated with drip systems. Water saving in drip irrigation as compared to gravity fed irrigation system has been reported to vary in the range of 40-60%. Some of the limitations of drip irrigation are: high initial cost, localized water application, clogging of drippers, requirement of constant water and power supply, high level of know-how and sensitivity to damage by sun, rodents or birds, farm animals and implements. But studies of Srivastava and Upadhyaya (1998) showed that energy requirement for pumping water from varying groundwater depths for drip irrigation reduced substantially as compared to gravity irrigation system.

Recent developments in Pressurized Irrigation Systems

To overcome some of the limitations of Sprinkler, micro-sprinkler or drip system, such as high cost, high-energy requirement, need of technical expertise by user etc. various attempts have been undertaken. A brief review of work is presented below.

LEPA systems

Low Energy Precision Application (LEPA) systems (developed at Texas A&M, USA) are similar to linear move irrigation systems, but are different enough to deserve separate mention of their own. The lateral line is equipped with drop tubes and very low pressure orifice emission devices discharging water just above the ground surface into furrows. This distribution system is often combined with micro-basin land preparation for improved runoff control (and to retain rainfall which might fall during the season). High efficiency irrigation is possible, but requires either very high soil intake rates or adequate surface storage in the furrow micro-basins to prevent runoff or non-uniformity along a furrow.

LEPA type Micro sprinkler

Under AICRP on Water Management, Agronomic Research Station, Chalakudy of Kerala Agricultural University has developed a LEPA type micro-sprinkler. Visalakshi et al. (2000) reported that it is suitable to irrigate vegetable, horticultural, medicinal and ornamental plants consists of a sprinkler head made of small piece of LDPE pipe (5 to 8 cm) with diameter (8-12 mm) having nozzles of 1 mm diameter drilled on opposite sides of pipe piece, 5 mm away from both the ends, which are plugged by end caps. A hole of 4.4 mm diameter is drilled at the center of the pipe to insert the micro tube pin connector. A 6 mm diameter, 1.0 m long micro tube is attached to the above sprinkler head unit at the center through the pin connector. The other end of micro tube can then be attached to lateral, again through another pin/tap connector. The micro tube with the sprinkler head unit is tied to a riser pipe, fixed near the plant to be irrigated. Since these units are light in weight, the energy required to rotate the unit along with water is considerably small and the pressure required for operation of these units is only 0.3 to 1.0 kg/cm^2 to give discharge rate of 30-45 lph. The area of coverage varies from 3.0 to 5.0 sq. m. The life of system is expected to be 8 to 10 years and cost of this system is reported as Rs. 12,000/-per hectare.

LEWA system

Drawing lessons from LEPA Irrigation systems and considering the needs for small holder irrigation, attempts were initiated under the Team of Excellence on Pressurized Irrigation Systems, sponsored by NATP at ICAR-RCER, Patna through a project entitled “Pressurized Irrigation Systems” to develop a low cost water and energy efficient water application device. According to Singh et al. (2002) and Singh et al. (2015) LEWA device is made of 25 mm diameter and 40 cm long piece of PVC pipe having 1.5 mm diameter holes with different spacing and orientation in two opposite directions. It is characterized with high application rate, which is greater than the infiltration rate of the soil of testing site to attain high sub-surface uniformity. It

operates satisfactorily at an operating pressure of 0.4 Kg/cm^2 at its nozzle head to deliver a discharge of 0.25-0.3 lps. The throw diameter of LEWA is 6 m while measured surface uniformity values are less than 50 % (CU). Low surface uniformity can be of serious concerns during real time irrigation. Attempts are continuing to improve its performance further along with development of its system components to qualify as an irrigation technology package. LEWA with proper modification and system development can be one of the promising answers for low cost irrigation technology package especially suiting to small farm conditions.

The cost of production (in laboratory) of LEWA nozzle comprising of the rotating mechanism is estimated to be Rs. 50/-. It is very well suited to field crops such as rice, wheat, pulses, oilseeds etc. It can operate at 4-6 m of static water head stored in a storage tank also. Initially LEWA has been tested on HDPE and fixed PVC pipe networks, but considering the cost implications several quality of flexible pipes ranging from Rs. 15 – Rs. 70 per meter have been tried and initial observations reflect that due to low operating pressure requirement these pipes can be used successfully. The costs of the pipe have direct implications on its life span hence users have option to opt as per their capacity and choice. Field tests of LEWA on rice when compared with wild flooding resulted in 30 to 50 % of water and energy saving whereas on wheat it indicated 10-15 % of water saving and 30-50% of energy saving over sprinkler. Currently attempts are in vogue to improve the surface uniformity of LEWA.

International Development Enterprise (IDE) has attempted to bring variations by modifying the product manufacturing appropriate to low operating pressure requirements. Some of the variations comprise of flexible thin-walled pipe used for sub-main and laterals. The lifespan (1 to 2 years compared to 5 or more years for the regular drip system) is shorter but the costs are significantly lower.

Automation of Micro-irrigation system

An automized micro-irrigation system consists of three integral components i.e. sensors, control valves and monitoring software/decision support systems. A good quantum of work has been carried out in Maharashtra on cotton through automized drip irrigation at Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola and Marathwada Krishi Vidyapeeth, Parbhani. Taley and Shekhar (2000) presented a case study on computerized drip irrigation project for cotton –growing on large scale. At Mahatma Phule Krishi Vidyapeeth, Rahuri, an automized drip irrigation system 'Vardan' was tried in pair-row planted sugarcane. The system was controlled by solenoid valves and gypsum blocks were used as soil-moisture sensor. Luthra et al. (1997) developed an automized irrigation system wherein tensiometer was used to sense soil moisture deficit; later Luthra et al (2000) designed and developed an efficient valve control system for automation of drip irrigation and fertigation. Joshi (2000) and Reddy et al (2000) described automation in micro-irrigation, schematically. Abraham et al (2000) tried two automated drip irrigation systems based on soil electrical conductivity and leaf air temperature difference in Okra and observed that the systems maintained the designed soil moisture content and air-leaf temperature differential throughout the study period. Details of Indian experience on automized irrigation have been presented by Chaudhary and Batta (2004).

Irrigation Scheduling And Methods

After careful selection of suitable irrigation method it is important to know the time and amount of irrigation application. There may be mainly two situations: (i) when adequate water is available on demand, and (ii) when only limited water is available. In both the situations, time and depth of water application depends on soil-water-plant-atmosphere relationship. There are number of approaches like (i) Transpiration approach, (ii) Soil-water content approach, (iii) Available soil moisture depletion approach, (iv) Soil moisture tension approach, (v) Meteorological approach,

(vi) Plant indicators approach based on visual plant symptoms, plant water content and water potential, leaf diffusion resistance, plant temperature and critical growth stages of different crops. Yadav et al. (2000) reported that for most of the crops and crop sequences at various locations, information regarding critical crop growth stages and their sensitivity with respect to water and yield had been generated in the country. The most common approach of irrigation scheduling in our country is still based on the ratio of IW/CPE due to simplicity in understanding and application. For example in wheat crop IW/CPE approach was effectively employed in irrigation scheduling. The optimum IW/CPE ratios for scheduling irrigation of wheat at different locations varied between 0.60 to 1.05 and number of irrigation between 2 to 7 at various locations in the country. Optimum irrigation schedule based on meteorological IW/CPE approach in respect of pigeonpea, mungbean, blackgram and lentil are presented in Table 1. Optimum irrigation schedules through micro-irrigation for sugarcane, cotton, and horticultural crops at AICRP centers in different agro-ecological regions have been developed under AICRP on Water Management as reported by Batta et al. (2000) and presented in Table 2.

Table 1: Crop yield, irrigation water requirement, and water-use in major oilseed crops at optimum schedules of irrigation (based on IW/CPE ratio) at different locations.

Location/State	Soil type	Season	No. of irrigation (depth, cm)	Optimum IW/CPE ratio	Irrigation after interval	Yield (t ha - 1) @	Irrigation water requirement (cm)	Water use (cm)
Groundnut								
Rahuri (MS)	Black clay	Kharif	4(7)	Variable 0.4-0.9		1.92	28.0	35.0
Chiplima (Orissa)	Clay loam	Rabi	10 (6)	1.20/1.25		2.26	54.0	71.8*
Parbhani (MS)	Black clay medium clay	Rabi Summer	6(6) 14(6)	0.75/0.80 0.75/0.80		2.99 1.87	36.0 84.0	53.0* 92.0*
Mustard								
Delhi	Sandy loam	Rabi	2(6)	0.40		1.66	12.0	16.9
Kharagpur (WB)	Sandy loam	Rabi	3(6)	0.80		2.00	18.0	32.6*
Navsari (Guj.)	Black clay	Rabi	5(6)	0.80		1.24	30.0	30.0
Rapeseed								
Hisar (Haryana)	Sandy loam	Rabi	1 (7)	0.2	2.32	-	-	-
Karnal (Haryana)	Sandy loam	Rabi	1 (7)	3-4 WAS		-	-	-
Bhatinda (Punjab)	Sandy loam	Rabi	2 (7.5)	0.6 & 4 WAS	0.77	14	-	-
Sunflower								
Powarkheda (MP)	Black clay	Rabi	2(7.5)	0.60/0.65		1.58	15.0	18.1
Kota (Raj.)	Black clay	Rabi	5(6)	0.75/0.80		2.50	30.0	30.0
Belvatagi (KN)	Black clay	Kharif Rabi	4(6) 5(6)	0.60/0.65 0.90/0.95		1.06 1.39	24.0 30.0	26.0 30.0
Faizabad (UP)	Silt loam	Rabi	8(6)	1.20/1.25		0.95	48.0	57.7
Morena (MP)	Sandy loam	Spring	6(7.5)	0.75/0.80		1.47	45.0	54.8
Bilaspur (MP)	Sandy loam	Rabi	4(6)	0.75/0.80		2.29	24.0	24.5
Ludhiana (Punjab)	Sandy loam	Spring	3(7.5)	0.60/0.65		3.08	22.5	39.8*

Source: Annual Reports of All India Coordinated Research Project on Water Management for the year 1991-92 to 1996-97, Prihar and Sandu (1987), Rajput et al. (1995).

Table 2: Optimum irrigation schedules through micro-irrigation for sugarcane, cotton, horticultural crops at AICRP centres in different agro-ecological regions.

CROP	CENTRE	Irrig. Interval (days)	(%) PE	(%) wetted area	Crop/ Fruit Yield (t/ha)	(%) Yield increase over surface irrig.	(%) Water saving over surface irrig.	REMARKS
Sugarcane	**Bhavanisagar**	1	75	80	193.1	51.0	22.3	
	Madurai	3	60	80	147	14.8	29.1	
	Rahuri	1	100	80	157.3	19.7	43.2	
	(Suru Sugarcane)	1	--	--	3.08	3.0	42.3	Normal planting 1.2 x 2.1 m is superior over paired row planting.
Summer Groundnut	**Bhavanisagar**	1	80	---	3.60	31.5	46.3	Irrigation by micro-sprinkler
	Navsari	1	90	---	2.41	38.5	10.2	Irrigation by micro tubes
	Madurai	3	100	---	2.72	59.0	6.4	Irrigation by micro sprinkler. Fertilizer application partially or filly through fertigation was superior to basal application.
Banana	**Bhavanisagar**	2	@24 lit/plant	--	46.9	14.6	38.0	Effect of diff. Irrig. levels was non-significant.
	Parbhani							
	Rahuri	1	100	70	57.1	12.0	22.0	Plant Spacing 1.5 x 1.5 m
	Navsari	1	75	70	62.4	13.2	42.2	Plant spacing 1.5 x 1.35 m
Pomegranate (3 yr. Old pl.)	**Belvatgi**	1	75	60	13.9 (Kg/tree)	71.0	19.6	---
Ber (3 yr. Old pl.)	**Belvatgi**	1	75	60	15.0 (Kg/tree)	28.2	18.2	---
Acid lime	**Madurai**	Daily	50	---	71.0 (Kg/tree)	5.0	49.4	
Curry leaf	**Belvatgi**	1	50	---	17.1	26.6	34.4	Plants spacing 1 x 0.5 m
	Bhavanisagar	1	40	100	5.61	- 9.3	39.9	Effect of different irrigation treatments non significant Irrigation by micro -sprinkler gave highest WUE
Bitter gourd	**Rahuri**	1	100	---	1.80	14.0	42.0	
	Chalakudy	Daily	75	---	3.79	23.1	70.6	Irrigation through bubbler
Ridge gourd	**Rahuri**	1	100	---	2.06	17.1	59.0	
Little gourd	**Dapoli**	1	60	60	2.14	--	63.1	

In India for rice generally two types of irrigation practices for scheduling irrigation are followed. These are continuous submergence, and intermittent submergence, which include rotational and occasional submergence. Extensive field experiments have been conducted at different centers of AICRP on Water Management located throughout the country to find out optimum irrigation schedules for the two irrigation practices. Irrigation with 7 cm water 3 days after disappearance of ponded water in Kharif season saves around 35 % water without significant reduction in yield. Irrigation schedules in rice that alternate wetting and drying or saturation till tillering followed by maintenance of 5-7.5 cm of water thereafter could save 50 % of water as compared to continuous submergence without affecting the yield. In case of rainfed upland rice, deep ploughing and subsoiling across the slope help in conserving moisture in wet season, which enables enhanced root growth and extraction of soil moisture from deeper layers.

Technologies for Efficient use of Water

The efficiency of irrigation water can be increased by its judicious use on the farm. The on-farm water management including in-situ moisture conservation, reduction in seepage loss through lining material and improvement in conveyance efficiency of irrigation channels, application efficiency, scheduling of irrigation, change in crop establishment and other management practices, and multiple use of irrigation water increases the water use efficiency and crop productivity. Upadhyaya (2015) has presented challenges and opportunities in agricultural water management technologies.

In-situ moisture conservation

Use of cowpea, lantana, Daincha, paddy husk, paddy straw, grass, black polythene etc. were tried as mulch at different location under AICRP on Water Management in order to conserve in-situ moisture. Research experience has proved that use of mulch is an effective technology of in-situ moisture conservation and it helps in reducing water requirement of crop from other sources besides maintaining good crop yield.

Reduction of seepage losses through lining materials

Use of plastic sheet Silpaulin, 250 Micron thick LDPE film have been found as effective lining material over brick and cement concrete lining to control seepage from channels and ponds at Dapoli, Almora and Palampur. Undoubtedly, lining is effective in reducing the seepage loss but technical skill and precautions are required in joining and fixing of lining material to make it viable and acceptable by users.

Rain water harvesting

Maximum storage and utilization of rainwater resource reduces the irrigation cost drastically. Mishra et al., (1997) studied the effect of bund height on water, soil and nutrient conservation and rice yield under the agro-climatic conditions of Bhubaneswar. No reduction in crop yield was observed even at rainfall storage depth of 20 cm. Khepar *et al.,* (1999) have shown that increase in rainfall storage depth from 10 to 15 cm significantly reduces the depth of irrigation water applied, runoff (excess rainfall) and increase in deep percolation. The crop yield did not differ significantly under different storage depths. A simple technology to store and utilize the rainwater is to raise the bunds of about 25 cm around farmers' fields. This technology was tried in farmers' fields and following benefits were reported.

(i) Arrests the rainwater in the fields during monsoon. Allows rice crop to utilize maximum rainwater and reduces the irrigation requirement through other source of irrigation.

(ii) Arrests the soil and nutrients in the fields by minimizing the runoff. This practice does not allow soil deposition in drains resulting in increase in their bed levels and thus more water spillage and spread in the area.

(iii) Bunds help in storing the rainwater on the land surface and

replenishing the ground water below the land. This causes ground water to rise and it can be utilized for irrigation during non-monsoon period.

Surface Water Management

In surface water management, the water available at the surface through canal, tanks, ponds or other sources needs strategic planning. Upadhyaya (2002) has reported problems related to water release, allocation, distribution, and utilization in the command of Patna main Canal. The main problem in the canal commands as reported by the farmers also, is non-availability of canal water when it is required and excess flow of water when it is not required. Due to this some of the command is over-irrigated whereas others don't get water as per their requirement. In nut-shell there is a large gap between supply/ availability and demand/ requirement of water. Under such situation spatial and temporal crop water requirement in the canal command can be computed and given to Water resources department in order to inform the water users well in advance about time and quantity of water to be released from canal. If water users know about the water deficit, they can plan about meeting out this deficit through other water resources. Thus, the gap between availability and requirement can be reduced to a great extent. Singh et al (2004) reported that involvement of wider group of constituencies in water management could lead to more effective participatory water management. Through training camps, farmers may be educated and made aware about the proper utilization of available water. Upadhyaya et al. (2004 a) reported that encouragement for formation of Water Users Associations in canal commands and establishing linkages with Water resources department (Water suppliers) through frequent meetings, dialogue and discussion could help in appreciating the problems and seeking the solutions in participatory mode.

Ground Water Management

Development of rigid PVC tubewells, improved propeller pumps, improved foot valve, chain pumps for water lifting in tribal areas, efficient reflux valve, safety device against overheating of diesel engines, low cost well screens for shallow tubewells are some of the water use efficient technologies developed under AICRP on optimization of ground water utilization through wells and pumps. Proper selection, care and timely maintenance of pump, motor suction and delivery pipes and other accessories/ attachments not only improves the efficiency of the system but life of the system also increases. Singh et al (2004) reported that demonstrations through various means of communication under ICAR-DFID Project accelerated adoption of optimization of rice transplanting time. It not only improved rice-wheat productivity but also encouraged groundwater utilization in the project area. Timely raising of rice nursery using tubewell water, registered 2.5 times increase in groundwater market. Routing of pumped water for irrigation through a reservoir or tank and integrating with horticulture, fishery & livestock is another example of technological push to encourage ground water utilization for improving water productivity in the region.

Conjunctive use of water

In order to explore the possibility of conjunctive use in canal command, a simple decision support tool has been developed by Upadhyaya et al. (2004 b) in visual basic (both in Hindi and English), which is capable enough to convince the water users about conjunctive use under the situation when increase in yield leading to monetary benefit is more than additional cost incurred in providing irrigation through ground water. The tool is being tested for various situations like (i) owning tubewell, (ii) Renting pumping set and (iii) purchasing water.

For conjunctive use of saline and canal water, it has been suggested by CSSRI, Karnal that under the short supply of canal water, when the farmers are forced to pump saline ground water or drainage waters to meet the crop water requirements, water from the two sources can be applied either separately or mixed. Mixing of waters to acceptable quality for crops also results

in improving the stream size and thus the uniformity in irrigation, especially for the surface method practiced on sandy soils. Allocation of two waters separately, if available on demand, can be done either to different fields, seasons or crop-growth stages such that higher salinity water is not applied to sensitive crops or at sensitive growth stages.

Multiple uses of water

Bhatnagar et al (2004) reported that multiple use of water in waterlogged/ water stagnated area by routing the canal or ground water through a fish pond-cum-secondary reservoir and planting vegetable or fruit plants on the bunds is widely accepted technology among farmers. By weekly exchange of water, fish harvest upto 10 t/ha as additional income can be obtained. If an integrated farming system is followed in which output of one system (like excreta of animals and birds) is input to other system (fish in the pond), the nutritional value of water for fish, crops, fruits and vegetables increases resulting in increase in production and income many folds.

Integrated Water management technologies communicated by ICAR Research Complex for Eastern Region, Patna and adopted in the canal command

Some of the water management technologies communicated and adopted by large number of farmers in the canal command are:

(i) Installation of low cost wooden gates on outlets of distributary for better control on water and its efficient utilization.

(ii) Raising bund height (from 7.5-15 cm to 25-30 cm) around rice fields to conserve rainwater in their fields and reducing pressure on canal.

(iii) Advancement of rice transplanting time by 15-30 days by raising nursery in the last week of May to the middle of June and transplanting the crop between the last week of June and middle of July.

(iv) Multiple uses of water, which has been adopted by the SHGs and farmers of the project area under four situations i.e. (i) Pen culture for fish cultivation in waterlogged areas, (ii) Rice-fish cultivation in seasonally waterlogged areas, (iii) Rice-fish cultivation in irrigated areas, and (iv) fish cultivation in local depressions/ pits. This technology has not only helped the SHGs and farmers in improving their income and livelihood but their understanding has also developed.

(v) One of the recent water application devices developed at ICAR Research Complex for Eastern Region, Patna is Low Energy Water Application (LEWA) device, which operates at 0.4-0.6 kg/cm^2 pressure. It can be used for irrigating rice, wheat and other close growing crops. The developed device has resulted in reduced overall energy requirements and high water and nutrient-use efficiency of the system as compared to other pressurized irrigation systems.

(vi) Upadhyaya et al. (2015) studied the spatial and temporal variation of water under different tillage practices in wheat and reported that Zero tillage in wheat establishment saves 25 to 30 % of water in first irrigation as compared to conventional method of wheat sowing. It also saves time, energy and money.

(vii) Raised bed furrow method of wheat establishment in water scarcity area as it saves 40-45% of water compared to conventional method of wheat establishment with only 10 % reduction in yield.

(viii) Deep tillage by tractor mounted disk plough after every three years in the fields immediately after wheat harvesting not only breaks the hard layer formed below the soil, but also improves the soil structure, infiltration characteristics, soil pulverization, soil temperature and reduction in weed growth.

(ix) Boro-rice in waterlogged areas equipped with irrigation facilities.

(x) Efficient and water saving irrigation methods considering shape, size and slope of land, type of soil, crop, climate and availability of water source.

Future challenges

Since land and water resources are diminishing, the need of the hour is to utilize these resources effectively and efficiently. Only then it is possible to produce more food from the available land and water resources. To achieve this goal there is a need to focus our research efforts on the following issues

(i) Automation of irrigation systems

(ii) Development of decision support systems for judicious utilization of rain, surface and groundwater resources.

(iii) Revival of old indigenous water storage or use technologies and their integration with latest technologies

(iv) Development of cost effective water management technologies/ practices suitable for small landholders.

(v) Impact of climate change on available water resources and coping up strategies.

(vi) Factors affecting water productivity and implementation of interventions, which can improve water productivity in various agro-climatic zones.

(vii) Minimizing gap between water supply and water demand by establishing linkage between water suppliers and water users

(viii) Capacity building and training of water users and water suppliers to create awareness about use of this precious resource.

(ix) Development and transfer of socially acceptable and economically viable sustainable water management technologies in farmers field for effective implementation and upscaling in participatory mode.

Conclusions

Water saving and water use efficient technologies, which are socially acceptable, economically viable, technically feasible, environmentally harmless, psychologically impressive, easily implementable, simple, sound, and sustainable can be developed and implemented by stakeholders in participatory mode. In past many water conservation technologies have been developed and tested at the experimental farm but only few of them have been modified and up-scaled after testing at farmers' field. Thus, we have to go a long way in implementation of water saving and water use efficient technologies for judicious utilization and management of water resources in order to enhance agricultural production, and maintaining environmental, social and economic security in the country.

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Production Potential of Rice as Influenced by Crop Establishment Methods and Levels of Nitrogen Application

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Abstract
A field experiment was carried out during the*kharif*season to compare the effect of crop establishment methods and split application of nitrogen on production potential of rice under irrigated ecosystem. The treatment was comprised of methods of crop establishmenti.e. transplanting of seedlings, drum seedling of sprouted seed and direct seeding (broadcast) of sprouted seed in main plot and four split application of nitrogen i.e. ½ basal+½ PI stage, ½ basal+¼ maximum tillering + ¼ PI stage, 1/3 basal + 1/3 maximum tillering + 1/3 PI stage and ¼ basal + ¼ maximum tillering + ¼ PI stage + ¼ flowering (anthesis) stage in sub plot and replicated in thrice.Results revealed that growth parameter *viz.* plant height, dry weight, crop growth rate and relative growth rate was found to be significantly superior with transplanting of seedlings as compared to others methods of crop establishment.

Further, the grain yield (6.10 t ha^{-1}) was also found to be significantly higher with transplanting of seedlings as compare todrum seedling of sprouted seed (5.87t ha^{-1}) and direct seeding (broadcast) of sprouted seed (5.40 t ha^{-1}). With respect to split application of nitrogen, it was noted that the significantly higher growth and yield attributes was recorded with application of ¼ basal+¼ maximum tillering+¼ PI stage+¼ flowering (anthesis) stage. Therefore, it may be concluded that rice grown with crop establishment methods of transplanting the seedlings along with split application of N i.e. ¼ basal + ¼ maximum tillering + ¼ PI stage + ¼ flowering (anthesis) stage was found to be the best alternatives to the rice farming community.

Key words: Rice, crop establishment methods, N scheduling, grain yield

Introduction
Rice (*Oryza sativa* L.) is the most important cereal crop as it is a staple food for more than 70% of the world's population. That is why the rice production always holds a key role in the overall food situation of the whole world. Rice occupies an area of about 155.13 million hectare at global level with production of 596.4 million tonnes and 3.84 tonnes per hectare, respectively (Anonymous, 2003). Fortunately India ranks first in acreage and second in rice production only after china. During the year 2003-2004, India produce 87.12 million tonnes rice from 44.8 million hectare of land. About 63% of total area of the country is situated in eastern part of country covering UP, Bihar, West Bengal, Assam, Orissa and Madhya Pradesh. Among other Agronomic practices crop establishment methods considerably increase the productivity of rice. Ideal planting is important for better and efficient utilization of available plant growth resources in order to get optimum productivity of rice. It has observed that uneven plant stand due to faulty method of crop establishment favour low fertilizer use efficiency and result in poor growth and yield of rice. Although transplanting method has been found to be the best for higher productivity of rice (Jane and Samvi 1981), but it is not available preposition due to higher labour charge and availability problem for short span. Therefore, alternative must be explored. Alternatively, direct seeding in rows or broadcasting of sprouted seeds under puddled condition have been reported ideal planting method to ensure optimum population at the lowest cost (Reddy *et al.,* 1987).Positive response to nitrogen application in rice has been reported by number of researchers. However, its time of application contributes significantly towards nitrogen use efficiency and rice

productivity. Application of adequate quantity of nitrogen at right stage of the crop synchronizing well with periods of most efficient utilization that influence the growth, development and yield of rice. Nitrogen moves very rapidly in the soil and subjected to various losses mainly due to leaching, de-nitrification, volatilization and surface runoff resulting into reduced nitrogen use efficiency. To overcome this problem, split application of nitrogen is recommend and response per unit of nitrogen in rice was reported to be more when applied in split doses (Singh, 1996).

Material and Methods

Experiment was carried out at central research farm, Department of Agronomy, Sam Higginbottom Institute of Agriculture, Technology and Sciences,Naini, Allahabad, Uttar Pradesh, located at 25.28^{0}North latitude, 81.54^{0}East longitude and 98 meter altitude above the mean sea level. The experimental soil pH 7.8, organic carbon (0.36%) available Nitrogen202 kg ha^{-1}, available phosphorus 18 kg ha^{-1}, available potassium 160 kg ha^{-1}. The experimental was laid out in factorial randomized block design with twelve treatments and three replications. The treatment consists of three rice crop establishment methods viz. transplanting of seedling(CE_1), drum seedling of sprouted seed(CE_2) and direct seeding (broadcast) of sprouted seed(CE_3) and four application of nitrogen, viz. ½ basal + ½ PI stage(SN_1), ½ basal + ¼ maximum tillering + ¼ PI stage(SN_2), 1/3 basal + 1/3 maximum tillering + 1/3 PI stage (SN_3)and ¼ basal + ¼ maximum tillering + ¼ PI stage + ¼ flowering (SN_4) stage with variety NDR-359. Tillage operation in direct seeding in dry field were done directly without any primary land preparation and for direct seeding of sprouted seed through drum-seeder in puddle soil and hand transplanting consist of one cultivator, 2 puddling and 1 planking . Butachlor @ 1.5 kg ha^{-1} was applied as pre-emergence for weed control in rice and weeding was done three times, first weeding at 52 DAT/DAS and second at 71 DAT/DAS, third DAT/DAS with the help of *khurpi*. Application recommended dose of fertilizers i.e. 120 kg N: 80 kg P: 60 kg K: 25 kg Zn ha^{-1}. Nitrogen, phosphorus, potassium and zinc requirement of the crop was met with the application of urea (46%N) was applied as per treatments and when needed as per recommended treatments schedule. Single super phosphate (16%P_2O_5), muriate of potash (60%K) and full dose of zinc were applied at time of transplanting and direct seeding (broadcast) of sprouted seed. The data on crop establishment (%) , No. of tillers/m^2, dry weight, CGR, RGR, No. of grains/panical,1000-seed weight,grain yield and straw yield obtained inone year and subjected to the statistical analysis.

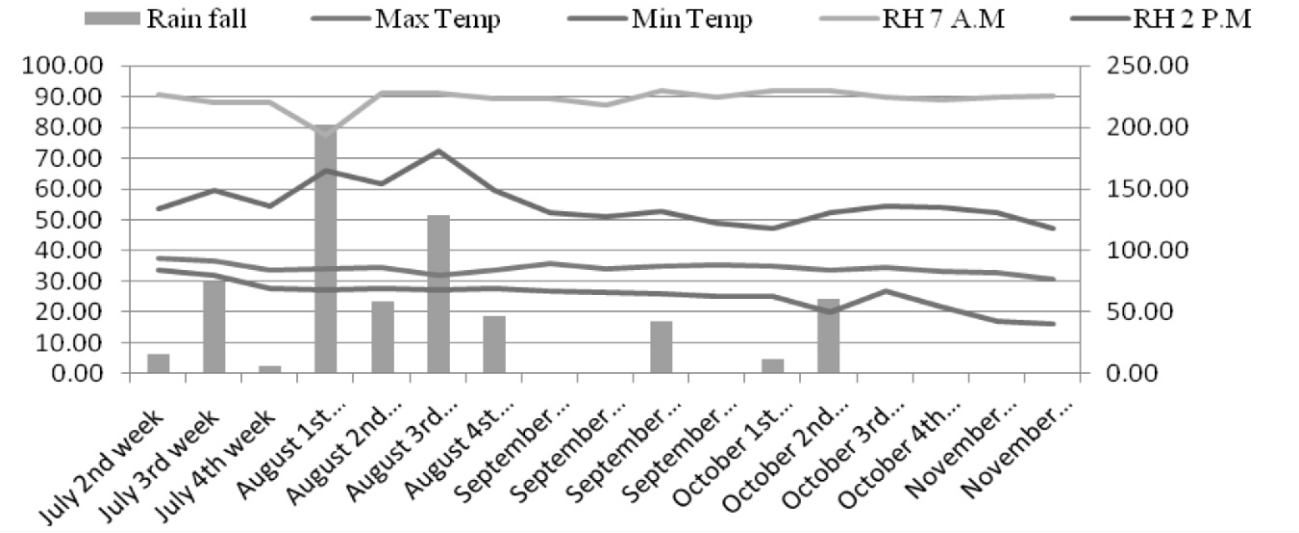

Fig 1 Monthly rainfall and mean temperature during growing seasons of the experimentation

Table 1 Effect of crop establishment methods and split application of nitrogen on growth, yield attributes and yield of rice

Treatment	Crop establishment (%)	Plant height (cm)	Tillers/ m^2(No.)	Dry weight/plant (g)	CGR	RGR	Grains/ panicle (No.)	1000-grain weight	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest Index (%)
Crop establishment method											
CE1	94.50	126.17	298	292.50	9.15	0.113	239.00	20.75	6.10	9.40	39.19
CE2	88.50	114.92	174	241.25	6.67	0.107	209.42	19.75	5.87	9.15	39.09
CE3	87.17	117.33	453	130.33	2.79	0.090	151.67	19.92	5.40	8.51	38.77
SEd±	1.24	1.29	9.13	8.86	0.004	0.001	9.42	0.37	0.11	0.17	0.14
CD(P=0.05)	2.58	2.68	18.93	18.37	0.007	0.002	19.55	0.77	0.23	0.35	0.28
Split application of nitrogen											
SN1	89.44	120.33	334	208.89	4.78	0.103	201.11	19.78	5.72	8.76	39.26
SN2	90.56	118.22	304	238.89	7.61	0.104	199.22	20.44	5.77	9.10	38.83
SN3	88.78	120.11	310	211.56	5.48	0.103	190.00	20.39	5.72	8.97	38.89
SN4	91.44	119.22	282	226.11	6.94	0.103	209.78	19.94	5.94	9.24	39.09
SEd±	1.44	1.49	10.54	10.23	0.004	0.001	10.88	0.43	0.13	0.09	0.16
CD(P=0.05)	NS	NS	21.86	21.21	0.008	NS	NS	NS	NS	NS	0.32

Table 2: Interaction effect of crop establishment methodand split application of nitrogen on rice yield

Crop establishment method (CE)	Split application of nitrogen (SN)			
	- $_1$½ basal + ½ PI stage	SN_2½ basal + ¼ maximum tillering + ¼ PI stage	$SN_3$1/3 basal + 1/3 maximum tillering + 1/3 PI	SN_4¼ basal + ¼ maximum tillering + ¼ PI stage + ¼ flowering (anthesis) stage
Transplanting of seedlings	5.80	6.00	6.10	6.50
Drum seeding of sprouted seed	5.83	5.53	6.00	6.13
CEDirect seeding (broadcast) of sprouted seed	5.53	5.80	5.06	5.20
CD (P=0.05)	0.47			

Result and Discussion

Effect of weather

The weather condition differed markedly during years of experimentation particularly with respect to rainfall. The rainfall received during 2007-08 (797.1 mm). Consequently, more number of irrigation was given to the crops during second and third year. The average temperature particularly at reproductive stages of both the crops was more conducive.

Effect of crop establishment methods

Method of rice planting was found to be significant with respect to growth attributes of rice during the experimentation (Table 1). Transplanting of rice seedlingswas produced significantly highercrop establishment (%) and plant heightas compared to other crop establishment methods. Favourable effect of rice transplanted with seedlings was due to better initial establishment and efficient cell-division and cell elongation in the meristamatic tissue (Ramaiah*et al.,* 1986). Plant dry weight, crop growth rate and relative growth rate were recorded the maximum in crop establishment methods of transplanting of seedlings closely followed by drum seeding of sprouted seed and direct seeding (broadcast) of sprouted seed.Similarly, higher leaf area index (LAI) may be associated with increase in assimilation of food material through photosynthesis on account of vigorous root and shoot growth, which ultimately lead to the higher dry matter production (Tsai *et al.,*1986).Butmaximum tillers/plantwere found higher with direct seeding of sprouted seed all over planting methods.

The yield attributes and grain yield of rice differed significantly with different establishment methods (Table 1).The crop establishment methods with transplanting of rice seedlings was found the highest grain yield(6.10 t ha^{-1}) than other crop establishment methods. However, drum seeding of sprouted seed was noted statistically at par with transplanting of seedlings. Similarly, grains/panicle and1000-seed weight was recorded the maximum in transplanting of seedlings closely followed by drum seeding of sprouted seed. However, same trained was found in straw yield and harvest index. Higher grain yield in hand transplanted rice was mainly due to higher yield attributes and better crop management practices adopted (Gopal*et al.,* 2010).

Effect of split application of nitrogen

Different nitrogen scheduling of rice had significant variation in growth attributes *viz*. no. tillers, plant dry weight and CGRduring the experimentation (Table 1). Irrespective of the split application of nitrogen in rice, significantly highest tillers/plant was recorded with application of N as ½ basal + ½ PI stage. The split application of nitrogen ½ basal + ¼ maximum tillering + ¼ PI stage was produced the highest dry weight. However, the split application of N i.e. ¼ basal + ¼ maximum tillering + ¼ PI stage + ¼ flowering (anthesis) stage was found to be statistically at par (Tsai *et al.,* 1986).The maximum crop growth rate (CGR) was recorded with split application of nitrogen as ½ basal + ¼ maximum tillering + ¼ PI

stage. However,split application of nitrogen maintained the continuous supply of nutrients, which might have favoured the crop growth (Singh *et al.,* 2006).

Application of split levels nitrogen in rice differed significantly with respect to yield attributes and yield (Table 1). However, the split application of nitrogen i.e. ¼ basal + ¼ maximum tillering + ¼ PI stage + ¼ flowering (anthesis) stagerecorded the highest grain yield (5.94 t ha^{-1}). However, the similar trend was found other yield attributes of rice *viz.*grains/panicle. The split application of nitrogen i.e. ½ basal + ¼ maximum tillering + ¼ PI stage was recorded the significantly highest 1000-grain weight. However, the split application of N i.e. ½ basal + ½ PI stage was found significantly maximum harvest index (39.26). This phenomenon may be due to the positive interaction effect of crop establishment method and split application of nitrogen for higher uptake of nutrients through better established roots, which increased the utilization of moisture and nutrients and resulting in better plant growth (Reddy *et al.,* 1987).

Interaction effect

Interaction effect was found to be significant with respect to crop establishment methods and split application of nitrogen on grain yield of rice (Table 2). The crop establishment methods i.e. transplanting of rice seedlings and split application of nitrogen i.e. ¼ basal + ¼ maximum tillering+¼ PI stage+¼ flowering (anthesis) stage was found to be significantly superior (6.50 t ha^{-1}) over rest of the treatment combinations but statistically at parwith split application of N i.e. 1/3 basal + 1/3 maximum tillering + 1/3 PI stage. This interaction may be due to the 'precision effect' of transplanting coupled with split application of N, which prevented the loss of nutrient and favourable condition for better growth and development of the crop. Similar finding were observed by Singh *et al.* (2004).

Thus, it was concluded that crop establishment methods i.e. transplanted rice through manually along with split application of nitrogen i.e. ¼ basal + ¼ maximum tillering + ¼ PI stage + ¼ flowering stage are the best management practices for higher and sustaining the productivity of rice in rice in Indo-Gangetic plains of irrigated condition of Eastern Uttar Pradesh on a long-term basis.

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Quantitative Analysis of Yield Contributing Traits and Seed Quality Parameters in Wheat (Triticum aestivum L.)

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Abstract
In the present investigation 72 exotic and indigenous genotypes of bread wheat along with three checks were evaluate during *Rabi* season, 2013-14. The experiment was conducted in Augmented Block Design having 8 blocks of plots each at Men Experiment Station farm and seed attributes tested in Seed Testing Laboratory of Seed Technology Section, Narendra Deva University of Agriculture & Technology, Narendra Nagar Kumarganj, Faizabad (U.P.). Highly significant differences were observed among the genotypic for all the seed yield traits. The phenotypic coefficient of variability (PCV) ware close to genotypic coefficient of variability (GCV) for more of the traits which indicate that environmental effect has no considerable effect on the total phenotypic variation. Vigour index showed the highest genotypic coefficient of variation followed by vigour 1000-seed weight, days to maturity and plant height. A highest estimate of both heritability and genetic advance was exerted by 1000-seed weight followed by number of tiller per plant and Vigour index. Heritability and genetic advance indicated that the nature action and reliability or those characters for selection and emerged as ideal traits for improvement through selection.
Keywords: Wheat, GCV, PCV, Heritability.

Introduction

Wheat (*Triticum aestivum* L. em.Thell.; 2n=42), a self-pollinated crop of the *Graminae* family (Sub-family *Poaceae*) and genus *Triticum*, is the world's largest famous energy rich cereal crop. It has been described as the 'King of cereals' because of the acreage it occupies, high productivity and the prominent position it holds in the international food grain trade. Globally, *aestivum* wheat is most important species which covers 90 per cent of the area. Second popular wheat being durum wheat which covers about 9 per cent of the total area while *T. diccoum* wheat and *T. monococcum* wheat cover less than the one per cent of the total area. The availability of genetic variability is the basic pre-requisite for genetic improvement through systematic breeding programme. For developing wheat varieties, indigenous and exotic germplasm is the back bone of successful breeding programme for improving yield and yields contributing traits. It is true that more diverse plant greater are the chances of obtaining high heterotic crosses and broad variability in segregating generations during genetic improvement. Selection and hybridization techniques are used for improving genetic constitution of a genotype. Selection is usually practiced for pooling favourable genes while hybridization is predominantly utilized to accumulate favourable genes in a variety for obtaining better performance for this purpose donor can be sorted out from available germplasm, because germplasm serves as valuable natural reservoir providing several better attributes. The identification of donor parent for important characters through assessment to genetic variation in the available germplasm and the information about character association are required to device a successful breeding programme.

Materials and Methods

The present study was designed to work out status of variability, heritability and genetic advance among the seventy two wheat genotypes at field experiment under present investigation was conducted during *Rabi*, 2013-14 at Main Experiment Station (MES) Kumarganj and lab experiments were conducted in Seed Testing Laboratory Seed Technology Section, N.D. University of Agriculture and Technology, Narendra Nagar (Kumarganj) Faizabad (U.P.).The experimental materials of studies comprised of 72 wheat varieties/lines/genotypes from Australian and Indian origin excluding 3 check varieties *viz*., PBW-502, HUW-234 and NW-2036. The experiment was laid out in Augmented Design. The observation were recorded on eleven different seed yield traits viz. days to days to 50% flowering, days to maturity, plant height (cm), number of tillers/plant, length of spike (cm), number of spikelets/spike, 1000-grain weight (g), seed yield/plant, seed germination (%), seedling length (cm) and vigour index. Standard statistical techniques such as analysis of variance (Federer, 1956), genotypic and coefficient of variation (Burton and de Vane 1953), estimate of broad sense Heritability (h^2b), (Hanson *et al.* 1956), and genetic advance as per cent of the mean was computed by (Johnson *et al.* 1955). The vigour index was calculated as per the method prescribed by Abdul-Baki and Anderson (1973) and expressed in whole number.

Results and Discussion

The analysis of variance revealed highly difference among the genotypes for all the eleven studied characters an indicated presence of considerable amount of variability in the genotypes (Table-1). The magnitude of environmental variance was relatively lower than the genotypic variation. It indicated that there was not considerable effect of environment on the genotypic coefficient of variability (GCV). Highest magnitude of genotypic coefficient of variation was observed for vigour index (54984.14) followed by 1000-seed weight (46.32), day to maturity (17.04) and plant height (8.79)while high value of phenotypic coefficient of variability (PCV) was estimated for vigour index followed by 1000-seed weight (47.72), day to maturity (31.19) and plant height (16.45) [Dhanda *et al.* (2004), Wani *et al*. (2011), Mehta *et al.* (2013) and Kumar *et al*. (2014)]. This indicated greater scope of obtaining high selection response for these traits owing to presence of high genetic variability. This can be ascertained from the heritability estimates in broad sense which include both additive and non-additive gen effects. Heritability in broad sense (h^2_b) and genetic advance in per cent of mean as direct selection parameters provide index of transmissibility of traits which gives indication about the effectiveness of selection in improving the characters. Highest estimates of both heritability and genetic advance was exerted by 1000-seed weight (97.07&38.02) followed by number of tillers per plant (96.76 & 38.19), vigour index (91.25 & 21.17) and seedling length (87.03 & 16.45) respectively [Singhara (2003) and Chandra *et al.* (2010)]. Heritability and genetic advance indicated that the additive nature of gene action was reliable for the characters such as 1000-seed weight, number of tillers per plant and vigour index for selection and emerged as ideal traits for improvement through selection. The most preferable genotypes having high variability, heritability and genetic advance for characters other than seed yield per plant may be used as donor parents in hybridization programme for improving the characters for which they showed high value of heritability and genetic advance (Table-2). The improvement of complex character like seed yield per plant depends upon the genetic variability, heritability and genetic advance. This suggested possibility of obtaining reasonable improvement through selection. The results suggest the possibility of improving seed yield traits through superior genotypic selection.

Characters	Source of variation		
	Blocks	Checks	Error
	D.F.(7)	D.F.(2)	D.F.(14)
Days to 50% flowering	0.327	50.560**	5.166
Days to maturity	0.950	150.500**	14.146
Plant height (cm)	0.400	78.010**	7.657
No. of tillers per plant	0.002	5.751**	0.023
Length of spike (cm)	0.006	0.650**	0.095
No of spikelets per spike	0.128	11.825**	2.518
1000-seed weight (g)	0.048	371.986**	1.399
Seed yield per plant	0.002	0.875**	0.032
Seed germination (%)	0.493	51.633**	9.177
Seedling length (cm)	0.037	31.796**	0.581
Vigour Index	325.42	445142.200**	5269.279

* and ** significant at 5% and 1% level of probability, respectively.

Table-2: Estimates of range, grand mean, phenotypic (PCV) and genotypic (GCV) coefficients of variation and genetic advance in percent of mean (G) for eleven characters in wheat

Character	Range	Grand mean $\bar{X}$	PCV (%)	GCV (%)	Genetic advance in per cent of mean (G)%)	Heritability (h^2b %)
Day to 50 % flowering	69.84-83.99	74.24 ±1.37	7.68	2.51	2.62	32.73
Day to maturity	104.24-117.80	109.50 ±1.88	31.19	17.04	5.35	54.65
Plant height (cm)	80.97-101.29	93.47 ±1.38	16.45	8.79	5.06	53.45
No. of tillers per plant	3.53-5.64	4.05 ±0.08	0.74	0.71	38.19	96.76
Length of spike (cm)	8.28-12.39	9.95 ±0.16	0.16	0.07	3.65	42.04
No. of spikelets per spike	41.87-62.58	49.97 ±0.79	3.68	1.16	2.51	31.59
1000-seed weight(g)	25.92-50.42	37.64 ±0.59	47.72	46.32	38.02	97.07
Seed yield per plant	5.11-8.52	6.12 ±0.09	0.14	0.11	10.37	76.42
Seed germination (%)	89.78-98.01	94.88 ±1.51	14.48	5.31	3.05	36.64
Seedling length (cm)	20.93-16.93	22.80 ±0.38	4.48	3.90	16.45	87.03
Vigour index	1601.68-2705.82	2164.24 ±36.30	60253.42	54984.14	21.17	91.25

The wide range of variation for different characters and comparison of means of germplasm lines using least significant differences indicating existence of very high degree of variability for all the characters in the indigenous and exotic lines of wheat. Wide spectrum of variation was observed for seed characters of seventy two wheat genotypes. High magnitude of genotypic and phenotypic coefficients of variation were observed for vigour index, indicating thereby, substantial scope for improvement in this character after hybridization and subsequent selection. The moderate estimate of GCV and PCV were observed for 1000-seed weight, days to maturity and plant height one or both parameters, which suggested possibility of obtaining reasonable improvement through selection.

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Role of Farmers Participatory Vegetable Breeding in Kashmir

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Abstract
Vegetable crops are conducting under Farmers Participatory Research Trial in Temperate regions of Kashmir Valley. The trials are designed and managed by farmers, the researchers have only advice for selection of the resource conservation technology (treatments). Farmers have full control over the selection of treatments to be used on his/her field. The main objectives of this type of research is to be established and demonstrate the benefits of resource conservation technologies like raised bed, furrow irrigated planting system, zero tillage etc. over the conventional practices. In these type of trial farmers are briefed about new practices. The participating farmers are encouraged to experiment their own and are given the full control over the selection of subset of resource conservation technologies to be tested on their fields with a view to assess farmer innovation and acceptability.

Introduction

Vegetable crops are conducting under Farmers Participatory Research Trial in Temperate regions of Kashmir Valley. The trials are designed and managed by farmers, the researchers have only advice for selection of the resource conservation technology (treatments). Farmers have full control over the selection of treatments to be used on his/her field. The main objectives of this type of research is to be established and demonstrate the benefits of resource conservation technologies like raised bed, furrow irrigated planting system, zero tillage etc. over the conventional practices. In these type of trial farmers are briefed about new practices. The participating farmers are encouraged to experiment their own and are given the full control over the selection of subset of resource conservation technologies to be tested on their fields with a view to assess farmer innovation and acceptability.

Why Participatory Crop Improvement (PCI)

Poverty in Asia is most severe in rainfed areas. Classical breeding approaches have been successful in developing improved varieties of vegetables for favourable environments. However, these approaches have been less successful for all the target environments because they fail to account for the high levels of social and agro-ecological diversity in these areas. Witcombe *et al*. (1998) report weaknesses in the formal testing system in India that have reduced the chances that rice varieties released for marginal areas would meet farmers' needs. The failure of the system is evidenced by for example, the rejection of many rice varieties by farmers, and the rapid and high adoption by farmers of such non-released varieties such as Mashuri rice that had been rejected in the formal testing. Green revolution and plant breeding techniques mostly benefit the farmers in high potential environments and those who can afford (and choose to use) inputs such as fertilizers and pesticides. But several million poor farmers in developing countries most of whom operate small farms under unstable and difficult growing conditions, in a precarious situation cannot afford to use inputs

to alter their fields to provide the growing conditions that many new varieties need or suit their requirements. The adoption of new plant varieties by this group has been hampered by the constraints of poverty and the international policies promoting an industrialized model of agriculture. As a consequence low yields, crop failures, malnutrition, poverty and famines are still widespread. On a global level despite the green revolution hunger and poverty are still widespread; about 2 billion people still lack reliable access to safe, nutritious food and 800 million of them are chronically malnourished (Reynolds and Borlaug, 2006). Plant breeding has not been as successful in marginal environments as in favourable ones because farmer's do not have their fields highly productive, demand uncommon traits as well as unusual combinations of traits where trade-off seems tricky for a breeder and varietal development and official release consumes about 15 years by which a variety almost loses its relevance, hence, many varieties released officially are never grown but many unreleased varieties are widely grown by farmers. The success of PPB should therefore be measured more by the number of new varieties produced and used in those niche environments (and the improvements they contribute to farmers' livelihoods) than by the total number of hectares sown globally to a particular variety. In Syria, where a PPB programme on barley started in 2000, 25 varieties have so far been selected, named and multiplied; each of them occupies between 5 and 25 000 hectares. Similarly, six barley varieties have been named and multiplied for their adaptation to the north-west coast of Egypt, and three varieties of barley and one of lentil are being multiplied by farmers in Eritrea. Other successful examples can be found in countries as diverse as China (maize), Nepal (rice and maize), Mali (millet), Cuba (maize, beans, rice, cassava and tomatoes) and Honduras (maize and beans). PPB provides a forum for building participants' knowledge and skill in genetic resources conservation and empowers rural institutions and farmers in community-based crop improvement and biodiversity enhancement (Sperling et al. 2001; Sthapit and Rao 2007). PPB can also be less costly to conduct than traditional breeding, due to potential savings on field testing sites, lower overhead costs and the shortening of the research period required for producing useful materials. A recent cost-benefit analysis of participatory and conventional plant breeding conducted in Syria shows that the benefit/cost ratio of PPB is 2.6 times higher than that of conventional plant breeding (Mustafa et al., 2006).

To this, the response has been the creation of a novel and promising set of research methods collectively known as Participatory Crop Improvement. Participatory means that farmers, besides others, such as consumers, vendors, industry and rural cooperatives participants are more involved in the breeding process and breeding goals as defined by farmers instead of international seed companies with their large-scale breeding programs.

Participatory Crop Improvement (PCI)

Participatory Crop Improvement (PCI) involves many stake holders in crop improvement which brings on their empowerment besides the usable end product development. Farmers' involvement in participatory crop improvement (PCI) can take many forms (Figure 1): defining breeding goals and priorities; selecting or providing sources of germplasm; hosting trials on their land; selecting lines for further crossing; discussing results with the scientists; planning for the following year's activities; suggesting methodological changes; and multiplying and commercializing the seed of the selected lines.

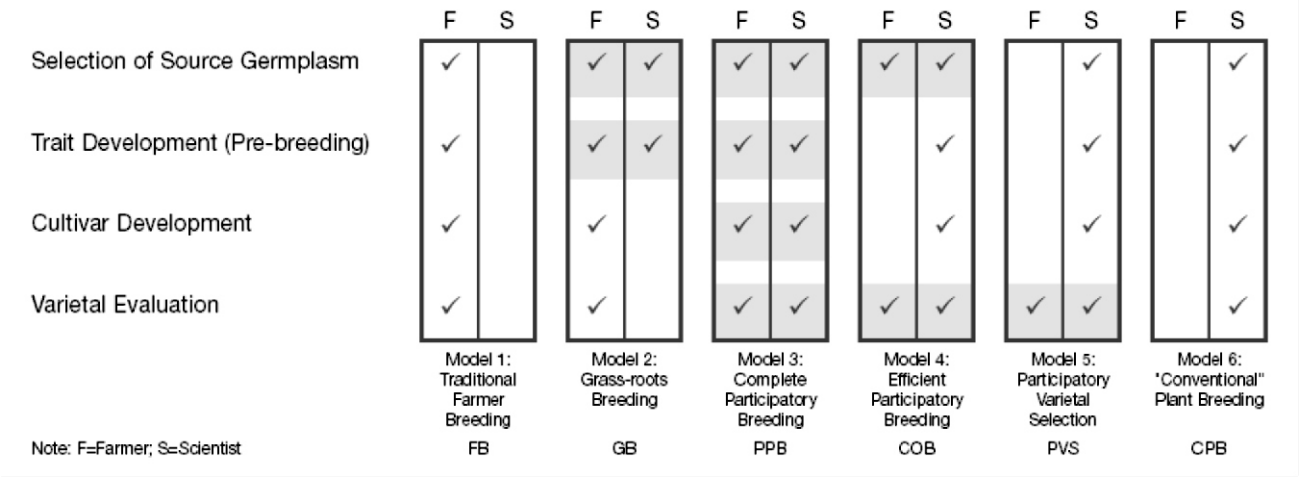

Figure 1. Various approaches to participatory plant breeding based upon stages of participation in breeding process. (Source: Modified from Morris and Bellon, 2004)

Participatory Crop Improvement approaches can be usefully categorized into Participatory Varietal Selection (PVS) and Participatory Plant Breeding (PPB). (Witcombe *et al.* 1996).

1. Participatory Variety Selection (PVS)

PVS is the selection of fixed lines (released, advanced lines or landraces) by farmers in their target environments using their own selection criteria. In PVS farmers are given a wide range of novel cultivars to test for themselves in their own fields. A successful PVS programme has four stages:

1. Participatory rural appraisal (PRA) to identify farmers' needs in a cultivar
2. A search for suitable material to test with farmers
3. Experimentation on the acceptability of this material in farmers' fields
4. Wider dissemination of the cultivars farmers prefer.

It is important to note that this process is not simply a relabelling of old techniques such as front-line demonstrations or minikits. Traditional approaches do not start with a PRA; they offer little choice in new cultivars but only the few that have been selected after years of formal trials; they tend to involve only a few farmers; and management is improved by a 'recommended package of practices' that is beyond the resources and risk-taking capacity of most resource-poor farmers. In the PSP Mother and Baby trials system all the varieties are grown in Mother trials in a one-field, one replicate design. Typically, there are about 5–6 Mother trials. Baby trials are more numerous, with each farmer growing a single entry and comparing it to his or her local variety. In the Mother trials quantitative estimates of yield are obtained, but in the Baby trials PSP simply collects farmers' perceptions on yield. One of the great strengths of PVS is that it is both an extension and a research method. For example, PVS trials in upland rice in Ghana resulted in a dramatic spread of new varieties to new villages over a single season (Craufurd *et al.*, 2002).

2. Participatory Plant Breeding (PPB)

PPB is a breeding process in which farmers and plant breeders jointly select cultivars from segregating materials under target environment. A successful PPB has the following features:

- understanding reasons for growing diverse varieties;
- identification of expert farmers with skills in managing diversity and seed selection;
- setting up breeding goals (and roles of participants) jointly to meet farmers' needs;

- use of landraces as parent materials;
- decentralized selection of segregating lines by farmers;
- use of farmers' observation and opinions;
- farmer participation at all stages of selection and evaluation;
- transfer of skills and knowledge between breeder and farmer;
- evaluation and monitoring of varietal spread by scientists;
- use of informal seed supply systems for wider dissemination.

The breeding strategy that has been followed in PSP PPB programmes involves:

1. Making a careful choice of parents (often using PVS to help identify them)
2. Making only a few crosses
3. Using a large population size in each cross
4. Selecting in the target environment with the participation of farmers
5. Employing PVS to test the products derived from the PPB programme.

The capacity of any breeding programme is limited and as more crosses are made the populations derived from sizes (Witcombe and Virk, 2001). Hence, one possible breeding strategy is to select a few crosses that are considered most likely to give desirable segregants and produce large populations from them. The use of few crosses with large population sizes is not a common strategy. Many breeding programmes use many more crosses and hence restrict the size of the F_2 populations that are evaluated. Depending on the circumstances, such a strategy may be correct. The optimum number of crosses will differ depending on how competitive the breeding is, how targeted it is to a specific environment, the type of parental material used, and whether the breeding can be considered strategic or adaptive. We now have empirical evidence that making few crosses in rice in PPB programmes is effective. The experiments, however, were not designed to make a comparison to such alternative approaches as a many-cross strategy. Nonetheless, the breeders involved in the programmes who have had experience of both few- and many-cross strategies appreciated the reduced complexity of a programme that uses fewer crosses. We assume that the most likely explanation is that F_2 and F_3 population sizes have been too small to recover and select desirable segregants.

What we have found is that PVS and PPB are used in combination. We start with PVS and that helps to identify parents, then we carry out PPB. As soon as there are products from this PPB, we test them in PVS trials. This is a continuous process because new varieties whether introduced from classical breeding programmes or from PPB, are always becoming available and can be tested by PVS.

This strategy is well suited to the constraints and advantages of PPB in that:

- PVS aids the selection of parents. It is effective in identifying locally adapted parental material and in identifying breeding goals – for example, early maturity – that assists the selection of complementary parents
- Participatory breeding programmes conducted by NGOs will not have many resources to devote to such technical processes as making many crosses
- Large population sizes are easy to deal with when grown by farmers. For example, in collaborative breeding a farmer can cost-effectively grow and select from a very large population of rice. The farmer was, in any event, going to grow rice, and if the PPB material yields adequately, costs (or benefits) are only the difference between the yield of the population and the yield that the farmer would normally have obtained from his or her own variety.

  There are two further important benefits

from farmer participation:

- Selection is carried out in the target environment (minimizing the untoward effects of genotype x environment interaction) and the selection is for traits that farmers consider important. When breeding for drought-prone environments in particular, conventional multilocational trials are difficult to analyze. Trials in the most drought-stressed environments produce many missing values and are often excluded for this reason, despite such trials being the most relevant them have to be smaller. However, theoretical considerations provide strong arguments for using large population Participatory trials do not suffer from this disadvantage. Indeed, when a variety fails in a farmer's field this gives valuable information on
- PPB generally involves a higher and more complex degree of involvement of farmers, as they are engaged in decision-making in earlier and more fundamental stages of the variety development chain; PPB therefore has a higher empowerment effect than PVS. Before proceeding, it is important to note that farmers' interests in the outcomes of PPB or PVS rarely end with the evaluation of improved materials. Farmers' ability to certify or multiply and distribute seed is directly affected in many countries by legal regulations and standard-setting bodies. PPB and PVS therefore can and should raise farmers' awareness of those regulatory frameworks and, where possible, involve farmers in efforts to influence the modification of those frameworks if they limit farmers' ability to maximize the benefits of exploiting the materials they participated in improving.

Research conducted on "Performance of Radish (*Raphanus sativus* L.) genotypes for yield and qualitative traits at experimental and farmer's field"

Radish (*Raphanus sativus* L.) is one of the most popular vegetables. It is an important winter vegetable grown all over the India. The edible portion of the crop is its fleshy root which is used as salad and vegetables while the tender leaves are used as vegetables. Besides roots and green leaves, its immature pod usually called mongra is eaten raw and also cooked as vegetable. It forms an important dietary component in day to day human food. Roots, leaves, flowers and pods of radish are effective against gram positive bacteria. However radish is low in calories, but roots and leaves are rich source of vitamin A, vitamin C, mineral and carbohydrates. The high nutritive value of radish is considered quite useful for patients suffering from piles, liver troubles, enlarged spleen and jaundice (Brar and Nandpuri, 1972). Radish roots are good appetizer. The juice of fresh leaves is useful as diuretic and laxative. In homeopathy, radish is use for neuralgic headaches, sleeplessness, and chronic diarrhoea. Besides health promoting substances, it also fits well in multiple cropping and brings lucrative returns to the farmers. Under the agro-climatic conditions of Kashmir, the main season for radish is August to September with a good quality roots being available from October to January. Under the valley conditions radish is also grown during March and April. However, during summer radish of good quality is not available particularly during May to August.

Conclusion

On the basis of findings obtained from this investigation, it can be concluded that the traits like leaf number, leaf weight, leaf width and root diameter which exhibited positive direct effects along with positive correlation with root weight as important components of root weight and selection based on these characters will result in the development of high root weight superior genotypes of radish. CO-1, Kalayani White, HK-

111, White Round, Japanese White Long and IIVR-1 were recorded to be Superior and best genotypes on farmer's field in terms of root yield and quality attributes and Anantnag Red Round and Chinese Pink were reported as better genotypes for quality attributes which may be used in future breeding programme. This strongly supports the current objectives of the farmers in this region also. The PVS programme has given the breeders a systematic way to approach the farmers. The interaction with farmers and social scientists involved in the study helped breeders and farmers develop a better understanding of the complexity of the problem.

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Technological Innovations in Manufacture and Preservations of Paneer : An Overview

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Introduction:

Paneer, the indigenous variety of soft cheese, is obtained by the acid and heat coagulation of milk at high temperatures. The phenomena of coagulation involves the formation of large structural aggregates of protein in which milk fat and other colloidal and the soluble solids are entrained with whey. Good quality paneer is characterized by a white colour; sweetish, mildy acidic, nutty flavor; spongy body and closely knit texture. Paneer is highly nutritious since it retains about 90% fat and protein, 50% minerals and 10% lactose of the original milk. It contains approx 46% total solids, 1.75% proteins, 25% fat, 2% carbohydrates and 1.5% minerals. According to the FSSAI, paneer means “product obtained from cow or buffalo milk or combination thereof, by precipitation with sour milk, lactic acid, or citric acid. It shall contain not more than 70% moisture and the fat content should not be less than 50% expressed on dry matter”. Milk solids may also be used in preparation of paneer. Bureau of Indian Standards (BIS 1983) imposed maximum of 60% moisture and minimum of 50% fat in dry matter for paneer. The demand for the value added products with paneer as the base material is growing in the urban areas. This is likely to increase the return on investment. There is a need to tap the market potential of paneer both for domestic consumption as well as export. The product technology and quality show wide variation (Rao et.al; 1992). The technology needs to be upgraded to manufacture paneer of a consistent quality at a large scale and make its merchandising attractive, convenient and economical.

Historical Perspective:

Historical paneer may be traced back to nomads of south-west Asia who were the first to develop distinctive varieties of cheese (Mathur et. al, 1986). One of the unique Iranian nomadic cheese is called 'Paneer-Khiki'. It was originally developed by the well known 'Bhakhtiari' tribe, that resided in Isfahan (in summer) and Shiraz (in winter).When salted, it is known as 'Paneer-e-Shour'. The literal meaning of word paneer (Persian) is container and that of 'khiki' is skin. Paneer is also the Hindi name of Withania coagulans, vegetable rennet that yields bitter curd. White paneer is a staple food of nomads of Afghanistan. A product similar to this, white unripened cheese, known as Kareish in Egypt, Armavir in the western Caucasus, Zsirpi in the Himalaya, Feta in the Balkans and Quesco Criollo, Quesodel Pais and Questo Llanero in Latin America (Sanders 1953). Similar products are also found in South and Central America, Mexico and the Caribbean Island (Torres and Chandan, 1981).

Manufacture of Paneer:

Acid and Heat Coagulation:

Chemical and physical change in casein and whey proteins brought about by the combined influence of heat and acid treatment, form the basis of paneer making. When milk is acidified, the

colloidal calcium phosphate in the casein micelles progressively solubilises and aggregation of the casein occurs as the isoelectric point (pH 4.6) is approached (Mulvihill and Gufferty, 1995). In milk of normal pH, the casein micelles are stabilized by hydration and steric repulsion due to their negative charge. On acidification, the micelles become unstable and aggregate as a result of charge neutralization, leading to the formation of chains and clusters that are linked together to give a three dimensional network. In milks, preheated milk interaction of whey proteins with casein micelles surface and reduce the hydration barrier against aggregation, thus allowing aggregation and gelation to occur at a higher pH than in unheated milk. Heating milk also result in dissociation of k-casein from micelles, and this would further sensitize the a-s casein framework to calcium induced aggregation.The development of typical rheological characterictics of paneer could be due to the intensive heat induced protein-protein interaction. Paneer manufacture essentially involves the formation of co-precipitates due to complexing of whey proteins denatured by heat and the casein. Serum proteins, particularly β-lactoglobin,are bonded to k-casein via disulphide bridges and calcium linkages. The higher the degree of co-precipitation, the greater will be the total solids recovery and yield of paneer.

Processing Conditions:

High heat treatment of milk improves the solids recovery, yield, flavor and body and texture characteristics of paneer. A heat treatment upto 90˚C without any holding is recommended (Sachdeva and Singh, 1988a). Coagulation of milk at 60˚C results in paneer with a very weak and loose body unsuitable for frying. Coagulation at 70˚C produces the desirable body and texture characteristic. Higher temperature of coagulation induces greater solids recovery but lower yield due to increased moisture expulsion. The optimum pH of coagulation of milk at 70˚C is between 5.30-5.35.The concentration of citric acid solution that results in the best product is 1% stronger impart hardness and cause greater solids loss.

Coagulants:

Certain non-conventional, low cost coagulants can be used in the manufacture of paneer without any loss of its yield and quality (Sachdeva and singh, 1987). These include inorganic acid like hydrochloric acid is the most economical among the chemical coagulants. The use of citric acid in naturally sourced whey reduces the requirement of citric acid and increase the solids recovery without any loss of paneer quality. Whey culture with *Lac. acidophilius* @2% and incubated overnight at 37˚C can be effectively used as a substitute for citric acid.

Incorporation of hydrocolloids:

Coagulation of milk for the manufacture of paneer is carried out at 70˚C in the conventional process. Coagulation at higher temperature results in increased solids recovery but at the same time the yield is lower because of lower moisture retention. The adverse effect on the body of paneer obtained on coagulation at higher temperature (90˚C) and thereby retaining the maximum total solids can be overcome by incorporation of certain hydrocolloids (Sachdeva and Singh, 1988b). The water binding capacity and consistency of paneer can be improved by the addition of sodium alginate (0.1%) and pre-gelatinized potato starch (0.15%). Coagulation at 90˚C with stabilizers incorporated in milk results in higher yield and imparts better body and texture characteristic in paneer, eliminating the cooling step at the same time.

Paneer from Cow Milk:

Paneer is best made from buffalo milk.

Cow milk yield an inferior product in terms of body and texture (Sachdeva et al; 1985). It is criticized to be soft, weak and fragile and unsuitable for frying and cooking. The responsible factor for this remarkable difference in paneer quality lies in the marked qualitative and quantitative difference in buffalo and cow milk itself. Buffalo milk containing considerably higher level of casein and minerals, particularly calcium and phosphorous, tends to produce hard and rubbery body while cow milk tends to produce soft and mellow characteristic. By replacing milk paneer retains higher fat, proteins and ash contents and less moisture and lactose as compared with paneer from cow's milk (Boghra and mathur, 1995). Buffalo milk and paneer there from were found to contain higher calcium, magnesium, phosphorous, citrate, copper, iron and Zinc and lower sodium, potassium and chloride contents in cow's milk and paneer there from. To make paneer exclusively from cow milk, certain modifications in the conventional procedure have to be made. Addition of calcium chloride at the rate of 0.08-0.1 percent to milk helps in getting a compact, sliceable, firm and cohesive body and closely knit texture (Sachdeva et al., 1991). In another study (Mistry et al., 1992) addition of 0.05 percent (W/V) calcium sulphate to cow milk has been recommended for better sensory scores in raw paneer. In fried paneer the sensory scores were best with 0.02 percent (W/V) added calcium sulphate. A higher temperature of coagulation (85^0c) needs to be employed when making paneer from cow milk and the optimum pH of coagulation is in the range of 5.20-5.25.

Preservation:

The relatively short life of paneer is a major handicap in the commercial adoption of paneer manufacture. The shelf life of paneer is reported to be only 6 days under refrigeration though its freshness is lost within 3 days (Bhattacharya et al., 1971). At room temperature paneer does not keep good for more than one day. The heat treatment given to milk is more than enough to destroy all the pathogenic and spoilage microorganisms. Thus it is the contamination either during or post manufacturing which is responsible for this spoilage. Paneer blocks obtained after pressing are immersed in water for cooling. It is during this period that the microorganisms establish themselves in the product and proliferate on storage later on. The dipping water is a potent source of contamination and its quality is very important.

The spoilage in paneer occurs due to the surface growth of microorganisms. A greenish yellow slime forms on the surface and the discolouration is accompanied by an off-odour. It is only the surface that gets spoiled early while the interior remains good for a longer time. To curb the surface growth of microorganisms and thereby increase the shelf-life of paneer, the following practices can be successfully adopted.

Chilling:

Rapid chilling of paneer is necessary to arrest the growth of microorganisms. Normally the producers do not see it that the temperature of paneer has been brought down sufficiently (5-10˚C) and it usually remains in the range of 20-30˚C at the time of packaging. If such paneer is transferred to a refrigerator or cold store, it takes quite some time to cool down to the desired temperature. Microorganisms get fully established by that time and cause spoilage of the product. The bacteriological quality of chilled water should also be very high.

Brining:

Paneer dipped in 5 percent brine solution lasts for nearly 20 days as against control that is spoiled after 6 days of storage at 8-10˚C. The sensory attributes are rated higher for salted samples. Since paneer is mostly salted and

spiced before consumption, the salting at the time of dipping can be advantageously used in extending the shelf life of paneer.

Use of chemical preservatives:

A shelf life of 32 days under refrigeration can be achieved when panner is treated with a combination of delvocid and hydrogen peroxide (Sachdeva and singh, 1990). Shelf life of 40 days using benzoic acid (1200 ppm) under refrigeration conditions and 20 days at 37˚C has been reported (Modi and jain, 1988). Singh et al (1989) reported a shelf life of 36 days at room temperature by adding sorbic acid to milk (0.15%) and subsequent wrapping of paneer in sorbic acid coated paper.

Freezing:

On storage of paneer at sub zero temperatures i.e.-13˚C and -32˚C for 120 days the flavor and appearance is not affected but its body and texture deteriorates and the product becomes crumbly and fluffy on thawing (Arora Gupta, 1980). Blast freezing has recently been used to enhance the shelf life of panner. The paneer block is cut into pieces of approx, 1.5 x 1.5 x 1.5 cm size and blast frozen at a temperature below-20˚C. The product can be stored under frozen conditions (below -18˚C) for more than one year without any deterioration in its quality (Punjrath et al., 1997).

Vacuum packaging:

Vacuum packaging of paneer in laminated pouches can help increase the shelf life of paneer to about 30 days at 6±1˚C (Sachdeva et al., 1991). The body and texture of paneer also improves on vacuum packaging as it becomes more compact and shows better sliceability. Paneer packaged in high film (EVA/EVA/PVDC/EVA) under vacuum and heat treated at 90˚C for one minute is reported to have a shelf life of 90 days under refrigeration (Punjrath et al., 1997).

Heat Sterilization of Paneer:

Although the refrigerated shelf life improves markedly by the various treatments given to raw panner, the shelf life at room temperature does not improve noticeably. Heat sterilization of paneer is an effective treatment for improving the shelf life of paneer at room temperature. Paneer packed in tins along with water/brine and sterilized in an autoclave at 15 psi for 15 min lasts for 4 months. The perception of an oxidized flavor renders the product unacceptable afterwards. A slight amount of cooked flavor accompanied by maillard browning, the intensity of which increases slightly during storage, is noticed.

PANEER MANUFACTURE EMPLOYING ULTRAFILTRATION

Membrane processing has a potential application in the manufacture of paneer. Ultrafiltration (UF) when employed for paneer manufacture offers advantages like access to mechanization, uniform quality, improved shelf life, increased yield and a nutritionally better product. The process developed (Sachdeva et al., 1993) involves standardization and heating of milk followed by UF whereby lactose, water and some minerals are removed. UF of milk and the removal of permeate is synonymous to removal of whey by coagulation. The concentrated mass which has about 40 percent total solids is cold acidified to get the desired pH. Till this point, the product is flowable can be easily dispensed into containers with automatic dispensing machines. The filled containers are then subjected to texturisation by microwave heating in a domestic microwave oven. The can also be achieved in a continuous process by using microwave tunnels. Such tunnels comprise of a series of magnetrons under which the product moves continuously on the conveyor belts. The resulting product has typical characteristics of normal paneer. The yield increases by about 25 percent which is due to the retention of good quality whey proteins and the

slightly increased moisture content.

In another approach, a fully mechanized process has been developed which yields a long shelf life paneer like product (Rao, 1991). Standardized buffalo milk is concentrated partly by vacuum concentration process and partly by employing UF to a level of total solids desired in the final product. After packing in metalized polyester pouches, product is formed by a texturising process at 115˚C, which permits concomitant sterilization. The process permits greater product yield due to retention of whey solids, being 35 percent as compared to 15 percent obtained by conventional batch process.

RECOMBINED MILK PANEER:

The manufacture of paneer from recombined milk is not too difficult provided appropriate modifications are made to the standard paneer making technique. The procedure for the manufacture of paneer as suggested by Singh and Kanawjia (1991) is followed (Fig.1).The recombined milk is prepared by blending skim milk powder, butter oil/cooking butter/cream and potable water. The milk is standardized to a fat and SNF ratio of 5.8 and 9.5 per cent using skim milk powder and fat from above mentioned sources. The content is homogenized at 2000 psi.The milk is kept aside for 3-4 h for complete interaction and hydration of milk constituents.

Heating and coagulation of milk:

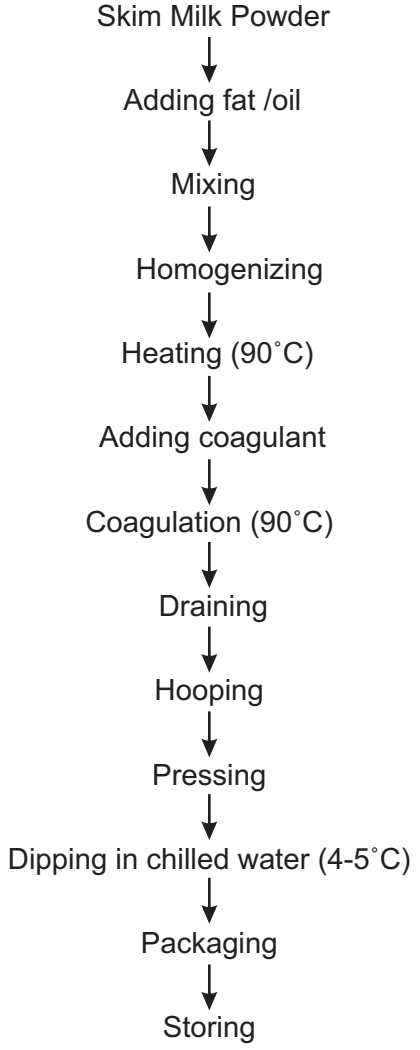
The milk is heated to 90C without holding. Prior to coagulation, 0.10 per cent calcium chloride is added to milk. The milk is coagulated using 10 percent citric acid solution heated to 90C.citric acid solution is added with continuous stirring till clear whey separate out.

Draining:

After coagulation the curd is allowed to settle down for 5 min. The whey is drained through stainless steel strainer. The temperature of the contents is not allowed to go below 70C until this stage.

Hooping and pressing:

The curd is collected and filled in hoops lined with khaddar cloth. Pressure is applied on the top of the hoop by placing a weight of 45 Kg for 10 min (0.045) Kg/sq cm). The pressed block of curd is removed from hoop, cut into 5-6 piece and dipped in plain chilled water for about 2h.



Packaging:

The chilled piece of paneer are removed from the water and placed on wooden planks for 15-20 min to drain loose water. Thereafter, the paneer is cut into required size piece and package in suitable bags. The paneer is stored at refrigeration (5-10˚C).

Table: Proximate composition of recombined and reconstituted milk paneer

Type of paneer	Moisture	Fat	Protein	FDM
Buffalo milk	55.19	23.80	17.99	53.11
Recombined Milk	57.40	22.92	16.16	53.80
Reconstituted Milk	57.30	17.40	22.80	40.50

Proximate Composition of Paneer:

The moisture is quite higher (57.40 %) in recombined milk paneer as compared to buffalo milk paneer (55.19%). Buffalo milk paneer contain relatively more fat and protein as compared to recombined milk paneer.

Reconstituted Milk Paneer:

The procedure for the manufacture of paneer from reconstituted milk suggested by Singh and Kanawjia (1992) is presented in Fig 2.The whole milk powder (WMP) is dissolve in potable water at 50 C allowed for 3-4 h and then converted into paneer. The TS content in reconstituted milk is kept higher (18-20 %TS). The purpose of increasing the TS level in milk to reduce the bulk handling and also is reduced the requirement of coagulation water energy and labour for manufacture of paneer.

Whole Milk Powder
↓
Adding water (40-50˚C)
↓
Mixing
↓
Heating (90˚C)
↓
Adding calcium chloride (0.1-0.15 %)
↓
Adding citric acid solution
↓
Coagulation (90˚C)
↓
Draining
↓
Hooping
↓
Pressing
↓
Dipping in chilled water (4-5˚C)
↓
Packaging
↓
Storing (6-8˚C)

Conclusion:

Paneer is analogous to fresh, unripe soft cheese made by heat and acid coagulation of milk. It is used as a base material for the preparation of a large number of culinary dishes and is highly nutritious and wholesome. There is a wide variation in the chemical composition and yield of paneer because it is produced in unorganized sector in very small quantities using traditional methods. Hence there is a need to adopt standard procedure for paneer preparation to conform FSSA requirements. In last few years, some of the organized dairies have taken trials to produce paneer in continuous machines on commercial scale. FSSA standards for moisture level needs to be revised and separated from channa. Shelf life limitation is also a major constraint for its large scale production as it is spoiled within 2 days at room temperature or 7–10 days under refrigeration. Using antimicrobials and natural antioxidants and vacuum packaging significantly increased the shelf life of paneer.

ABSTRACT

Crop, Seed, Nutrient, Disease and Pests Management, Livelihood Improvement through Innovative Agriculture.

1.1 ARSENIC UPTAKE AND ACCUMULATION IN RICE (*ORYZA SATIVA L.*): ITS EFFECT ON DIFFERENT RICE GENOTYPES OF EASTERN INDIA

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Arsenic (As), a ubiquitously present trace element found in both an organic and inorganic form is an environmental and food chain contaminant. Human exposure to As over a long period leads to As poisoning or Arsenicosis, which has become a major threat to public health. Apart from drinking of As-contaminated groundwater, As is also introduced in the food chain by its excessive uptake from soil by crop plants or the irrigation of plants with As contaminated water. Most of the areas of eastern India are affected with As-contamination. Rice (*Oryza sativa* L.) being the major cultivated crop of Eastern India has been found to be considerably much efficient in As uptake from soil among a number of terrestrial crop plants.

This leads to As accumulation in rice grains and may be hazardous for the individuals consuming large quantities of contaminated rice in diet. However, the mechanism of As uptake and its detoxification is not well understood in rice. Hence, there is a need to develop a better insight into the uptake and metabolism of different forms of As and their detoxification mechanism. The contrasting response of different rice genotypes may help in identifying the better performing genotypes with capability to withstand As contaminated environment. This study may also be advantageous in elucidating the mechanism associated with As-tolerance.

1.2 ENHANCEMENT OF SOIL HEALTH AND INCOME SUSTAINABILITY THROUGH RESOURCE RECYCLING THROUGH INTEGRATED FARMING SYSTEM MODELS

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Experiments were conducted at ICAR Research Complex for Eastern Region, Patna during 2007 to 2015 for the purpose of efficient farm based resource recycling, increasing land and water productivity, sustaining soil health and maintaining soil fertility, securing nutritional security and enhancing livelihood of small and marginal farmers. To achieve these objectives one acre IFS model (Crop + Goat + Poultry + mushroom) and two acre IFS model (Crop + dairy) + fish) were developed in view of midland irrigated and lowland irrigated areas where more than 80 percent farmers have an average land holding size of 0.32- 0.48 ha and could not fulfill the family needs by growing crops alone. In the developed models allocation of area under crops, livestock, fishery, horticulture and other enterprises have been made in such a way that it could fulfill the demand and needs for farm families (nutrition and income) and system (nutrient/resource recycling) at the same time. Under crop components, rice-wheat, rice maize, rice- gram and rice- mustard- moong (cereal based cropping system) and cowpea-okra- tomato, okra- cabbage- cucurbits- cabbage and okra - cauliflower - onion (vegetable based cropping systems) were followed. Pattern of nutrient recycling within the system was also studied. All around the field bunds, pigeon pea plantation were done to enrich the field bunds and to

supplement additional protein to the farm families. Under one acre model, Cowpea - cauliflower- onion cropping system along with poultry + mushroom + goatry fetched the highest net income of Rs. 76,628/annum (Rs. 210/day, B:C:: 1.5) with an initial investment cost of Rs.1,02,220**/-,** while under two acre IFS model, a net return of Rs. 1,26,160/annum (Rs. 346/day, B:C:: 1:7) was achieved with an initial investment of Rs.2,05,500. An additional employment of 67 and 197 man-days were also generated through one acre and two acre model, respectively.

Studies on nutrient recycling under one and two acre IFS model revealed that about 47.9kg of nitrogen, 38.8kg of phosphorus, 38.2kg of potassium and 65.6kg of nitrogen, 8.5kg of phosphorus and 47.7 kg of potassium were added in the soil upon resource recycling within the system, respectively. An appreciable increasing trend was also found in case of NPK and O.C. status of soil over rice- wheat cropping system where organic carbon (O.C.) was found in decreasing trend during the years of experimentation.

1.3 SUSTAINABLE DEVELOPMENT THROUGH INTEGRATED FARMING SYSTEM

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Sustainable development is development that meets the needs of the present without compromising the needs of future generations to meet their own needs. Sustainable development has three principal dimensions: economic growth, social equity and protection of the environment. Underlying the economic dimension is the principle that society's well being would have to be maximized and poverty eradicated through the optimal and efficient use of natural resources.

Agriculture plays a crucial role in sustainable development. Sustainable development in agriculture must include integrated farming system (IFS) with efficient soil, water crop and pest management practices, which are environmentally friendly and cost effective. In IFS, the waste of one enterprise becomes the input of another for making better use of resources. IFS also play an important role in improving the soil health by increasing the nitrogen, phosphorous, organic carbon and microbial count of soil and thus, reduces the use of chemical fertilizers. Moreover, IFS components are known to control the weed and regarded as an important element of integrated pest management and thus minimizes the use of weed killers as well as pesticides and thus protects the environment.

1.4 ASSESSMENT OF NUTRIENT CONTRIBUTION TO YIELD OF HYBRID MAIZE THROUGH OMISSION PLOT TECHNIQUE IN CALCAREOUS SOIL

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Maize is rapidly emerging as a favourable option for farmers in South Asia as a non-traditional component crop of rice and wheat based systems. Achievements of attainable yield are often constraints by imbalanced and inadequate use of essential plant nutrients. The availability of N, P, K and other essential nutrients in fields could be assessed by the “Omission Plots” techniques where a

particular essential nutrient is omitted from the fertilization schedule keeping the supply of other limiting nutrients in ample quantity. Therefore, the present experiments was conducted on omission plots to evaluate the nutrient response on hybrid maize and soil properties.

The experiment was conducted in calcareous soils at Research Farm, Rajendra Agricultural University, Pusa, Samastipur, Bihar (India) during *rabi* 2014-15. Nine treatment combinations *viz.* T_1 (NPKSZn), T_2 (-N), T_3 (-P), T_4 (-K), T_5 (-S), T_6 (-Zn), T_7 (Inbred variety under unfertilized check), T_8 (Inbred variety with ample NPKSZn), T_9 (hybrid variety under unfertilized check) were taken with randomised block design. In hybrid maize (DKC9081) the fertilizer was applied by fixing the target yield at 10 t/ha ($N:P_2O_5:K_2O$, 210:140:200) and in inbred maize (cv. Laxmi) at 6 t/ha ($N:P_2O_5:K_2O$, 150:70:120) through urea, triple super phosphate and muriate of potash. The sulphur was applied at 30 kg/ha through bentonite-S and Zn at 3 kg/ha through Zn-EDTA as per treatment combinations.

The grain yield of hybrid maize was found to decrease with the omissions of nutrients. The grain yield of hybrid maize and inbred maize was 9.91 t/ha and 5.90 t/ha under ample fertilized plot with NPKSZn. In general, maximum decline in hybrid maize grain yield was recorded for N followed by P, K, S and Zn omission plots. Due to omission of N, P, K, Zn and S the grain yield declined by 73.3, 29.7, 24.6, 11.8 and 16.5 percent over ample dose of NPKSZn. Under unfertilized check, the hybrid and inbred maize grain yield declined by 81.5 and 79.9 percent over ample fertilized (NPKSZn) plots.

The available nutrient in post harvest soil decreased over their initial value in accordance with target omitted nutrient. Maximum decline in availability of nutrients was recorded for N followed by K, P and Zn in target omitted nutrient plots. Application of ample dose of NPKS and Zn not only improved the yield but also improved the available nutrient status in post harvest soil.

1.5 EFFECT OF BALANCE FERTILIZERS APPLICATION ON YIELD AND ECONOMICS OF WHEAT

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Wheat is one of the most important cereals crop grown in Madhya Pradesh. It is grown in Vindhyan plateau agro climatic zone in soybean -wheat cropping system. The productivity of wheat in the state continues to be quite low on account of several biotic and abiotic stresses besides, unavailability of quality seed of improved varieties, imbalance use of fertilizers and seed sowing through broadcast or seed drill. In such situation demonstration was conducted of balanced dose of fertilizers with improved variety of wheat along with seed cum fertidrill machine on the farmer's field by KrishiVigyan Kendra against the imbalance use of fertilizers in this zone during 2008-10.Significant response on the percentage basis of all yield attributes viz. No. of effective tiller/plant, No. grains/ear, test weight (1000 grains) and yield q/ha 10.5,6.3,2.23 and 20.07 %respectively were found more in recommended practice as compared to farmers practice. The enhancement yield of wheat 20.07 % more in recommended practices over farmers practices which proves response of balance fertilization as per soil test value. Consequently farmers gain additional profit in term of monetary 7150 and 10248Rs/ha and percentage return to fertilizers 3.7 to 4.8 % during 2008-2010 which is beneficial in future to farmers and improve their standard of living as per FAI expectation.

1.6 EFFECT F ORGANIC AMENDMENTS ALONG WITH FLY ASH ON SOIL QUALITY UNDER VERTISOL (*TYPIC HAPLUSTERT*) OF INDIA

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An incubation study was conducted to characterize soil quality as affected by organic amendments (FYM, biochar and, poultry manure @ 25 t ha^{-1}) along with or without fly ash (@ 22.4 t ha^{-1}) in Vertisol. Physical and chemical parameters of soil quality like pH, EC, bulk density, porosity, moisture content, organic carbon and available N, P, K measured at the end of incubation period *i.e.* 10th week showed that combined application of soil amendments (FYM + fly ash, biochar + fly ash, poultry manure + fly ash) had significantly better results than individual application of the respective soil amendments. Soil microbial biomass carbon (SMBC) and dehydrogenase enzyme activity (DHA) increased steadily up to 6th weeks of incubation with a marginal decrease during last phase. At the end of incubation period (10th week), SMBC and DHA was highest in the soil amended with FYM + fly ash; T_5 (476.6 mg/kg of soil and 10.28 µg TPF g^{-1} soil h^{-1}). The soils treated with organic amendments particularly FYM and poultry manure along with fly ash showed best performance in terms of soil quality improvement in Vertisol.

1.7 RESPONSE OF DIVERSIFIED RICE-WHEAT CROPPING SYSTEM ON SYSTEM PRODUCTIVITY AND PROFITABILITY IN SOUTH BIHAR

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An experiment was conducted at Nalanda College of Horticulture Noorsarai, Nalanda, Bihar during 2012-13 and 2013-14 on different eight crop sequences. *viz.,* Rice-Wheat (Existing cropping system), Maize-Potato-Onion, Okra-Potato-Okra, Okra-Cabbage-Bottlegourd, Okra-Cauliflower-Spongegourd, Onion-Onion-Bottlegourd, Okra-Tomato-Cowpea and Okra-Brinjal-Cowpea. The experiment was laid down in Randomized Block Design with three replications. The soil of the experimental plot was clay loam with 7.45 pH, and 0.61% organic carbon. The available nitrogen, phosphorus and potassium was 258 kg 14.45 kg and 138 kg ha^{-1} respectively. Result of two years mean data showed that among these eight treatments, Onion-Onion-Bottlegourd recorded significantly highest rice equivalent yield (358.65 q ha^{-1}) over rest of the crop sequences. Although, Okra-Potato-Okra, Okra-Cabbage-Bottlegourd and Okra-Tomato-Cowpea recorded (290.62, 289.51 & 284.77 q ha^{-1} respectively) which was statistically at par with each other, while existing Rice-Wheat cropping system observed lowest 112.76 q ha^{-1}. The system Onion-Onion-Bottlegourd recorded maximum net return Rs. 349571 ha^{-1} followed by Okra-Tomato-Cowpea (Rs 271653) and Okra-Cabbage-Bottlegourd (252957) while existing rice-wheat system recorded lowest Rs. 110712 ha^{-1}. The benefit cost ratio varied as per the cost of cultivation in different crop sequences. Okra-Tomato-Cowpea recorded significantly higher B:C ration (3.0) followed by Onion-Onion-Bottlegourd (2.89) and Okra-Brinjal-cowpea (2.50). The maximum available N, P & K in soil after harvest was recorded in Okra-Tomato-Cowpea crop sequence with 277.52, 15.73 and 143.00 kg ha^{-1} respectively. Based on the result it is suggested that the crop

sequence Onion-Onion-Bottlegourd may be adopted by farmers for higher income per unit area while, Okra-Tomato-Cowpea as low cost income technology.

1.8 EFFECT OF PLANTING PATTERN AND NUTRIENT SOURCES ON PERFORMANCE OF MAIZE – COWPEA INTERCROPPING ON MIDHILLS OF MEGHALAYA

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To evaluate the effect of planting pattern and nutrients sources on maize and cowpea in an intercropping system, a field experiment was conducted on research farm of the College of Post Graduate Studies (CAU-Imphal), Umiam Meghalaya in split plot design with 3 replications. The treatment consists of four planting pattern (Sole maize, Sole cowpea, 1:1 maize + cowpea and 2:2 paired row maize + cowpea) and four nutrient sources (inorganic, FYM, ambrosia weed biomass and 50% through FYM + 50% through ambrosia weed biomass) allocated to main and sub plots, respectively. Yield attributes, yields and uptake of primary nutrients varied significantly in both the crops due to both the factors investigated. Highest grain, stover and biological yield of maize was recorded from sole maize which was at par with paired row planted maize but significantly higher over the maize intercropped in 1:1 planting pattern with cowpea. Maximum grain yield in maize was recorded from inorganic nutrient source which was at par with combined nutrient application through FYM and ambrosia. Pod, haulm and biological yields (t ha^{-1}) of cowpea were significantly higher in sole planted cowpea over both the intercropped planting pattern. Among nutrient sources, maximum pod and biological yield of cowpea was recorded from inorganic nutrient source which was significantly superior to all the organic sources. The effect of planting pattern and nutrient sources on nutrient uptake i both the crops was in similar line on their economic yields. Further, performance of whole intercropping system evaluated as MEY, LER and ATERs and all these differed significantly due to planting pattern. Inorganic nutrient source recorded significantly higher MEY over the organic sources and the later were at par among themselves. Sole cowpea and intercropped maize and cowpea treatments left positive impact on soil properties studied in terms of pH, soil organic carbon (SOC), available N, P and K, SMBC and DHA however, the difference was non-significant for pH, SOC, MBC and available K. All organic sources being at par among them recorded significantly higher positive impact on soil properties over inorganic nutrient source. Maximum net return and B: C ratio was obtained when cowpea was grown in between paired rows of maize and nutrient supply was shared equally by FYM and Ambrosia.

1.9 PUTATIVE INTERACTIONS AMONG *IN-SILICO* PREDICTED MIRNAS AND LNCRNAS OF PIGEONPEA (*CAJANUS CAJAN* L.)

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Pigeonpea (*Cajanus cajan* L.) is one of the most frugally significant legume crop of *Fabaceae* with enormous agricultural and therapeutic value. In plants, the majority of transcripts expressed are noncoding RNAs, ranging from short RNAs (microRNAs) to long RNAs covering up to hundreds of kb. Availability of genome sequence of pigeonpea reveals deep understanding of microRNA and long non-coding RNA. While the activities of microRNAs are destabilizer and repressor of the translation of

protein-coding transcripts (mRNAs) have been studied in detail, the impact of microRNAs (miRNAs) on long noncoding RNAs (lncRNAs) is only future. Limited number of studies referred interaction between miRNAs and lncRNAs, where lncRNAs act either as inhibitory decoys or as regulatory targets of miRNAs, but such interactions are still poorly explored. These miRNA–lncRNA regulatory paradigms control gene expression patterns cascading major cellular processes which are central to plant physiological and pathological processes. Our outcomes divulge an unconventional regulatory link between two important classes of non-coding RNAs, and advance our understanding of miRNA functions. We report and summarize the several types of microRNA–lncRNA crosstalk identified and discuss their influence on gene expression programs in pigeonpea.

1.10 IDENTIFICATION OF SUPER-EARLY MATURING PIGEONPEA GENOTYPES

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Pigeonpea, a drought tolerable crop, with a distinct advantage of having wide range of variation for maturity, leading to its adaptation to a wide range of environment and cropping system. The majority of pigeonpea-based cropping systems worldwide belong to medium (160–180 days) and long (>180 days) maturity groups. Few cultivars are of early (120–140 days) maturity group. Due to ever increasing pressure on land, there is an immediate need for intensification of cropping systems in a sustainable way. These medium- and long-duration varieties have long vegetative growth phase (120–160 days), mainly attributed to slow initial growth leading to poor productivity, less efficient utilization of land and other resources. Considering these constraints, attempts were made at NBPGR, New Delhi to identify high-yielding super early pigeonpea lines by screening selected 2000 accessions evaluated at five different locations throughout India. Of which 65 extra early accessions and more than 350 early maturing plant types were identified. The super-early lines generated in this study may also help to address photo/thermo sensitivity associated with this crop, as early pigeonpea lines tend to be less photo/thermo sensitive. These super-early lines are expected to have significance in cropping systems of global legume growing regions. This new maturity class will open new niches for pigeonpea such as wheat-based cropping systems, rice fallows, high hills and short growing environments affected by terminal drought or frost and may help in sustainable intensification of various farming systems worldwide.

1.11 STUDIES ON SEED QUALITY PARAMETERS IN CHICKPEA (*CICER ARIETINUM* L.) GERMPLASM

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Chickpea (*Cicer arietinum* L.) is the most important *Rabi* season self pollinated, diploid (2n=2x=16) pulse crop. It is belongs to the family *Fabaceae* and sub family *Papilionaceae*. Seed vigour is an important quality parameter which needs to be assessed to supplement germination and viability to gain insight into the performance of a seed lot in the field or in storage. With multi component concept rather than single seed vigour is highly complex phenomenon quantifiable property of the seed. At germination levels it not only involves speed and totality of germination but also punching power of the

seedlings at different range of environmental conditions. Above facts consideration in mind the experiment on thirty five genotypes of chickpea was carried out during 2014-2015 in Completely Randomized Design (CRD) with three replications in Laboratory. Evaluated ten seed vigour traits *viz.* 100-seed weight (g), field emergence (%), speed of germination (at field), germination, speed of germination, root length (cm), shoot length (cm), seedling length (cm), seedling dry weight (mg) and vigour index. Highly significant differences were observed among the genotypes for all the seed vigour traits.

A very strong highly significance and positive correlation of vigour index at genotypic and phenotypic level were observed with root length, shoot length, seedling length and seedling dry weight. Path coefficient analysis carried out at genotypic as well as phenotypic level, identified root length, shoot length and germination *percentage* as major direct contributors towards, vigour index. Root length, seedling length, seedling length and germination emerged as most important indirect contributors to vigour index. The characters identified above as important direct and indirect components in vigour index merit due consideration in formulating effective selection strategy in chickpea for improving overall seed quality.

1.12 NITROGEN MANAGEMENT FOR MAIZE + LEGUME INTERCROPPING IN ACIDIC SOILS

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A field experiment was conducted during *Kharif* 2014 at Research Farm of CPGS (CAU), Umiam to study the performance of maize-legume intercropping as influenced by varying levels of recommended N to both maize and intercrop legumes. The investigation consist of two intercropping systems i.e. maize-soybean and maize -groundnut intercropping with 0,75 and 100% RDN of maize to maize and 0,50,100% RDN of intercrop to intercrop and 25% RDN of maize to intercrop was applied. Application of variable RDN to maize - legume intercrop significantly varied maize plant height at 60 and 90 DAS and leaf area and LAI at 60 DAS, however, plant dry weight was differed significantly at all stages of observation. All the yield attributes and yield of maize under nitrogen treated plots were higher over control. Treatment 75% RDN of maize to maize + 25% RDN of maize (IC) to IC recorded maximum uptake of N, P and K by maize grain, stover (kg ha^{-1}) except for P uptake in stover and total K uptake which was observed at 100% RDN of maize to maize - 0 RDN of IC to IC treatment However, the yield of legume intercrops increased only upto 50% RDN of IC to IC. Maximum net return, B: C ratio and MEY was associated with different levels of RDN over control. Growth parameters and yield attributes of maize were statistically at par due to intercropped legumes at all stages of crop growth except for dry matter accumulation $plant^{-1}$ at 30 DAS and harvest stage. Soybean intercropped maize recorded significantly more stover and biological yield (t ha^{-1}) of maize over groundnut intercropped maize. All the growth and yield parameters of intercrops were significantly affected when intercropped with maize except for shelling percentage and pod yield. Intercropped groundnut recorded significantly higher uptake of total K over intercropped soybean while total uptake of N and P was non - significant between them However, maize - groundnut intercropping gave significantly higher maize equivalent yield and left more residual N in soil over maize - soybean intercropping.

1.13 LONG TERM EFFECT OF RESIDUAL ZINC AND CROP RESIDUE ON DEPTH WISE DISTRIBUTION OF SOIL AVAILABLE ZINC.

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The present investigation is a part of ongoing experiment on Long-Term Effect of Residual. Starter Zinc and Crop Residue on Sustainability of Crop Production. This experiment was started during *Kharif,* 1994. Four levels of Zn were applied once to the first crop only while crop residue of previous crop with four levels is being applied after each crop harvest. The present investigation was undertaken to adjudge the effect on 17th and 18th cropping cycle i.e., rice as 33rd and 35th crop and wheat as 34th and 36th crop under rice-wheat cropping system. The depth wise distribution of available Zn content in post harvest soil after wheat (36th) as influenced by residual effect of starter Zn and continuous incorporation of crop residue of previous crop under rice-wheat cropping system observed as the available Zn content in surface soil (0-15 cm) varied from 0.38 to 1.21 mg kg^{-1} while at 15-30, 30-60 and 60-90 cm depths, it ranged from 0.37 to 1.09, 0.36 to 1.01 and 0.30 to 0.96 mg kg^{-1}, respectively. Available Zn content in soil continuously decreased with increasing soil depth irrespective of treatment indicating that Zn was accumulated in surface soil and very less or no downward movement of Zn in soil, however the rate of decrease was more in plots receiving crop residue (0.42-1.21 to 0.33-0.96 mg kg^{-1}) than in plots receiving no crop residues (0.38-0.42 to 0.30-0.35 mg kg^{-1}) might be due to complexion of Zn with organic matter which reduce the leaching loss. There was significant variation in Zn due to different treatment at all the depth. i.e., levels of crop residues, Zn and their interaction were found significant. The Zn was recorded maximum in treatment receiving 100% of crop residue and 10 kg ha^{-1} of zinc. The available zinc in soil increased significantly with increasing levels of residual zinc (0.53 to 0.76, 0.51 to 0.70, 0.48 to 0.62 and 0.44 to 0.60 mg kg^{-1}) and crop residues (0.40 to 0.99, 0.39 to 0.93, 0.38 to 0.89 and 0.32 to 0.51 mg kg^{-1}) at all depths of soil sampling, however the availability of Zn at no crop residues and 25% crop residues were at par at all depths (0.40-0.43, 0.38-0.40, 0.38-0.89 and 0.32-0.84 mg kg^{-1}). The treatment effect was distinct with respect to zinc content throughout the depth.

1.14 ASSESSMENT OF NUTRIENT CONTRIBUTION TO YIELD OF HYBRID MAIZE THROUGH OMISSION PLOT TECHNIQUE IN CALCAREOUS SOIL

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Maize is rapidly emerging as a favourable option for farmers in South Asia as a non-traditional component crop of rice and wheat based systems. Achievements of attainable yield are often constraints by imbalanced and inadequate use of essential plant nutrients. The availability of N, P, K and other essential nutrients in fields could be assessed by the “Omission Plots” techniques where a particular essential nutrient is omitted from the fertilization schedule keeping the supply of other limiting nutrients in ample quantity. Therefore, the present experiments was conducted on omission plots to evaluate the nutrient response on hybrid maize and soil properties.

The experiment was conducted in calcareous soils at Research Farm, Rajendra Agricultural

University, Pusa, Samastipur, Bihar (India) during *rabi* 2014-15. Nine treatment combinations *viz.* T_1 (NPKSZn), T_2 (-N), T_3 (-P), T_4 (-K), T_5 (-S), T_6 (-Zn), T_7 (Inbred variety under unfertilized check), T_8 (Inbred variety with ample NPKSZn), T_9 (hybrid variety under unfertilized check) were taken with randomised block design. In hybrid maize (DKC9081) the fertilizer was applied by fixing the target yield at 10 t/ha ($N:P_2O_5:K_2O$, 210:140:200) and in inbred maize (cv. Laxmi) at 6 t/ha ($N:P_2O_5:K_2O$, 150:70:120) through urea, triple super phosphate and muriate of potash. The sulphur was applied at 30 kg/ha through bentonite-S and Zn at 3 kg/ha through Zn-EDTA as per treatment combinations.

The grain yield of hybrid maize was found to decrease with the omissions of nutrients. The grain yield of hybrid maize and inbred maize was 9.91 t/ha and 5.90 t/ha under ample fertilized plot with NPKSZn. In general, maximum decline in hybrid maize grain yield was recorded for N followed by P, K, S and Zn omission plots. Due to omission of N, P, K, Zn and S the grain yield declined by 73.3, 29.7, 24.6, 11.8 and 16.5 percent over ample dose of NPKSZn. Under unfertilized check, the hybrid and inbred maize grain yield declined by 81.5 and 79.9 percent over ample fertilized (NPKSZn) plots.

The available nutrient in post harvest soil decreased over their initial value in accordance with target omitted nutrient. Maximum decline in availability of nutrients was recorded for N followed by K, P and Zn in target omitted nutrient plots. Application of ample dose of NPKSZn not only improved the yield but also improved the available nutrient status in post harvest soil.

1.15 GROWTH AND PRODUCTIVITY ENHANCEMENT OF WHEAT AS INFLUENCE BY CROP RESIDUE MIXED FARM YARD MANURE AND FERTILIZER COMBINATIONS IN MAIZE (*ZEA MAYS* L)-WHEAT (*TRITICUM AESTIVUM* L) CROPPING SYSTEM

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Field experiments were conducted during *kharif* and *rabi* season of 2011-12 and 2012-13 at Indian Agricultural Research Institute, New Delhi to evaluate the effect of integrated nutrient management on growth and yield of wheat in maize-wheat cropping system. Our result showed that tallest plants (96.4, 90.2 cm) and highest dry matter accumulation (1283.8, 1153.4 g) were recorded at maturity with the application of 100% RDF and were significantly higher over control during 2011-12 and 2012-13, respectively. This treatment was closely followed by 37.5% RDF + 37.5% RDN + BF. Growth indices, *viz.* crop growth rate (CGR) and relative growth rate (RGR) were significantly higher due to different treatments over control, except RGR at 60-90 DAS during both the years of study. Net assimilation rate (NAR) was significantly higher with the application of different nutrient combinations over control except at 0-30 DAS and 60-90 DAS during 2012-13 and 2011-12 respectively. The maximum values of these indices were recorded with the application of 100% RDF than rest of the treatments, minimum values were recorded with the application of 75% RDF at all the growth intervals during both the years. CGR recorded a gradual increase with enhancement of growth stages with maximum values at 60-90 DAS while the RGR recorded a reverse trend in comparison to CGR. In most cases the minimum values of these growth parameters were recorded under control plot. Application of 100% RDF recorded the significantly highest grain yield (5.21 and 4.73 t ha^{-1}) over control during 2011-12 and 2012-13, respectively. This treatment was closely followed by 37.5% RDF + 37.5% RDN +BF treatment and recorded significantly higher yield over control during both the years.

1.16 MORPHO-PHYSIOLOGICAL TRAITS RESPONSE OF RICE (*ORYZA SATIVA* L.) GENOTYPES GROWN UNDER MULTIPLE STAGES DROUGHT STRESS CONDITION

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Drought is the most important constraint reducing rice yield in rainfed and poorly irrigated areas. Forty rice genotypes were evaluated under drought stress and irrigated non-stress condition in *kharif* 2015 at ICAR RCER, Patna with the objective to study the effect of multiple stages drought stress on yield and yield attributes of rice genotype. The effects of water deficit stress on various physiological and biochemical traits associated with drought tolerance were also studies at different growth stages. Result revealed that irrespective of the genotypes, there was significant reduction in grain yield of rice under drought stress condition as compare to non-stress (irrigated) condition. Among rice genotypes, IR 84899-B-179-16-1-1-1, IR83929-B-B-291-2-1-1-2, IR84899-B-183-CRA-19-1, IR 83387-B-B-27-4, IR83929-B-B-291-3-1-1, IR84894-143-CRA-17-1 and IR88964-24-2-1-4 were identified promising under multiple stages drought stress condition as compare to check varieties. Irrespective of genotypes, drought stress at various growth stages caused significant reduction in grain yield (91.7%), plant height (23.1%), plant biomass (54.5%), test weight (25%), relative water content (29.5%), photosynthetic rate (31.6%), stomatal conductance rate (31.0%), chlorophyll content (21.5%) and grain fertility (52.8 %) and increase in grain sterility percentage (67.7 %), proline content (73.8%) and transpiration rate (31.9%) in rice genotypes. Significant variation was also observed among genotypes for leaf rolling, leaf drying, stress recovery and relative water content under drought stress conditions. These drought tolerant rice genotypes can be adopted in large area in rainfed ecosystem where drought is frequent, particularly at seedling and reproductive stage.

1.17 EFFECT OF SOWING WINDOWS ON PLANT GROWTH, PHYSIOLOGY AND YIELD OF WHEAT GENOTYPES IN EASTERN INDO GANGATIC PLAIN

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Terminal heat stress is one of the major causes of low productivity in eastern region of India. The aim of present experiment was to evaluate the performance of ten wheat genotypes (HI 1563, HD 2987, Kundan, Raj 4238, GW 273, NW 1012, DBW 14, Halna, HD 2733 and HD 2967) for terminal heat stress tolerance on the basis of physiological processes (RWC, photosynthetic rate, chlorophyll, proline and TBARS content) and yield attributes at anthesis stage. Sowing was done with three replication assigning sowing time as per sowing condition of farmers of Eastern region of India (Timely sown-25 November, Late sown-20 December and very late sown-5 January) in field (plot size= 5.4 m2) having with clay loam soil. Study revealed that the RWC (%), photosynthetic rate and content of chlorophyll was goes down while the level of proline and TBARS content was

increased from timely sown to very late sown condition. Moreover, there were decline in 1000 grain weight and final yield from timely sown to very late sown condition. Although less reduction in photosynthetic rate, chlorophyll content, yield and yield contributing traits were observed in wheat genotypes HD 2987, NW 1012, Kundan and DBW 14. This finding may be of use to heat stress condition thus will boost wheat production under late sown condition.

1.18 ROLE OF NEW JUTE VARIETIES IN ECONOMIC UPLIFTMENT OF JUTE GROWERS OF WEST BENGAL

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Jute is one of the major cash crops grown as *pre-kharif* before cultivation of *Aman* paddy by small and marginal farmers of West Bengal in about 0.57 million ha. In major jute growing districts, the productivity of jute fibre is 27 quintal per ha due to non-availability of quality seeds along with other production constraints. On time availability of new jute varieties is essential to make jute cultivation more profitable because they have the potential to give fibre yield up to 35-40 q per ha. The present study was conducted to popularize new tossa jute varieties *i.e.*, JRO 204, JRO 8432, CO 58, JRO 2407, JBO 1and S19.

The present study was conducted during 2009-14 in five districts of West Bengal namely, Nadia, Murshidabad, North 24 Parganas, Malda and Hooghly. Frontline demonstrations (40 ha.) involving 93 farmers were laid out under the supervision of Scientists of ICAR-CRIJAF, Barrackpore. Farmers were provided with certified seeds of new jute varieties along with truthfully labelled seeds of JRO 524. Field demonstrations of improved varieties, across the districts enhanced the fibre productivity by 12-17%, provided timely supply of other critical inputs. Among new jute varieties, JRO 204 recorded the highest productivity (32.8 q/ha) over the predominant variety JRO 524 (28.0 q/ha) across districts. By adopting these varieties farmers have earned a net profit of Rs. 21,055 – 25,412 per ha over JRO 524 (Rs. 11,529 per ha). Infusion of quality seeds of newer jute varieties in greater quantum in prevalent seed chain can enhance the jute fibre production and productivity in the state. Also sustainable livelihood security of jute farmers may be achieved by earning more profit through use of quality seeds.

1.19 PRODUCTIVITY AND RESOURCE USE EFFICIENCY OF DIFFERENT JUTE BASED CROPPING SYSTEM UNDER NUTRIENT AND CROP RESIDUE MANAGEMENT PRACTICES

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The growing demands of food and natural fibres can only be met by intensive cultivation of crops per unit area per unit time per unit resources. To achieve these twin targets, we have to think for more productive, more efficient and remunerative intensive cropping systems, which practice sustained use of natural resources. But intensive cropping systems increased the use of inputs like fertilizers, water and energy.Rise in fertilizers price because of price of fossil fuel (energy) required for production of fertilizers (especially N and P) is increasing day by day.For crop production input energy in fertilizers operation shared higher than all other operation.Hence, we should think about other source of

nutrients which substitute fully or partially for the nutrient requirement of crop and reduce the burden on inorganic fertilizers.

A field experiment was conducted to study the effect of nutrient and crop residue incorporation on productivity jute based cropping sequencein split plot design during 2012-14. The main plot comprised of five cropping sequences *viz.,* rice-rice, jute-rice-wheat, jute-rice-baby corn-jute (for leafy vegetable), jute-rice-garden pea, jute-rice-mustard-mung bean andfour nutrient management practices*viz.* 75% recommended doses of fertilizers (RDF) with and without crop residue (rice, wheat, corn, garden pea and mung bean with their respective cropping sequence) and 100 % RDF with and without crop residue in sub plot. Jute-rice-baby corn- jute(leafy vegetable) cropping system recorded the highest system productivity (192.36q/ha) followed by jute-rice-garden pea (88.6 q/ha), water use efficiency (34.86 kg/ha-mm), production efficiency (65.9 kg/ha/day), and economic efficiency (`724/ha/day) followed by jute-rice-garden pea recorded those parameter were (89.4 q/ha), 27.01 kg/ha-mm, 30.31 kg/ha/day and `346/ha/day, respectively.The land use efficacy (94.5 %) was higher in jute-rice-mustard- mungbean followed by jute-rice-baby corn-veg. jute(93.2%). The higher system productivity of all crop sequences was recorded with 100 % RDF with crop residue. However it was at par with &5% RDF with crop residue and100% RDF. This indicated that 25% nutrients may be saved by adding crop residue in different jute based cropping sequence besidescrop residue has beneficial effect on soil quality in long run.

1.20 EFFECT OF SOWING DATES AND INSECTICIDES ON YELLOW MITE, *POLYPHAGOTARSONEMUSLATUS* BANKS INFESTATION IN JUTE WITH CLIMATE CHANGE ADAPTATION PERSPECTIVE

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Jute is an important bast fibre crop. India ranks first in area coverage and production of jute accounting for 62.00% of the world's production. Among the plethora of constraints in jute cultivation, jute faces both biotic and abiotic stresses. Among the pest complex of jute, yellow mite, *Polyphagotarsonemuslatus* is one of the important destructive pest of jute and the loss caused by *P. latus* is reported to range from 10.00-42.00% depending on the level of infestation. The changes in sowing time would affect crop-pest phenological synchrony influencing pest densities. Insecticides have been the centre of controversy for a long time and are associated with risks to human health and/ or to the environment. The experiment was laid out in a factorial RBD with three replications in both the dates of sowing *viz.,* D_1-15th March and D_2-15th April with a variety, JRO-204 in 4X3m plots with 30cm X 10cm spacing. The insecticide treatments *viz.,*dicofol 18.5 EC, fenazaquin 10 EC and abamectin 1.8 EC were used at 45 and 60 days after sowing (DAS) and the control plots were maintained without any insecticides treatment. The observation on population count of yellow mite was taken at 1 day pre-spray at 45 DAS and 3 days post treatment at 48 DAS. Similarly, 1 day pre-spray at 60 DAS and 3 days post treatment at 63 DAS on ten randomly selected plants per plot using 1cm x 1cm white hard paper quadrate with 10× magnifying glass.

The maximum increase in yellow mite population was recorded when the crop stage was at 60 days old. The infestation of yellow mite on early sown crop (15th March), the population varied from 69.92- 156.54 mites/ cm^2, 8.31-29.92, 43.17-56.26 mites/ cm^2 of leaf during 2012, 2013 and 2014 cropping season respectively. Highest yellow mite infestation of 156.54 mites/ cm^2 was observed on

early sown crop at 60 DAS during 2012 cropping season. Whereas it was 10.35 and 55.27 mites/ cm^2 during 2013 and 2014 cropping seasons respectively. The late sown crop harboured significantly less mite population i.e. 25.07, 9.48 and 38.36 mites/ cm^2 of leaf during 2012, 2013 and 2014 cropping season respectively at peak period of yellow mite infestation. In case of mite infestation the post treatment observations after 48 DAS, 63 DAS indicated significantly less number of mite in abamectin 1.8 EC (0.0015%) followed by fenazaquin 10EC (0.015%) compared to dicofol treated crop. The superiority of abamectin 1.8 EC on suppressing the mite population was prominent even at 63 DAS as compared to control treatment.

1.21 CROP-WEED ASSOCIATION IN BROWN SARSON (*BRASSICA RAPA VAR.COMPESTRIS*) IN DIFFERENT ECOLOGIES IN KASHMIR.

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A survey program was undertaken in brown sarson crop during rabi season of 2014-15 in lower and middle belts of Kashmir valley. In lower and valley areas the cropping system being followed are rice – fallow/brown sarson, while in middle areas rice/maize – brown sarson/oat fodder is followed. In higher belts only one crop is taken during *kharif*. Farmers do not follow any weed management practices in brown sarson. The survey was done as per the norms set by Directorate of Weed Research Jabalpur. The data reveals that there was no considerable difference in the composition of weed flora at different altitudes. In lower and valley areas i.e. upto 1700 meters the dominant grassy weed *Poa annua* appeared to be the dominant weed with Importance Value Index (IVI) of 14.85 followed by *Poa angustifolia* with IVI of 10.04. In the category of broad leaves *Ranunculus muricatus* appeared the dominant specie with IVI of 13.46 followed by *Ranunculus arvensis*with IVI of 11.95 and *Stellaria media* with IVI of 10.25.

In middle area i.e. between 1700-2000 m the dominant grassy weed *Poaannua* appeared to be the dominant weed with Importance Value Index (IVI) of 25.22 followed by *Poa angustifolia* with IVI of 16.85. In the category of broad leaves *Ranunculus arvensis* appeared the dominant specie with IVI of 19.79 followed by *Stellaria media*with IVI of 17.78 and *Arenaria serpyllifolia* with IVI of 10.25. These weed species mostly come up during the second fortnight of Feb. if conducive temperature is above 10 to 15^0C, otherwise they appear in the first fortnight of March when temperature is above 15^0C with adequate moisture. Hence there is need to have a post emergence control measure which may reduce the menance of weeds and boot the yield.

1.22 EFFECT OF ELEVATED CO_2 AND TEMPERATURE ON PLANT GROWTH AND PHYSIOLOGY OF WHEAT GENOTYPES INSIDE OPEN TOP CHAMBERS

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Wheat is a staple food crop of many Asian countries. Four wheat genotypes (HD 2967, HD 2733, DBW 17 and Halna) were evaluated inside open top chambers (OTCs) at ICAR-RCER, Patna, in *rabi* season 2014-15 with an objective to assess the impact of elevated CO_2 (25% higher than ambient) and temperature ($2^0C^>$ ambient) on morpho-physiological traits and yield. The treatment condition in each OTC was OTC1 (ambient CO_2; 400 ppm), OTC2 (25% higher CO_2; 500ppm), OTC3

(500ppm+2^{0}C$^>$ ambient temperature) and OTC4 (2^{0}C$^>$ ambient temperature). Results revealed that all the genotypes of wheat showed positive response with elevated CO_2 while response was negative with elevated temperature. Elevated CO_2 have positive effect in terms of physiological changes; RWC (%), MSI (%), Photosynthetic rate, chlorophyll and TSS content was improved. Genotype Halna followed by DBW 17 was least affected due to elevated temperature as compared to other genotypes. Moreover, genotype HD 2967 (4.18 t ha^{-1}) followed by HD 2733 (4.17 t ha^{-1}) response was more positive towards elevated CO_2 as compared to other genotypes of wheat studied. Finding of this study suggest that elevated CO2 has positive impact on C_3 crop (wheat) in terms of growth and yield but response was variable across the genotypes. Identification of suitable genotypes of wheat for changing climate will ensure optimum yield thus improve livelihood security in term of food availability.

1.23 IMPACT OF INCREASING TEMPERATURE AND ATMOSPHERIC CO_2 CONCENTRATION ON PLANT GROWTH, PHYSIOLOGY AND YIELD OF RICE GENOTYPES IN EIGP

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One of the pre-eminent manifestations of climate change is the increase in atmospheric CO_2 concentration and temperature. Both CO_2 and temperature are the key variables of global climate and may cause significant changes in crop productivity. An experiment was carried out inside open top chamber (OTCs) in *kharif* season 2014 to evaluate the performance of four rice genotypes under elevated CO_2 enrichment and rising temperature with four set of condition *i.e.* OTC1 (ambient condition), OTC2 (25% higher CO_2 than ambient), OTC3 (25% higher CO_2 + 2˚C $^>$ ambient temperature) and OTC4 (2˚C $^>$ ambient temperature). The study revealed that rice genotypes performed better under elevated CO_2, with slight changes in development, such as growth and in yield attributing traits, depending on the genotypes. However, the beneficial direct impact of elevated (CO_2) on crop yield can be counteract by elevated temperatures. Rice genotype IR83376-B-B-24-2 was highly responsive while IR84895- B-127-CRA-5-1-1 response was less positive toward elevated CO_2. Physiological traits like relative water content (RWC %), membrane stability index (MSI %), chlorophyll content, photosynthetic rate and TSS content were improved under elevated CO_2. However, responses of these traits were negative with elevated temperature.

1.24 IMPACT OF TERMINAL TEMPERATURE ON SELECTED WHEAT GENOTYPES OF EASTERN INDIA

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Global warming is a major limiting factor to worldwide agricultural productivity. Terminal temperature stress associated alteration in optimal environment affects wheat cultivation. However,

terminal temperature response in wheat obviously varies with its genotypic differentiation. The present study envisioned to evaluate the consequences of terminal temperature on six elite wheat genotypes (DBW14, Halna, HD2987, HD2733, NW1012 and Raj4238) under different sowing conditions (timely, late and very late) in Rabi season.Comparison of considered wheat genotypes at anthesisstage in terms of morphological, anatomical and physiological studies assisted in understanding the different strategies acquired by the plants in response to stress. Heat stress has been found to dramatically affect stem length and anatomy, tiller length, starch deposition in stem cells,pollen viability, photosynthesis rate, transpiration rate and K^+ concentration. The study also revealed diverse impact of temperature on early wheat seedlings based on the differences perceptible in overall growth, fresh weight, water content, chlorophyll content, photosynthetic capacity, transpiration rate and K^+ concentration.Proteomic analysis of the considered genotypes exhibited overexpression of the 55kDa band for heat shock protein (HSP) in tolerant genotypes with increasing stress. The combined study at seedling and matured stages successfullyindicatedNW1012 as themost tolerant genotype under heat stress followed by Halna and DBW14, whereas HD2733 and Raj4238 were the most sensitive ones.Overall the study suggested that wheat genotypes exhibited differential ability in response to temperature, thereby tolerance, which may furthercontribute in understanding the heat stress associated factors and elaborated analyses of 'omics'.

1.25 COMPREHENSIVE PHYSIOLOGICAL ANALYSIS AND ROS PROFILING IN SELECTED RICE GENOTYPES UNDER SALINITY STRESS

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Frequent occurrence of abiotic stresses has been identified as major constraints for rice production. Salinity is one of the vital factors limiting rice productivity. Salt tolerance in rice varies with genotypic diversity and growing phase with seedling stage being most susceptible towards salinity. Present study intended to evaluate the consequences of 200mM NaCl stress for varying time period (24, 48 and 72h) on selected rice genotypes [IR83373-B-B-25-3 (IR83373) and IR84895-B-127-CRA-5-1-1(IR84895)] at seedling stage and their revival ability after removal of stress. IR64; well known for its salt sensitivity was considered as standard for comparison. Variations were noticeable in different parameters involving photosynthetic performance, proline content, lipid peroxidation, K^+/Na^+ ratio. Accumulation and detoxification of reactive oxygen species (ROS) was also considered as a major determinant of salt tolerance.

Grounded on these studies, IR84895 seedlings displayed more dynamic growth, better water contentand photosynthetic performance, elevated proline and lesser malondialdehyde (MDA) level as compared to the other two genotypes. IR84895 also elucidated an increased antioxidant activity with successive intensification of salinity that might be involved in effective ROS-scavenging. Overall, IR84895 seedlings exhibited exceptional salt tolerance and recovery even after perceiving high dosage of NaCl. Another genotype IR83373 showed intermediary salt tolerance performing better than IR64 but poorer than IR84895. This study recommended IR84895 for improved crop performance in saline environments. The contrasting rice genotypes may assist in revealing the molecular basis of tolerance to salinity stress.

1.26 SOYBEAN (*GLYCINE MAX* L.) GERMPLASM EVALUATION THROUGH MORPHOLOGICAL AND QUALITY CHARACTERIZATION

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The protection of Plant Varieties and Farmers Right Authority (PPV& FRA) provide guidelines for the conduct of test for distinctiveness, uniformity and stability. In this study characterization of 13 soybean varieties was done as per DUS guidelines (PPV & FRA, 2009). The varieties were characterized 20 characters, viz. Plant growth type, days to 50% flowering, leaf shape, leaf colour, plant growth habit, flower colour, plant height(cm), pod pubescence, pubescence colour, pod shattering, days to maturity, seed size, seed hilum colour, cotyledon colour, seed oil content and seed protein content. Most of the varieties have medium height except 524 and 2008 were short type and Pusa 16, Pusa 20, Pusa 24 were tall. Green leaf colour was common as compare to dark green colour (eg 750-1, Chatkabhuj). All candidate varieties showed purple flower colour whereas, Pusa 20 and Pusa 24 have white flower colour. All varieties were early maturing type. Most of the varieties have high protein content with medium oil content except variety 2008, which have high oil content (22.7%).

1.27 CULTURAL AND PATHOGENIC VARIABILITY OF *ALTERNARIA BRASSICAE*, CAUSING ALTERNARIA BLIGHT OF RAPESEED AND MUSTARD

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India is one of the leading countries with respect to production, consumption and import in vegetable oils. In India, rapeseed-mustard (*Brassica* spp.) contributes 28.6 per cent in the total production of oilseeds. The oleiferous *Brassica* species, commonly known as rapeseed-mustard, are one of the economically important agricultural commodities. Rapeseed-Mustard crops in India are grown in diverse agro-climatic conditions ranging from north-eastern/north-western hills to down south. In India it had the area of 6.3 m ha with production of 7.6 m tonnes and productivity of 11.90 q/ha. India contributes 28.3% and 19.8% in world acreage and production. Yield gap between the potential yield and the yield realized at the farmer's field is very wide which is largely because of several diseases, which adversely affects the crop. Among diseases Alternaria blight caused by *Alternaria brassicae* (Berk.) Sacc. is one of the most common and destructive disease of Indian mustard, which causes up to 47 per cent yield loss. Lack of resistant varieties indicates the presence of several variants in the pathogen. Information on cultural and pathogenic variability of *A. brassicae* population in India are meagre. A comparative knowledge of the nutritional patterns and factors influencing its growth are prerequisite to any study leading to the understanding of host-pathogen relationship and specificity. Alternaria blight severity on rapeseed-mustard differs among seasons and regions as also between individual crops within a region. This may be due to existence of variability among isolates of Alternaria species. Special attention was focused on cultural and pathogenic variability among seven isolates of *Alternara brassicae* collected from different geographical location of India. Affected leaves samples were collected from eight different places for the isolation and purification of pathogens and to study their cultural and pathogenic variations. The fungal colonies of different isolates of *A. brassicae* varied

in their cultural behaviour ranging from fluffy to compressed, with wavy, smooth to rough margins. Colonies colour varied from black, brown, light brown to dark brown and growth was either slow, medium or fast on different culture media. Among the media in general, the maximum growth of each fungal isolates were recorded on PDA as compare to others; while slowest growth was recorded on radish root agar medium.

The maximum mycelial growth of 89.93 mm was recorded in the isolate obtained from Pantnagar on PDA while, minimum growth (32.40 mm) was noted on radish root agar medium of Madhya Pradesh isolate. All the isolates were found pathogenic in nature on different *Brassica* spp. Average maximum per cent disease intensity of isolates was recorded on *B. campestris* var. yellow *sarson* (69.70) followed by *B. juncea* (61.90) and was *B. nigra* (57.33), while it was minimum in *B. carinata* (18.33) and *B. napus* (16.50). The conidial length, width, beak length, transverse and longitudinal septation ranged between 102.68 to 141.50nm; 11.10 to 15.80nm, 49.50 to 67.55nm, 6.25 to 9.25nm, 0.75 to 1.75nm in different isolates. The maximum conidial length, width, beak length, transverse and longitudinal septation was recorded in Pantnagar, Uttrakhand isolate and minimum in raipur, Chattishgarh. Isolates obtained from Uttrakhand showed highly virulent reaction on *B. campestris,* isolate Chattishgarh were less virulent. None was recorded avirulent.

1.28 SCREENING OF PROMISING GENOTYPES OF RICE (*ORYZA SATIVA* L.) AGAINST *RHIZOCTONIA SOLANI* KUHN.

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Rice is one of the most important cereal crops of the world. In India it occupies an area of 42.86 million hectares with production of 95.97 million tonnes, and productivity of 2.239 tonnes ha^{-1}. It contributes 20.25 per cent of agricultural G.D.P. This crop is attack by many diseases caused by fungi, bacteria, viruses, nematodes and several physiological disorders which caused annual loss of 12 to 25 per cent of the total production, while fungal diseases alone caused annual damage of 12 to 20 per cent of its production. Among these diseases, the sheath blight caused by *Rhizoctonia solani* Kuhn. earlier considered as minor disease is now regarded as an internationally important. The pathogen mainly infect leaf sheath but symptoms may be produced on any aerial part of the rice plant. Thus, sheath blight caused by *Rhizoctonia solani* Kuhn. is most economically important disease and have possessed challenge to the farmers for successful cultivation of rice and ultimately to the plant pathologists. Keeping this fact in view, to find out resistant/tolerant germplasm against the causal pathogen, screening was under taken in field as well as laboratory conditions. Out of 108 germplasm, screened under natural as well as under artificial inoculated condition, none of the entries were found immune or resistant. However, forty five entries *viz.,* Ramkajra, Baigani black, Beni, Prasada, Narendra-118, Narendra-97, Aswani, madhuri, Sawani, IET-14807, Pant Dhan-11, Gajgour, IET-16711, Karahni, Dalkachari, Bagri, Rambli-AS, Motiforam, Ram bhog, Kaland, Aktahwa -R, Lalkawa, Tulsi, IR-36, Suggapankhi, IET-16706, basti cul-9, Aktahwa- FIO, CR-1446, Sonachoor, Aktahwa, Bansfool, Saket-4, IR-24, NDR-359, NDR-637, Pant Dhan-4, NDR-330, Gajgour, T-182, IET-16705, Pusa-33, Akasi, IR-8, Saryukushmaha were found moderately resistant, 37 moderately susceptible and fourteen were observed susceptible. Rest of the entries showed highly susceptible reaction. Under artificial inoculated condition, out of 82 entries, none of the entry was found resistant. Only two entries *viz.,* Baigani black and Prasada showed moderately resistant reaction, seventeen moderately susceptible and twenty seven entries susceptible. Rest of the entries was found highly susceptible.

1.29 PROVIDING MANAGEMENT OPTIONS FOR FOLIAR BLIGHT DISEASE OF WHEAT IN NORTH EASTERN PLAIN ZONE OF INDIA

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Foliar blight is the most serious constraint to wheat yields in Eastern Plain Zone of India. The disease occurs either singly or as a complex of spot blotch [*Bipolaris sorokiniana* (Sacc.) Shoem.] and tan spot (*Pyrenophora tritici repentis*). A field experiment was conducted on the integrated management of major diseases in wheat through different combinations of balanced fertilization, and limited use of chemical fungicides (as seed treatment and foliar spray) and simultaneously, to observe their role in augmenting the grain yield and its attributes at IARI Regional Station, Pusa, Bihar (India) during 2012-13 and 2013-14.

The seed treatment with vitavax power was found better in term of field emergence and seedling blight. Balanced fertilization and seed treatment with vitavax power plus two foliar sprays of propiconazole resulted in least foliar disease severity along with highest yield significantly and its attributes in comparison to control. The findings of this investigation have important implication for management of major wheat diseases through the integration of balanced fertilization and seed treatment along with restricted use of fungicidal spray in NEPZ of India. The farmers of this region should adopt integrated approaches for the sustainable management of wheat diseases along with higher yield and productivity of the crop.

1.30 CONTROL OF PAPAYA DISORDERS AND DISEASES THROUGH BALANCED NUTRIENT APPLICATION AND COMMON PRACTICES IN NEPZ OF INDIA

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The investigations were carried out at Indian Agricultural Research Institute, Regional Station, Pusa, Samastipur (Bihar). Several physiological disorders such as bumpy fruit, deformed/discolored seeds occurred on papaya fruit and plants in North Eastern Plains Zone (NEPZ) of India leading to heavy economic yield losses. This anomaly bumpy fruit initially starts on the epidermis of young fruits, but symptoms become more severe on the mature fruits at ripening stage and check the fruit growth. Boron deficiency is a major production constraint of quality papaya cultivation under alkali (sandy loam) soils of NEPZ. Basal application of borax (as disodium octaborate tetrahydrate) @ 5.0 g/plant was found most effective for management of fruit bumpiness. Systematic field screening and surveys were conducted in the farmer's field and to observe the severity of this disorder. Despite the fruit deformity, root rot disease occurs as major serious problem in this region may also lead to unpredictable incidences in field ranging from10 to 100% in a single growing season. Symptoms in young trees include yellowing and collapse of leaves resulting in a soft, wet rot of the tap root which often extends into the trunk. In trees of bearing age, the tap root and lateral roots become severely decayed causing plants to topple down after fungal infection and plant die suddenly within 2-3 days. Papaya cultivar 'Pune Selection-3' was found most sensitive for these disorder and root rot disease, while Pusa Dwarf was tolerant. Integrated approaches including cultural control methods such as crop rotation, soil amendments, mulching along with fungicides and bioagents have played a role in the management of

papaya diseases which can protect the farmer's papaya orchard in NEPZ of India.

1.31 EFFECT OF PLANT EXTRACTS AGAINST *ALTERNARIABRASSICAE* (BERK.) SACC.OF INDIAN MUSTARD [*BRASSICA JUNCEA* (L.) CZERN.&COSS]

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Alternaria blight caused by *Alternariabrassicae* (Berk) Sacc. is one of the most virulent on all brassicaceous plants and cause adverse effect on both quality and quantity of the crop.Six plant extract *viz*., Datura (*Daturastramonium)*, Eucalyptus (*Eucalyptus globulous*), Karang (*Pongamiaglabra*),Neem (*Azadirachtaindica*), Madar (*Calotropis gigantean)* and Wild sage (*Lantana camara)* were evaluated *in-vitro* by poison food technique @ 3, 6, 9 and 12% concentrations against *Alternariabrassicae*causing blight of mustard.The inhibition of growth and spore germination of the fungus increased with the increase in concentration of the test plant extracts. The results revealed that all the plant extracts inhibited the percent growth inhibition against test fungus as compared to control. However *A. indica* was found most efficacious with growth inhibition of (38.7%) followed by *E. globulus* (36.7%). Some extract such as *P. glabra* and *D. stramonium* showed moderate inhibition over control (30.9 and 21.6 respectively). Among all plant extract, *C. gigantean* showed least (15.3%) inhibition over control against *A. brassicae*. These plant extracts can possibly be used as management of seed-borne pathogenic fungi in an eco-friendly way.

1.32 IN-VITRO EVALUATION OF BOTANICALS AGAINST SCLEROTINIA BLIGHT OF MUSTARD INCITED BY *SCLEROTINIA SCLEROTIORUM*.

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Indian mustard (*Brassica juncea* (L.) Czernj. Cosson) is also known as Rai or Laha belong to Brassicaceae and Centre of origin Mideterian. Rapeseed- Mustard are the world's third most important sources of vegetable edible oil. Sclerotinia blight disease is a necrotrophic pathogen with worldwide distribution known to infect over 400 species of plants (Boland and Halls, 1994). In India, Sclerotinia blight was reported from Pusa (Bihar) in1915. Sclerotinia blight earlier was considered as minor problem but it has become serious problem of most mustard growing areas. Infection and symptoms of Sclerotinia rot are visible after flowering. Sclerotinia infection may be observed as individual plants scattered throughout the field, or in patches in the field where moisture was greatest. Lodged crops are more susceptible to Sclerotinia mold development. There by, for the management of this disease the in-vitro botanical were evaluated in the form of crude extract @ 20% against *S. sclerotiorum*. The fungal growth was reached at 7th day after inoculation. Experiment resulted that *Allium* sativum, *curcuma longa* and *zingiber officinale* were found most effective followed by *Azadirachta indica* (50.33 mm) *Allium cepa*,(28.30 mm) *Allium sativum*,(0.00 mm) *Lantana camera*,(74.33 mm) *Datura stramonium*,(67.70 mm) *Zingiber officinale*,(17.33 mm) Capsicum *annuum*,(74.00 mm) Ocimum tenuiflorum,(53.33 mm) *Parthenium hysterophorus* (71.67 mm), and *Curcuma longa* (15.67mm) over untreated control. Forther for, studied the standardization of significantly effective *In-vitro* evaluated three different botanicals @ 20, 40 and 60 % concentrations. The result of standardized botanicals with different concentration *Allium sativum* (0.00 mm) was recorded that was found superior effective to

inhibited mycelia growth of *S.sclerotiorum* where, the curcuma longa as the gradually increase the botanical crude extract @ 20% (25.60 mm),40% (18.40 mm) and 60%(12.80 mm) then mycelial growth were gradually inhibited. Simamilar result found that the Zingiber officinale with different concentration 20% (31.60 mm), 40% (19.80 mm) and 60 %(13.80mm) recorded. *Allium sativum* have present *(*Allicin, di-allyl di sulphide) chemical ingredient that having the property to inhibited the mycelium radial growth and formation of sclerotia of *S. sclerotiorum in-vitro.*

1.33 AWARENESS OF IPM TECHNOLOGY IN VEGETABLE GROWERS

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Vegetables are an important source of vitamins, minerals, and plant proteins in human diets throughout the world. Vegetable cultivation is one of the more dynamic and major branches of agriculture, and from the point of view of economic value of the produce, it is one of the most important. Majority of Indians are vegetarian, with a per capita consumption of vegetables are 135 g/day as against the recommended 300 g/day. It is still very less than recommended diet level. Vegetables are rapidly becoming an important source of income for the rural population. India is fortunate enough to have a varied agro-climatic conditions found throughout the length and breadth of the country which enable to produce both tropical and temperate vegetables. Integrated Pest Management (IPM) is a combination of pest management techniques to reduce the need for pesticides. IPM programme relyon monitoring pests and damage.

The present study was conducted during 2013-14 in the Bgeshwar district of Uttarkhand. Out of 3 blocks only Bageshwar blocks was purposively selected. Two villages from each block were selected randomly. A sample of 80 vegetable growers was selected randomly. The data were collected through a well structured interview schedule. The collected data were analyzed with statistical tools like frequency, percentage and mean score. IPM practices were followed by farmers to a considerable monitoring (95%), seed treatment (68.75%), crop rotation, (53.75%) and identification of insect pest and disease (43.75%).

1.34 INFLUENCE OF DIFFERENT CONSTANT TEMPERATURES ON THE DEVELOPMENT OF *PECTINOPHORA GOSSYPIELLA* (SAUND.) (LEPIDOPTERA: GELECHIIDAE)

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The ecology and developmental life of pink bollworm, *Pectinophora gossypiella* (Saunders) a monophagous pest infesting cotton was studied at different constant temperatures in the laboratory conditions on artificial diet. There was much significant differences were observed in the total life-cycle at different temperatures. However, declining temperature had the influence on the life history which was evident in terms of extending the total life life-cycle period and also undergoing diapause. This was supplemented with an decrease in the duration of life-cycle as the temperature goes on increasing, *viz.,* 53.74, 39.85, 33.72, 30.41 and 28.93 days during 22, 25, 28, 31 and 34 ^{0}C respectively in the laboratory conditions. Total larval period also varied in different constant temperatures and decreased with the increase in the temperature and the percent larval mortality also increased with increase in the temperature. Mean number of eggs per female ranged from 19.24 to 136.58 eggs of which highest eggs was obtained at the constant temperature of 25 ^{0}C and the lowest was at 34 ^{0}C. Among the different

foods offered, significantly higher adult longevity was recorded on honey with protein-x followed by honey alone and, followed by sugar syrup, fresh cotton flowers, water alone.

1.35 IN VITRO EVALUATION OF SOME ANTIFUNGAL PLANT EXTRACTS AGAINST *ALTERNARIA BRASSICAE* CAUSING ALTERNARIA BLIGHT OF RAPESEED AND MUSTARD

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The oilseed crops, especially *Brassica* spp., play a pivotal role in the agricultural economy of India. Rapeseed mustard are most important *rabi* crops. Alternaria blight is caused by *Alternaria brassicae* (Berk) Sacc. and *Alternaria brassicicola* (Schw) Wiltshire is one of the most important limiting factors, causing yield losses from 17 to 45% in mustard (*Brassica juncea* L.) and even more severe losses (up to 70%) in rapeseed (*Brassica compestris*). The blight also reduces seed size and impairs seed colour and oil content. Keeping this in view for the management of pathogen, fifty plant species belonging to different families were collected and evaluated for their mycotoxic potential against the pathogen in *in vitro* condition. All the 50 plant species showed the different level of toxicity. Among them leaf extract of *Xanthium strumanium* (*Kanghi*) and *Tribulus terrestris* (*Gokhru*) exhibited maximum toxicity and inhibited the mycelial growth of fungus upto 76.35% and 70.45%, respectively. Rest of the plant also showed variable percentage of inhibition from 11.95 to 68.22% as compared to untreated check.

1.36 RELATIVE PERFORMANCE OF THIRAM AND BAVISTIN ON STORAGE QUALITY OF MUNGBEAN (*VIGINA RADIATA* L.)

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Quality of seed plays an important role in modern agriculture. Therefore it should be free from any fungal diseases. Keeping this view in consideration, the present study was taken to evaluate the relative performance of fungicides on different parameters of seed quality. Thiram and Bavistin both are used for seed treatment for protection against fungal diseases. Thiram is a type of sulfur fungicide, ectoparasiticide and animal repellent. Bavistin is a systemic fungicide with protestant and eradicant activity. Post harvest losses of grains due to the involvement of fungus during storage in tropical and sub-tropical countries. A lab experiment was conducted during kharif season with maintenance of relative humidity and temperature. The experiment consisted of two treatments of fungicide viz. Thiram and Bavistin, seed treatment of Thiram and Bavistin in Mung genotype and another set of moong genotype maintained without application as control. The experiment was laid out in CRD design with three replications. Morphological characters like shoot length, root length, leaf area and dry weight of seedling did differ significantly between treatments. Thiram fungicide application shows more positive response for seedling growth compared to Bavistin fungicide application. Thiram fungicide show better result when mung seed is taken as germination seed.

1.37 IMPACT OF IMPROVED PRODUCTION TECHNOLOGIES ON PRODUCTIVITY ENHANCEMENT OF MUSTARD IN SIDHI DISTRICT UNDER KYMORE PLATEAU AND SATPURA HILLS ZONE OF MADHYA PRADESH

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India is the fourth largest oilseed producer in the world. Among the edible oilseed crops cultivated in India, mustard occupying the second position after groundnut sharing 27.5 per cent in Indian economy. It is also one of the important oilseed crops of Sidhi District of Madhya Pradesh. The Krishi Vigyan Kendra, Sidhi conducted 64 frontline demonstrations to know the yield gap between improved package of practices (IP) and farmers practices (FP) under limited irrigation conditions. The study found, the yields mustard in improved practice ranges from 8.75 to 13.23q/ha whereas in farmers practice it ranges between 6.70 to 10.09 q/ha. The Frontline demonstration on mustard registered highest yield (13.23q/ha) was recorded in 2014-2015 in improved practice , which was 31.11 per cent more yield over the farmer's practice(10.09q/ha).The extension gap and technological gap were ranging between 1.87 to 3.60 q/ha and 2.95 to 11.43 q/ha respectively. The technology index ranged from 19.66 per cent to 57.15 per cent.

The trends of technology gap and index reflected the farmer's cooperation in carrying out demonstration with encouraging results in subsequent years. The cost benefit ratio was 2.15 to 3.64 under demonstration, while it was 1.91 to 2.85 under farmer's practice. The results indicates that the frontline demonstration made a good impact on the farming community of Sidhi district as they were motivated by the new agricultural technologies applied in the improved production technology of mustard crops.

1.38 STUDIES OF ZINC, SULPHUR AND MICRONUTRIENTS IN CLAY LOAM SOILS IN REWA DISTRICT OF MADHYA PRADESH

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The present studies was carried out in Rewa district of Madhya Pradesh mainly three blocks Sirmour, Raipur- Karchulian and Rewa to study of Zinc, Sulphur and micronutrients in clay loam soils. Rewa district lies between 24^0 53'29" N to $25^0$19'31" N latitude and $85^0$48'37" E to $85^0$53' 16" E lougitudes. Using GPS, there hundred and ninty two soil samples (0-15an) were collect a from farmer's field in each blocks. The soil samples were analysis pH, EC, organic carbon in standard procedures. The macronutrients (N, P_2O_5,K_2O) and available micronutrients (Zn, Cu, Fe, Mn, B, S) were analyzed by different standards procedure. The pH of the soils ranged from 6.4 to 7.8 with low EC (0.29 dsM^{-1}) and organic carbon.

The micronutrients Zn with mean value 0.32 $mgkg^{-1}$ about 64.3 per cent soil samples were deficient, whereas sulphur content in soils varied from 0.12 to 47.6 mg kg^{-1} with mean value 14.32mg kg^{-1} about 41.37 per cent soil samples were found deficient in each blocks of district. The rest of micronutrients were found in medium to high ranges. Considering soil nutrient index of soils of Rewa district were high in Mn, B and Fe medium in Cu and S while in case of Zn. The macronutrients index of soils low in N, medium in P and high in potash.

1.39 SOIL AND GROUND WATER AVAILABILITY ANALYSIS USING GIS FOR INCREASING CROP PRODUCTION

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This study was carried out taking consideration of soil properties and ground water availability analysis using LISS III image and toposheet of Madhubani district of Bihar employing Geographic Information System (GIS). Soil property analysis and ground water availability are the main prerequisite to achieve optimum utilization of land resources for sustainable agricultural production. An important problem in Madhubani district is to improve agricultural land management and cropping pattern to increase production with efficient use of land resources. The aim of present study is to determine physical land suitability for different crops using multicriteria decision technique and GIS approach for optimum use of land resources. The study was carried out in Madhubani district of Bihar state.

Maximum area of Madhubani district comes under flood or flood prone. Soil mapping and ground water mapping including flood area are very important to know the status of soil and water resources for better planning to increase the agricultural production in this area. This research will provide information to local farmers to select better cropping pattern and suitability. Toposheet of Madhubani district has been digitized. Different maps related to soil properties such as nitrogen (N), phosphorous (P), Potassium (K), pH, Organic Carbon (OC), Electrical Conductivity (EC) and ground water availability have been developed. These maps were developed blockwise. Maps show blockwise soil properties and ground water availability. These maps may be used to analyze land suitability for different crops in Madhubani district. Different soil samples were collected from twenty blocks of Madhubani district and these soil samples were tested to get their properties such as N, P, K, OC, EC and pH. After getting soil properties, these data were linked blockwise showing different blocks as different points on the digitized blockwise map of Madhubani district. Same as above, blockwise ground water availability was also shown on the map of Madhubani district. These maps including soil analysis have been used to develop land suitability maps for different crops and crop planning to increase crop production in this study area.

1.40 MECHANISM OF STRESS TOLERANCE IN WHEAT (*TRITICUM AESTIVUM*) WITH RE-ESTABLISHED DESICCATION TOLERANCE

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Re-established desiccation tolerance (Re-DT) is post-germination growth arrest of embryo if it is exposed to stress during germination. This tolerance is largely unknown and could in many ways be similar to secondary dormancy. This tolerance remained for few days (2-3 days) after germination in *A. thaliana* but after this time window, this tolerance does not come. Transcriptomic studies have indicated that this tolerance could be used by desiccation tolerant plant throughout its life cycle. As this tolerance withstands up to 90-95% of water loss, it should be studied for associated factors responsible for such extreme tolerance. In this study, this tolerance has been studied in two wheat cultivars contrasting in drought tolerance. Seeds were taken during after-ripening at the period of 15 days till 90 days after harvest. ROS (reactive oxygen species) and nitric oxides were measured in dry embryo/seed. Seed

germination in water and ABA was taken as measure of dormancy and ABA-sensitivity respectively. For desiccation tolerance, 1 day germinated seed was exposed to water (for DT) and PEG (for Re-DT) for next 24h, then desiccated (to 0.1g per gram DW) in desiccation chamber for 3.5 days, regrown in water for 3 days, and % survival was measured. For finding days after germination till this tolerance remains, 1, 2, 3, 4, and 5 day germinated seeds were exposed to water (for DT) and to PEG (for Re-DT) for next 24h , desiccated and regrown as above. Among wheat cultivars, PBW644 was drought tolerant and ABA-higher sensitive and PBW343 was drought susceptible and ABA-lesser sensitive. Level of DT was not changed during after ripening in both cultivars but level of Re-DT was higher in PBW644 at all stages of after-ripening. During post germination, level of Re-DT remained till 5th day thereafter decreased in PBW644, while in PBW343, it decreased after 2nd day post-germination. During after-ripening, dormancy and ABA-sensitivity decreased while ROS (H2O2, hydroxyl radicals, superoxides)/nitric oxides (NO) increased in embryo as well as in seed in both cultivars. PBW644 showed higher dormancy/ABA sensitivity and lesser levels of ROS (except superoxides)/NO than PBW343 at all stages of after-ripening. Therefore, there was positive relation of dormancy and ABA sensitivity while a negative relation of level of ROS/NO with dormancy/ABA sensitivity was observed.Seeds of PBW644 were more dormant, ABA higher sensitive, contained less ROS/NO in its embryo/seed than PBW343. DT/Re-DT was not related to dormancy status of seed used for germination. PBW644 showed higher level of DT/Re-DT than PBW343 and also proved to show this tolerance for longer time span during germination.

1.41 DRUDGERY REDUCTION OF FARM WOMENS WORKING IN THE AGRICULTURAL FIELDS DUE TO USE OF IMPROVED MACHINERY IN HOSHANGABAD DISTRICT OF MP

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Women play a significant and crucial role in agricultural development and allied fields .The nature and extent of women's involvement in agriculture, no doubt, varies greatly from region to region. Hoshangabad district lies under Central Narmada valley zone and the prevailing cropping system of the district is Soybean-Wheat. In Recent years Soybean crop in prevailing system has been replaced by Rice in the Kharif season. Presently rice is being grown in 50-60000 ha area and in increasing trend. The rice cultivation requires more labour than the any other crops. It is well known fact that 80-90% work in paddy field is being performed by the farm womens by the use of tradional machinery. The use of Improved machinery will increase the working efficiency with time and money saving. Keeping above in view, Paddy plant marker, Conoweeder and Serrated sickle has been provided to the farm womens working in rice field by KVK Hoshangabad. Results revealed that about 40-50 % working efficiency has been increased due use of improved machinery.

Use of Paddy plant marker for transplanting paddy increases working efficiency with less tiredness and reduced about 50 % drudgery of farm women over traditional practice of planting in submerged field without the use of plant marker. The planting efficiency of paddy was found increased by 33.77 % comparison to traditional practice. Use of Conoweeder for weeding in paddy saves the time and increases working efficiency of women's with less tiredness. It has been observed that weeding with Conoweeder in submerged paddy fields reduced 28% drudgery of over traditional practice of weeding by sickle. Also, the weeding efficiency was found to increase by 78 % comparison to traditional practice. Similarly the use of serrated sickle for harvesting paddy reduced 18% drudgery of farm women over traditional practice of harvesting by normal sickle. The working efficiency of women's was found increased by 28 % comparison to traditional practice with the use of serrated sickle.

Dairying / Livestock and Fisheries based Livelihood Improvement through Innovative Agriculture.

2.1 ENERGIZING LIVELIHOOD THROUGH SCIENTIFIC DAIRY FARMING: A BOOST FOR RURAL ECONOMY

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Despite milk being a very important part of the Indian diet, India was a milk deficit country post-independence. This situation pushed the government to launch “Operation Flood”, which so far has been one the most successful government-led programs on inclusive growth and livelihood generation. Today, India is not only self-sufficient in milk production but also a marginal exporter. At present, the livestock sector contributes to 4 per cent of India's GDP and the dairy sector comprises a king's share of it. Over the last few years, demand for processed milk and milk derivatives has been rising, driven by changing income and consumption patterns. Demand for milk is growing at a faster rate and is estimated to be 180 million tonnes by 2020.

This paper presents salient findings of a research carried out by the authors in different villages adopted by Krishi Vigyan Kendra of Arwal and Patna District in the last three years (2012-15). This study was conducted in purposively selected dairy farmers receiving regular scientific knowledge through various training programmes of KVK. The personal interview techniques were used for data collection and it was statistically analysed. The scientific knowledge related to selection of breed, shelter management, feed management for different class of animals, proper feeding of mineral mixture / urea treated straw /licking blocks, probiotic suppliments, vaccination schedule information, artificial insemination process, machine milking technique's and newer marketing strategies of local milk products like khurma and khoa based lai showed a highly significant influence to their overall economic status and thus energizing the livelihood of farmer's of selected villages. Skill development of rural dairy farmer's by facilitating technology guidance through KVK like institutions will not only improve the socio-economic status of the farm families but will also add in achieving the targeted milk production of our country.

2.2 STUDY ON CLEAN MILK PRODUCTION PRACTICES BY DAIRY FARMERS OF NALANDA DISTRICT OF BIHAR

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A study was conducted inselectedvillages to assess the adoption of clean milk production practices of Nalanda. The data were collected from 120 dairy farmer randomly by Pre-tested interview schedule. Dairy farmers were classified into large scale (above 40 dairy animals) , medium scale (20-40 dairy animals) and small scale (1-20 dairy animals) farmers depends upon no of animals at their houses. The study revealed that 5%, 10% and 85% dairy farmers belong to large, medium and small scale category, respectively. Approximately, 50% large scale farmers, 40% medium scale farmers and 20% of small scale farmers adopted drying of udder by clean muslin cloth before milking the animals. Pre- milking teat adopted by 70% large scale farmers, 40% medium scale farmers and 21% small scale farmers.

On the other side, post teat dip after milking of animal is followed 50%, 42% and 18% of the large, medium and small scale farmers, respectively. Majority of large farmers and medium farmers adopted machine milking practices. Infra-mammary infusion on the drying of animal is adopted by 20%, 10% and 5% of the large, medium and small scale farmers, respectively. The study revealed that large scale dairy farmers were more efficient in adoption of clean milk production practices than the medium and small scale farmers.

Due to considerable importance of clean milk production, there is a need to educate and encourage dairy farmer's particularly medium as well as small scale farmers about various aspects of clean milk production technique and the conducive strategies should be formulated by concerned activities for better adoption of clean milk production practices in Nalanda district of Bihar.

2.3 FORMULATION OF PLANT BASED MILK BEVERAGE USING MULTI COMPONENT MIXTURE DESIGN

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A three-component constrained mixture design was applied for optimization of the formulation of plant milk based beverage. Milk was formulated by blending of plant source milk (soy milk, sweet corn milk) and animal milk (cow milk). The variations in chemical composition and physico-chemical properties of 10 different formulations of soy-sweet corn-cow milk were studied. The variations in the concentration of soy-sweet corn-cow milk influenced the chemical composition and physico-chemical properties of the formulations. Increasing soy milk concentrations in the formulation resulted in relative increase in protein content, while the carbohydrate content increased with increasing sweet corn and cow milk concentrations. The protein and fat values were higher with values ranging from 2.67-3.55% and 2.22-2.57% respectively in the formulation containing all three milks (60-80% soy milk, 20-40% sweet corn milk and 0-20% cow milk). The ΔE* values of the formulation without cow milk was lower and the values increased with the addition of the cow milk. Titratable acidity values increased with increase in soy milk content but decreased with increase in sweet corn milk and cow milk content. The optimized blend was soy milk 63%, sweet corn milk 23 % and cow milk 13 %, with a protein content of 3.3% and energy value of 42 k Cal/ 100 g.

2.4 ECONOMIC VALUE OF FISHERY RESOURCES IN INDIA AND THEIR ROLE IN PROGRESS OF FUTURE AGRICULTURAL LIVESTOCK

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Fish, an important group of vertebrates and have received its attention from ancient times. It is an important aquatic fauna, which forms a good source of food to man. The importance of fish as food has resulted in the development of fisheries as an industry in many countries and tremendous progress has been achieved through sector in India. A considerable increase in export of fish and its products has played an excellent role in the economy of our country. It serves as a good source of 20% protein ,vitamin A,B, and D, 1-10% fats ,phosphorus and several minerals as Ca,Mg,K,Na,P,Fe,Cu, and Mn. Fresh water fishes which possess high food value are *Clarius batrachus,Channa* spp*,Heteropneustes*

fossilis,Clupea spp*,Labeo* spp*,Mystus* spp*,Wallago att*u etc. Brackish water fishes include the mullets(*Mugil* spp),*Lates calcarifer* and *Chanos chanos*. Among the marine fishes the Mackerels (*Rastrelliger kanagurta*), Bombay duck (*Harpodon nehreus*), sharks and rays are some of the commercial fishes of India. Other by products of fish includes fish oil, fish silage, fish soup, fish sausage with excellent nutritive value. The skin of many fish species such as cod, sharks and rays is used for making leather shoes, bags, suitcase and ornamental articles. Fishes having little food value used for feeding cattles, which possess high amount of Calcium Phosphate, along with vitamins. It is useful for feeding cattles, poultry for increasing milk and egg production. Inferior qualities of fish which are unfit for human consumption are used as a feed for animals. They are simply dried in the sun and are grounded forming the manure for the fields. It is an excellent by-product of curing yards and oil extracting plants. Integrated fish farming is practised in India, China, Thailand, Japan, Indonesia and Malaysia. The fish species which can be preferred for integrated fish farming are *Catla catla, Cirrhinus mrigala, Clarias ,Channa* spp, *Mugil* spp*, Labeo rohita* and many more. The practise of fish-cum-pig, fish-cum-duck, fish-cum-poultry farming can be easily adopted in different areas with some modifications for full or maximum utilisation of farm waste and available resources. It helps in recycling of animal wastes, and indirect use as a good fertilizer for other animals. Thus, fishery sector plays an important role in the development of Indian agricultural livestock.

2.5 ROLE OF INTEGRATED FISH FARMING IN THE PROGRESS OF AGRICULTURAL LIVESTOCK'S IN INDIA

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The practise of combining fish culture with agriculture or livestock for full utilisation of ecological resources and increased production is called Integrated Fish Farming. It increases the productivity and gives income from small land holdings. It can be easily adopted in India and in countries with some modifications for full utilisation of farm waste and other available resources. A large scale fish farming with agriculture includes Paddy-Cum-Fish culture, Rotational culture of rice and fish, Banana- Fish Culture Paddy-Cum–Fish culture is an old practise in eastern states of India. Paddy fields remain flooded with water for several months, so fish can be easily grown in such areas. Fishes used for such purposes include *Cirrhinus mrigala, Clarias batrachus, Channa* spp, *Mugil* spp, *Labeo* spp etc. should be able to live in shallow water and can tolerate high temperature and turbidity. Rotational culture of Rice and Fish, in which fish is culture after harvesting the paddy and the field, is converted into temporary pond of depth up to 60 cm. Banana Fish Culture or Coconut Culture in rows with continuous supply of water. Air breathing and larvivorous fishes can be cultured in these ditches. Fish farming with Livestock includes Fish- cum-Pig Farming in which pig houses are made near ponds, so that pig excreta are used as an artificial fertilizer and feed for fishes, which contains 70% digestible food for fishes. Fish-Cum-Poultry farming and Fish-Cum- Duck farming these are constructed on above the water level and droppings may be utilise as a good fertilizer being rich in Nitrogen and Phosphorus. It involves recycling of waste materials. It leads to an effective utilisation of waste products. Sequential linkage between two or more type of farming. Good source of meat, milk, eggs, fruits and food. It decreases the expenditure of adding external fertilizer, so increases the source of income to the farmers having small land holdings. It relics the full potential of aquaculture development in the country, India.

2.6 THE CONDITION FACTOR AND LENGTH–WEIGHT RELATIONSHIP OF *PUNTIUS SARANA* COLLECTED FROM TWO DIFFERENT SITES

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Length-weight relationships are of immense importance in fisheries research. The study of length-weight relationships (LWRs) of fish from fresh water resources usually serve as a baseline for comparison to other relatively altered water resources as well as man-made resources. In the present study Length-weight relationship and condition factor of *Puntius sarana*, an economically important small indigenous fish were estimated from 386 individuals. Which were collected from two sites namely Pakka pul of Gomti River in Lucknow and a pond at Bakshi ka Talab, Lucknow, Uttar Pradesh during April 2015 to February 2016, the mean total length and body weight were calculated. Log transform regression was used to study the length-weight relationship. The regression coefficients of the pond's fishes were significantly higher than those of the River. It was depicted that the value of Growth coefficient (b) for two populations were significantly different from one another and from three. The condition factor of both the sites also showed a significant difference. The fish population cultured in pond were found in better state. This study indicates the declining condition of River Gomti, at least at and around a particular studied site. The results obtained would be helpful for scientific management and conservation of the vital fish stocks in the Gomti River ecosystem.

2.7 TOXIC EFFECT OF FLUORIDE ON PROTEIN CONTENT & ITS AMELIORATION THROUGH ASCORBIC & CALCIUM NITRATE IN FRESH WATER FISH *HETEROPNEUSTES FOSSILIS*.

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Fluoride is a naturally occurring compound present on earth and it enters in aquatic environment by natural and anthropogenic sources. Fish are sensitive to environmental disturbances and in particular to any chemical change in aquatic environment. Fish is a significant source of protein for millions of people in the world. The present study consists of toxic effects of sodium fluoride & its amelioration by Ascorbic acid and Calcium Nitrate on protein content in different tissues such as gill, liver, kidney, muscles, and gonads of *H. fossilis*. Fish were divided in nine groups comprising two sub lethal concentration of fluoride in alone & along with Ascorbic acid, Calcium and both (AA+Ca^{+}). We find the significant depletion in protein of different tissues of fluoride exposed group after one month. A significant recovery from NaF-induced toxic effects occurred following administration of ascorbic acid and/or calcium, while combined treatment (AA + Ca^{+}) for 30 days manifested a synergistic effect. The transient fluoride-induced effects were reversible. The depletion in protein content suggests that F interferes with the protein metabolism which is required for proper growth and development of fish. The decline of fish growth would be an immense impact on aquatic ecosystems as well as a significant impact on one of the primary food sources for people around the world.

2.8 QUAIL FARMING A SUCCESSFUL BUSINESS FOR RURAL YOUTH IN VAISHALI DISTRICT

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The Japanese quail has played an active role in the lives of humanity since the 12th century, and continues to play major roles in industry and scientific research. Before 1950, Poultry farming in India was mostly a backyard venture. During last 3-4 decades Indian poultry industry has shown excellent growth and India has emerged as the fourth largest egg production and 3rd largest in broiler production in the world. Poultry farming is a profitable venture as a means of lively hood and income prosperity for rural youth.

In our country quail meat is famous since time immortal. In India keeping in the view of importance of quail in our food ICAR, CARI Bareilly Uttar Pradesh has introduced Japanese quail which is commonly known as *Bater* in 1974. Quail farming can play an important role in various socio – economic development by way of providing employment, supplementary income and productive food to all section of society. Quail are small birds and commercially grown for their eggs and meat. In India commercial farming for quail is increasing because, the demand for quail meat is increasing day by day in metros, capital and cities but the production of eggs and quail meat in the India is not sufficient to meet out the demand. Keeping in view of demand of quail meet and eggs and potential to explore the possibility of rural employment a training programme was organized at KVK Vaishali with the help of NABARD in 2012. After getting training from KVK Vaishali, one innovative farmer Mr. Rajdev Rai stated a business for quail farming in 2012 and formed **Panchmurti Bater Utpadak Sangh** with the financial support of NABARD and technical guidance from KVK Vaishali. Now they are working under banner of **Panchmurti Agro Producer Company.**

License requirement for quail farming

Quail being a protected species, a government license is required to sell it commercially. In India, the Department of Animal Husbandry, Dairy and Fisheries is responsible to grant such license as delegated by the Ministry of Environment and Forests. Several quail licenses have been already issued .Here are the important **terms and conditions for Quail license** as per letter No.3-22/84 - FRY (WL) dated 27.06.1997 of Ministry of Environment and Forests, New Delhi.

Quail farming has lot of scope in Vaishali district. Marketing of quail, no need to worry about marketing of quails as there is a local market demand for these birds. Birds can be sold very easily and fast especially in Patna.

2.9 ENTREPRENEURSHIP DEVELOPMENT THROUGH HIGH VALUE POULTRY BREED KADAKNATH IN THE TRIBAL DISTRICT JHABUA, M.P.

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India is a country with a prominent agrarian economy. More than 70 per cent of the total population lives in rural areas which is dependent on agriculture for their livelihood but agriculture is not enough to provide sustantial livelihood to each and every one of them. Entrepreneurship is the capacity to develop ideas and achieves success with them. Innovation, the acceptance of change and risk the

mobilization of resources and the tapping of opportunities are just some of the factors involved in creating a competitive or sustainable enterprise.

An Indian poultry breed, *Kadaknath* is native to Jhabua district of Madhya Pradesh, which is known for its black meat with better texture, quality and flavor. This species is known to bear special medicinal value in homeopathy and a particular nervous disorder. This breed is reared mainly by the tribal community of Bhil and Bhilala of district Jhabua in Madhya Pradesh. The bird was reared under backyard system by the tribal farmers, which resulted in high mortality, slow growth and delayed maturity. Further, due to its high demand and price the population of this bird is declining rapidly and it is under threat of extinction and genetic erosion. Hence, a programme was initiated for conservation and strengthening of this breed under National Agriculture Innovation Project - Component-3. In order to demonstrate the improved rearing technology for this bird, ten low cost poultry shades were constructed in the Jhabua diastrict. One hundred poultry chicks of ten days old age were made available to each tribal farmer. The growers were advocated on technologies for scientific poultry production, balance feeding, handling of feeder and drinkers, health management and marketing. Now the beneficiaries have been trained in managing the scientific production of *Kadaknath* in better way. They are using low cost nutritious poultry feed. This new *Kadaknath* production technology has reduced the mortality rate from greater than 50% to 5 -15% and thus enhanced the survival percentage.

The bird gaining the body weight in faster way and attaining saleable weight of 1 to 1.10 kg in 105-120 days as compared to six month under traditional backyard poultry system. The producers are selling this body weight of bird @ Rs. 600 to 800 /kg body weight. In this way, an individual beneficiaries is getting the net income of Rs. 0.95-1.0 lakh/year as compared to 28700/year under back yard poultry system. This improved rearing technology has been adopted by several other growers by constructing the poultry shades from their own resources /convergence.

2.10 BACKYARD POULTRY FARMING FOR LIVELIHOOD SECURITY

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Backyard poultry farming offers great opportunities for socio-economic development through income generation and enhanced nutritional security particularly to landless and small farmers especially women. The poultry rearing provides a renewable asset as a ready source of cash and quality nutrients in the human diet. Scavenging poultry birds normally maintained by women, sometimes contribute as much as 80% of annual income to household. Several batches of farmers and Rural youth from all the seven blocks of Jehanabad district namely Madanganj, Kako, Ghoshi, Hulasganj, Makhdumpur, Jehanabad and Ratni were imparted skill based training on various aspects of poultry farming at Krishi Vigyan Kendra, Jehanabad. As a result, considerable numbers of poultry farms have grown up in the district. The present study was conducted on 120 poultry rearers who are practicing this less capital intensive and livelihood oriented enterprise in the district with the objective to assess their knowledge regarding various poultry management practices including housing feeding, brooding, watering vaccination etc. and constrains faced by them in running this enterprise. Participants enriched with sound knowledge were provided chicks of local breed under demonstration programme of KVK as well by the district level agency ATMA.

Requirement of small space, low capital investment, quick return from outlay and well distributed turnover throughout the year make poultry farming remunerative and viable enterprise. Successful farmers are saving Rs. 15-20 per bird through boiler selling and many of them have also

involved in rearing local birds for egg production. The findings indicated that majority of the respondent possessed medium level of knowledge about selected poultry husbandry practices. It was also observed that poultry keeping was a gender friendly technology as in many cases women often control the whole process of backyard poultry keeping right from feeding to marketing contributing towards women empowerment by economic independence and nutrition security however with regard to constraints high mortality due to various disease and unhealthy management practices constitutes one of the greatest constraints in poultry farming that has to be addressed further through regular extensive training and capacity building programmes.

2.11 HYDROPONIC FODDER: A NEW DIMENSION IN URBAN LIVESTOCK FARMING

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In a tropical country like India livestock feeding largely consist of feeding crop residues supplemented with one or two individual concentrates .In addition green fodder are also fed to animals to increase their productivity. The Small ruminant like sheep and goat mostly depend on grazing in rainy season but during summer they require supplement with green fodder in addition to grazing to increase their productivity. In many parts of India livestock production is affected mainly due to the shortage of green fodder during summer so also due to the non availability of land for fodder cultivation. In addition to this dairy farmers in the urban and semi urban areas faced with scarcity of quality green fodder due to the non availability of enough land for fodder cultivation. Such farmers are dependent mostly on packaged cattle feed which is costly. To overcome this new concept of cultivating green fodder (Hydroponic Fodder) has gain momentum in recent times all over the world. Dr. Allen Cooper introduced the concept of hydroponic fodder during 1930. Hydroponics' means the technique of growing plants without soil or solid growing medium, but using water or nutrient-rich solution only, for a short duration.

Since hydroponic fodder involves sprouting of grains, it increases the vital nutrient content in the feed like amino acids, B-complex vitamins, vitamin-E, Beta Carotene, and biotin and reduces anti-nutritional factors. High digestibility of hydroponic fodder could increase the live weight gain in young stock which consumes less dry matter per unit live weight gain .Though we know that hydroponic fodder cannot substitute green fodder and hay completely, as it lacks in fiber content. But it is definitely a better substitute for farmers who fed packaged feeds. Hydroponic fodder is highly applicable in organic dairy farming, sheep and goat farming with higher productivity. This type of fodder production technique if carried out in a large scale especially for the production of organic products in the field of livestock will be economical and beneficial.

2.12 SPREAD OF ALIEN FISH PACU AND ITS IMPACT ON AQUACULTURE

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Many exotic fishes have been introduced illegally in India but only few of them sustained in Indian aquaculture system and other invaded into natural water bodies such as tilapia, silver carp, and Thai mangur causing loss of biodiversity in river. One of the alien fish red belly Pacu, *Piaractus brachypomus* a native of Amazon basin in South America have been introduced into West Bengal via Bangladesh probably in 2003, Pacu species often create confusion as it very much resembles to a highly carnivorous Piranha, a banned species in India. Pacu is flourishing well in aquaculture and having good demand in ornamental fish industry. This fish grows at fast pace, due to its omnivorous nature of feeding. The present study was conducted during May 2015 to January 2016, investigated the different impacts of illegally introduced fish Pacu, *Piaractus brachypomus* on aquaculture. Survey, screening and experimental work have been done to accomplish the objective. We found that Pacu is gaining importance as it can be a good alternative of IMCs or other indigenous fish due to its high growth rate on low investment. This species is slowly spreading in different agro climatic zone of India, West Bengal is considered as breeding ground from where seed is supplied to aqua culturist/farmers of Uttar Pradesh, Andhra Pradesh, Tamilnadu and Haryana. It is being cultured in poly and monoculture system. In a nutshell this alien fish have good potential to become a candidate species of aquaculture but can cause a threat to the Indian aquatic biodiversity if it escapes in to natural water bodies.

Horticulture, Floriculture, Beekeeping, Mushroom, Innovation in Post-harvest Technology

3.1 INTEGRATED APPROACH OF LITCHI BASED CROPPING IN POND BASED PRODUCTION SYSTEM

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A substantial area in Bihar is under waterlogged and marshy condition. This major area falls under those districts which found suitable for cultivation of litchi but, this type of waste land is not suitable for fruit cultivation including litchi due to water-logging, un-decomposed organic matter and swampy condition. Efforts are being made for restoration of these lands through construction of pond. The embankments of the ponds were utilized for litchi based cropping system which includes banana, papaya and vegetables/seasonal crops with litchi. The cropping system in bunds includes three tier model of litchi cum banana/papaya and crop/vegetables based system comprised with 5 bunds model (Bund I: Two row of litchi & banana + vegetables as intercrops, Bund II: Two row of litchi & papaya + annual crop as intercrop, Bund III: Two row of litchi + banana in between two litchi plants & intercrop, Bund IV: Two row of litchi + papaya in between two litchi plants & intercrop and Bund V: Two rows of litchi). The results indicated that in litchi based integrated pond management; banana and papaya showed encouraging production besides seasonal/vegetables grown on pond bank. Very good survival of litchi (Shahi-73.3% & China-91.67%), banana cv. Grand Naine (90%) and papaya cv. Pune Selection-3 (88%) plants were recorded at one year after planting. The average banana yield was obtained 16.15 -26.94kg/plant with 7-9 hands/bunch and 89-142 fingers/bunch. Papaya yield ranged from 12.5-35.5kg/plant with average no. of fruits 10-44/plant and fruit weight 0.92-1.25kg. Intercropping of pea, faba bean, maize and other vegetables have also been done with litchi planted on pond bunds during *Rabi* season 2015. The yield of different inter-crops revealed that the performance of maize, faba bean, knol khol, cabbage and pea crops was relatively better than other crops. The overall results revealed that the litchi based integrated pond management with banana, papaya and seasonal crops/vegetables could be an excellent approach for sustainable production, income generation and employment opportunity of the resource poor rural households besides the restoration of unutilized degraded waterlogged soil.

3.2 SEASONAL OCCURRENCE AND MANAGEMENT OF RED WEEVIL, *APODERUS BLANDUS* ON LITCHI

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Litchi (*Litchi chinensis Sonn*) is an important fruit crop belongs to family *Sapindaceae.* The damage caused by insect pests involves multiple species acting at the same time, and high pest populations prolong the period that litchi orchards are under threat. In India, nearly 42 insects and mite species reported to attacking on trees and fruits of litchi at different stages of growth. Earlier, only two species, namely, erineum mite and bark eating caterpillar were reported causing serious damage to litchi trees. Recently, litchi fruit borer and litchi leaf roller have acquired the status of major pests and now, litchi looper, litchi bug, red weevil and bag worm are emerging pests of litchi. Among litchi defoliators red weevil, *Apoderus blandus* is a major one. Field trial was conducted consecutively for two

years at research farm of ICAR-National Research Centre on Litchi, Mushahari, Muzaffarpur, Bihar to develop the eco-friendly approaches for managing the red weevil, *apoderus blandus* which is one of the major defoliator of litchi causing severe damage to the new flush resulting poor growth of the plant. Maximum population (11.00) of red weevil was recorded in 40th standard week while, minimum population (1.30) was recorded in 49th standard week. Thiamethoxam 12.6% + lambdacyhalothrin 9.4% (0.098%) was highly effective with 0.00 population against 11.33 in control followed by chlorfenapyr 10 EC (0.03%) and imidacloprid 17.8 SL (0.0089%) as registered 0.67 and 1.33 weevil population respectively after three days spraying.

3.3 INTEGRATED MANAGEMENT OF PAPAYA ROOT ROT CAUSED BY *FUSARIUM SOLANI*

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A new disease - Root rot of papaya was encountered at Pusa and other places of Bihar as a threat to papaya cultivation throughout the plant growth stage during the year 2012-13 and 2013-14 showing up to 100% incidence and resulted in gradual collapse of entire papaya plantations. During the present study the most effective fungicides, plant extract, organic cake and bio-agent were evaluated in different combinations under field conditions for the management of papaya root rot disease. It was observed that there was 81.5% disease incidence in control while the lowest disease incidence (29.60%) was recorded in treatment (T_{13}) (Comprising disease free seedling + mustard cake (10%)+ wild garlic (10%) + dipping of seedlings in thiophanate methyl (0.1%) 30 min.+ soil drenching with thiophanate methyl (0.1%) solution three times (1st at time of transplanting, second at 3rd MAT and third at 5th month after transplanting)+ Soil application of *Trichoderma viride* @ 50g/plant three times (i.e. 1st at time of transplanting, second at 3rd MAT and third at 5th MAT)+ soil application of *Pseudomonas florescence* @ 50g/plant three times (i.e. 1st at time of transplanting, second at 3rd MAT and third at 5th MAT). This was followed by treatment T_6 (37.0%), T_9 (40.7%) and T_5 (44.4%). The effect of different treatments on yield was also studied and the highest fruit yield (1064.67 kg/plot) was obtained from the treatment T_{13} followed by treatment T_9 (848.67 kg/plot) and T_5 (810.00 kg/plot) over the control T_1 (209.00 kg/plot).

3.4 YIELD AND WATER USE EFFICIENCY OF TOMATO AND RIDGE GOURD WITH MULCH UNDER VARIOUS MOISTURE REGIMES

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An experiment was carried out to study the combined effect of drip and mulching as well as surface irrigation on yield and water use efficiency of tomato and ridge gourd at ICAR Research Complex for Eastern Region, Patna. The treatments of the study comprised different combinations of two drip irrigation levels (100 and 70 % of crop water requirement PE) with and without polyethylene mulch and one surface irrigation as control. The yield and yield-contributing characters in the mulched treatments for all levels of irrigation were significantly higher compared to those in the unmulched treatments. The yield of tomato increased with the increasing amount of irrigation water in unmulched treatment. Mulched crop receiving drip irrigation at 100% PE produced the highest yield of tomato (42.2t/ha) and ridge gourd- (15.3t/ha) among all treatments. Non mulched crop receiving drip irrigation

at 100% PE produced similar yield as that of mulched crop with70 % PE and surface irrigated crop. In tomato, mulched crop produced 29% and 25.4% higher yield at 100 & 70% PE, respectively over non mulched crop under drip irrigation. Similarly mulching in ridge gourd also produced 23.4 and22.8% higher yield at 100 & 70% PE, respectively over non mulched. The mulched treatment at 100% PE showed better water use efficiency in both tomato (15.7 kg/m^3)and ridge gourd (3.9 kg/m^3) than unmulched one and required less water to produce per kg of fruit (kg/m^3). Drip irrigated crop recorded higher water use efficiency in both levels than surface irrigated crop. Among the various treatments, drip irrigation with polythene mulch recorded least weed density and higher weed control efficiency. While least water use efficiency, weed density, and weed control efficiency was obtained under no mulch with surface irrigation.

3.5 COMPARISION OF DIFFERENT FUNGICIDES FOR THE CONTROL OF DOWNY MILDEW OF CUCUMBER

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A field experiment was conducted to evaluate the performance of different fungicides against downy mildew on cucumber (*Cucumis sativus* L.) cultivated in high plastic tunnel at the farm of Ch. Khair Din and Sons, Mandiala Warriach, Gujranwala during Rabi, 2006-2007. Five different fungicides namely Dithane M-45, Copper oxychloride 50 WP, Ridomil Gold 72 WP, Success 72 WP and Alliet 80 WP were used at dose rate 5, 4, 2, 2.5 and 2 g/L^{-1} of water, respectively. Minimum disease incidence was recorded by spraying Success (9%), Ridomil (9.%) and Alliet (11%) compared with control (78%).Number of fruit per plant, length and yield of fruit was significantly higher in treated plots with Ridomil, Success and Alliet as compared to control and other fungicides.

3.6 SCREENING OF DIFFERENT GERMPLASM AGAINST LEAF SPOT DISEASE OF TURMERIC (*CURCUMA LONGA* L.) CAUSED BY *COLLETOTRICHUM CAPSICI*

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Turmeric (*Curcuma longa* Linn. C. domestica V.*)* known as Haldi and Indian saffron, is one of the most important and ancient spices of India. Turmeric (*curcuma longa* L.) is an important spices crop and emerged as. A high valued cash crop for intercropping in agro-forestry plantation like (*curcuma longa* L.). Among various diseases attacking turmeric, *Colletotrichum* leaf spot (*Colletotrichum capsici*) is the most divesting *disease.*An attempt was made to identify resistant sources in turmeric germplasm by screening them against *Colletotrichum* leaf spot disease under natural condition. The germplasm screening indicated that the maximum disease incidence was recorded in Morangia (PDI = 65.00), used as susceptible check and minimum disease incidence (PDI= 18.75) was recorded in three germplasm *viz*., RH-7, RH-411 and RH-412). Out of sixteen germplasm including one susceptible check, none of the germplasm showed highly resistant (HR) or resistant (R) reaction. Five germplasm *viz.,* RH-7, RH-50, RH-403, RH-411, and RH-412 showed moderately resistant (MR) reaction against the disease. Five no. of turmeric germplasm *viz.,* RH-7, RH-50, RH-403, RH-411 and RH-412 was found to be Moderately Resistant against *Colletotrichum* leaf spot disease, which may serve as source of resistance in future breeding programme.

3.7 MAXIMIZATION OF SEED SIZE TUBERS IN POTATO *CV.* KUFRI PUKHRAJ THROUGH MANIPULATION OF INTRA ROW SPACING, NITROGEN LEVELS AND CROP DURATION UNDER IRRIGATED CONDITION IN INDO –GANGETIC PLAINS OF BIHAR

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A field experiment was conducted during winter season (Oct-Feb) of 2013-14 and 2014-15 at Central Potato Research Station, Patna (Bihar) on sandy loam soil medium in fertility in randomized block design with four replications and eight treatments to produce maximum number and yield of seed size tubers by interaction of two nitrogen levels (120 and 150 kg N/ha), two intra row spacing (15 and 20cm), and two crop duration(haulm cutting at 70 and 80 days after planting) with popular potato cultivar of the region, " Kufri Pukhraj ".Well-sprouted tubers of Kufri Pukhraj of seed size 40- 50g were planted during second fortnight of October. The crop was raised following the seed plot technique of seed production. The harvested produce of each treatment was graded into G1 (10-25 g) G2 (25-50g) G3 (50-75g) and G4 (>75 g) size tubers, weight and number taken separately.

With narrow intra row spacing i.e. 15 cm, the weight and number of G1 and G2 grade tubers were significantly higher while wide spacing i.e. 20 cm produced higher yield of G4 grade tubers. The total tuber yield and tuber number was significantly more in closer spacing. Percent production of seed size tubers (G1+ G2+G3) to total tubers (both on weight as well as number basis) was higher at narrow spacing. The multiplication rate of tubers (on number as well as weight basis) was, however, higher at wider spacing. Increase in N level from 120 to 150 Kg /ha did not influenced significantly the grade wise tuber number as well as yield. Haulm cutting at 80 days after planting produced significantly higher yield of G3 and G4 grade tuber, while haulm cutting at 70 days after planting, produced significantly higher yield of G1 and G2 grades tubers. The total tuber number and tuber yield was significantly higher in haulm cutting at 80 days after planting. Plant spacing at 60 x 20 cm with 150 kg N/ha and haulm cutting at 80 days produced highest tuber yield and number of G4 (>75 g) grade tuber. Plant spacing at 60 x 15 cm with 120 kg N/ha and haulm cutting at 80 days produced highest total as well as seed size tuber yield and number. Lowest total tuber yield and number was observed in wider spacing with lower nitrogen level and shorter duration. Per cent production (both on weight as well as number basis) of seed size tubers (G1+G2+G3) to the total tuber was significantly higher at 60 x 15 cm with 120 kg N /ha and longer crop duration. Plant spacing of 60 x 15 cm with higher fertility levels and shorter crop duration (70 day) was found to be second best treatment in terms of production of seed size tuber. Thus, it is concluded that for maximization of seed size tubers in potato cultivar Kufri Pukhraj under irrigated Indo –Gangetic plains of Bihar, the intra row spacing should be reduced to 15 cm with either application of 120 kg N/ha and crop duration 80 days or application of 150 kg N/ha and crop duration 70 days.

3.8 STUDIES ON PHYSIOLOGICAL AND CULTURAL PARAMETERS OF THE FUNGUS (*ALTERNARIA SOLANI*) CAUSING EARLY BLIGHT OF POTATO

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Potato (*Solanum tuberosum* L.) is one of the most important solanaceous crop among all vegetables in the world. It is a major world food crop, consumed by over a billion people. Early blight of

potato caused by *Alternaria solani* is a very important disease and appears regularly on potato crop grown in our country. It is one of the major constraints affecting the production of this crop. The study was conducted during 2012-14 for the study of early blight pathogen at the laboratory of Department of Plant Pathology, College of Agriculture, Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad. The cultural characteristic of *A. solani* isolated from potato was studied on five solid media. The pathogen showed highly significant difference in its growth on five different solid media. The radial growth of *A. solani* was maximum on potato dextrose agar with average colony diameter of 64.68 mm followed by corn meal agar (63.91mm), oat meal agar (62.90 mm), Richard's agar (63.43 mm) and Czapek's Dox agar (47.91 mm). Greyish colour with irregular mycelia growth and smooth margin were observed on the basis of their colony characters in most of the cases. The mycelial growth from inoculated flasks was harvested everyday starting from first day up to 14th day. During the physiological studies the weight of dried mycelium was recorded and the results obtained were analyzed. Maximum growth was observed on ninth day of inoculation (249.66 mg). Subsequently, reduction in the growth of mycelium was observed due to autolysis.

3.9 ROLE OF HORTICULTURE PROFESSIONALS IN RURAL DEVELOPMENT

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India is a leading developing agricultural country with their 143 million hectares cultivable land, which is the highest percentage of cultivable land occupied by an individual country in the world. India is the second largest populated country by accommodating 17 percent of world's population. At least 65 percent of population of our country living in rural areas and among them 85% of the rural people are only dependent on agro-based activities and most of them are struggling for food security and their livelihood. Economic prosperity of rural people is our prime need and it can be obtained through region specific planning. Every region has specific potential and capabilities, so representative development planning of that area should be made for their better growth and development. However, horticulture sector play vital role in creating employment and generating good income with high value cash crops.

Horticultural crops are good source of nutrition which may be one of the best solutions of malnutrition, still a big problem in rural areas. The less production as well as productivity in traditional cropping system is a big reason of that. Here horticulture professionals can play big role through training and guidance of various scientific production technologies such as fruit nurseries, high density planting, drip irrigation, precision farming, organic farming, INM, IPM, mushroom production, canopy management, protected cultivation, value addition etc. for development of rural areas. Basically agriculture or horticulture professionals have good knowledge of agriculture or horticulture technologies so they can easily understand the problems and needs of rural people and able to recommend suitable technologies for their particular regions. Therefore, horticulture professionals can play integral role in promotion of appropriate rural technologies which can facilitate the rural communities to boost their efficiency and earnings.

3.10 ADOPTION OF HIGH YIELDING VARIETIES OF VEGETABLES IS A TOOL FOR RURAL LIVELIHOOD IMPROVEMENT

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In our country 30% population is living under poverty line. India ranks second in vegetable

production in world. But in our country productivity is very low due to lack of good package of practices and availability of high yielding varieties of vegetables. Farmers of the country are not aware about the new technologies in agriculture. They are not getting good return from the vegetables. The productivity of vegetable crops is poor as comparison to China. Crop continues to be quite low yielded due to infestation of disease & insect pest & not proper selection of cultivar. The yield of vegetable crops can be increased by the demonstrating the suitable cultivars at the farmers field under the supervision of scientists working in the operational area of KVK. It is observed after trial that farmers are planting vegetable crop as per the recommended practices with suitable cultivar recorded the higher yield as comparison to the farmers practices. It is found that tomato var. Kasi Vishwash average yield was recorded 533 q/ha over local check 430 q/ha, Palak var. Pusa Anmol average yield 104 q/ha over local check 91 q/ha, Cauliflower var. Sabour Agrim average yield 290 q/ha over local check 270 q/ha, Carrot var. Pusa Kesar average yield 121 q/ha over local check 97 q/ha, Radish var. Pusa Chetki average yield 130 q/ha over local check 96 q/ha, Okra var. Arka Anamika average yield 530 q/ha over local check 485 q/ha and brinjal var. Rajendra Baigan average yield 400q/ha over local check 334 q/ha. Percentage increase in productivity over local check was (21.61%), Palak var.-Pusa Anmol 14.28%, Cauliflower var-Sabour Agrim (37.26%),Carrot .var.Pusa Kesar (24.74%), Radish var. Pusa chetki (35.41%), Okra var. Arka Anamika (9.27%) and Brinjal var. Rajendra Baigan (19.76%). The results of the on- farm trial brings out the high yielding varieties are feasible and economic for the farmers and viable over the farmer's practices. Percentage increase in the average yield is quite high in the low input cost, so the adoption of HYV may improve the rural livelihood.

3.11 NUTRIENT CONTRIBUTION TO THE SOIL BY MAKHANA (*EURYALE FEROX*SALISB.) AND WATER CHESTNUT (*TRAPABISPINOSA*)

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A field trial on the comparison of nutrient contribution to the soil by Makhana and water chestnut to the soil wasconducted during 2012 to 2014 at the farm of theICAR RCER, Regional Research Centre for Makhana, Darbhanga, North Bihar, India, located in the Bagmati flood plain(lat. 26° 10'N, Long. 85° 87'E,Elev. 49 m a.s.l. and mean annual rainfall 1150 mm). To test the statistical significance, the data were analyzedusing't' test.Prior to the experiment, the field had not been under any cropping. The makhana (*Euryale ferox*Salisb.) and water chestnut (*Trapabispinosa*)were taken as the test crop.Makhana is an aquatic and emergent macrophyte known as Gorgon not or Fox nut belonging to family Nympheaceae, genus monotypic, diploid having chromosome number 2n = 2x = 58. It is grown in stagnant perennial water bodies like ponds, land depressions, oxbow lakes, swamps and ditches. It is a plant of tropical and subtropical climate. For its proper growth and development, the conducive range of air temperature is 20-35°C, relative humidity 50-90% and annual rainfall 100-250 cm. It is an exclusively self-pollinated plant in which fertilization takes place at an early stage of their development. It is an absolutely seed propagated plant.

Water chestnut is an annual floating-leaved aquatic plant of temperate and tropical fresh water wetlands, rivers, lakes, ponds, and fresh and slightly brackish reaches of estuaries. It is widely cultivated in Eurasia, Africa and Asia continents for its large nutritious seeds. The nut is tetrahedral, red, black, green, hard and woody with four sharp spines and spineless formed from the persistent sepals of the flower, that bear recurved barbs. The parent plant is killed by frost in autumn or decomposes quickly. Dry weight phytomass ca. 100 to 1500 g/m2 has been reported in native and introduced ranges. The nuts are 20% heavier than water upon maturity, and sink rapidly to the bottom where they overwinter in the sediment. The raw seeds are very nutritious and it contains 4.7% protein, 0.3% fat, 0.6% fibre, starch (carbohydrate) 23.3%, 1.1% mineral and 70% water.

Soil samples were also taken and analyzed treatment wise after harvest of each crop in each year. Plant samples were taken at physiological maturity for both the crops for the determination of N, P,

K, S, Fe, Mn, Cu and Zn in economic and byproduct parts of the plant. Crop uptake of these elements was estimated by multiplying the dry matter yields (after drying at 70°C to constant weight) of each crop with their corresponding nutrient contents. Nutrient contents in plant parts were measured using standard procedures (Jackson 1973). All nutrient concentrations in plant samples were expressed on a dry weight basis. Mean nutrient concentrations in the plant material of each crop were calculated.

Euryale ferox significantly contributed 34.35 kg/ha/yr N, 56.04 kg/ha/yr P, 53.07 kg/ha/yr K, 27.26 kg/ha/yr Fe and 12.31 kg/ha/yrMn to the soil system. However, the total uptake of these nutrients made by *Euryale ferox* was recorded to be 69.42 kg/ha N, 64.44 kg/ha P, 55.59 kg/ha K, 29.27 kg/ha Fe and 12.39 kg/ha Mn. In case of water chestnut, it was found that the quantum of contribution of nutrients on its decomposition of biomass to the soil system was not appreciable. Water chestnut contributed 7.54 kg/ha/yr N, 14.40 kg/ha/yr P, 16.20 kg/ha/yr K, 3.66 kg/ha/yr Fe and 0.85 kg/ha/yrMn to the soil system.This result confirms that the cultivation of water chestnut for 3-4 years even as a sole crop may not bring a substantial improvement in the fertility status of soil. The total uptake of nutrients made by water chestnut was 21.91 kg/ha N, 21.58 kg/ha P, 17.40 kg/ha K, 1.48 kg/ha S, 3.83 kg/ha Fe, 0.878 kg/ha Mn, 0.035kg/ha Cu and 0.601 kg/ha Zn.

3.12 EVALUATION OF CHILLI VARIETIES FOR BETTER PERFORMANCE UNDER FIELD CONDITION

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Chilli (*Capsicum annuum*), is valued for its diverse commercial uses. It is one of the major vegetable crops that is grown throughout the world especially in tropical and subtropical regions. India is a major producer, exporter and consumer of chilli. In India, chilli is grown in almost all states. Chilli prefers a warm humid climate during early stage and a dry weather towards the maturity of pods.

Diseases are the major problem for successful cultivation of chilli in India. For successful cultivation of chilli, it is important to identify resistant and tolerant varieties against major diseases. An experiment was conducted in KVK Gwalior (M.P.) to evaluate of different varieties of chlli for disease tolerant and better yield performance. A total of 26 varieties from seven institutes were evaluated under field condition for leaf curl, damping off and anthracnose disease. Among these Arka Khyati, Arka Meghana, Madhurima-148, Classica-152 and HVHP-053 (Rashi), EC-566320, Sonakshi-44, JM-283,Pant C-1, were found highly suitable for better growth and yield parameters. However Divya Jyoti ,Jayanti, JM-218, Pusa Jwala, Pusa Sadabahar, Phule Jyoti, Arka Lohit, Arka Harita, Natasha-727, P-1649 were found Moderately suitable for growth and yield. But some varieties like Pusa sadabahar, Kashi Gaurav, Arka meghana and Arka Harita were found susceptible for leaf curl disease and Jayanti, JM-283, JM-218, Kashi Anmol were found susceptible for Dieback at flowering and fruiting stage under field condition.

3.13 PREDICTING KALA ZEERA (*BUNIUM PERSICUM*) SEED YIELD LOSSES CAUSED BY MULTISPCIES WEED COMPETITION IN GUREZ VALLEY OF TEMPERATE KASHMIR.

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Monoculture of Kala zeera in Gurez valley of temperate Kashmir has led to serious weed problems and enhanced cost of production. Yield loss prediction enables the economic analysis of weed control, providing a basis for strategic use of herbicides and diversified weed management, but site differences restrict prediction to the environments for which the models are calibrated. Here an

attempt is being made to calibrate various yield reduction models for predicting kala zeera production. Keeping this in view an experiment was conducted at Mountain Agriculture Research and Extension Station (MAR & ES) previously Zeera Research Sub Station *Gurez* (78°, 20' N Longitude and 31° 20' E Latitude and at 2393 m amsl) *of Sher-e- Kashmir University of Agricultural Sciences and Technology of Kashmir*, Jammu & Kashmir during *Rabi* seasons of 2009-10 and 2010-11 on a flat narrow valley land. Two sets of treatments were imposed to represent both increasing duration of weed interference and the length of the weed-free period measured after germination. The first set of treatments consists of increasing duration of weed interference by delaying weed control from the time of crop emergence up to predetermined week (weedy up to 2, 4, 6, 8, 10 and 12 weeks after germination (WAG) of *Kala Zeera*). The second set of treatments established six levels of increasing length of the weed-free period (weed free upto 2, 4, 6, 10 and 12 WAG). Besides two controls (Weed free and weedy check). These comprised of 14 treatments which were laid out in Randomized Complete Block design with three replication.

Various linear, hyperbolic, and sigmoidal regression models were evaluated to predict yield loss, relative to yield in weed free environment. It was concluded that realistic hyperbolic yield loss models, driven by variables describing the competitiveness of multispecies weed infestation, allows for more accurate predictions as compared to linear and Sigmoidal models by registering higher coefficient of determination. Further the data taken at early stages of crop emergence have strong relationship with weed infestation (R^2=0.74-0.90) as compared to data taken at later stages (R^2= 0.33-049). Further relative leaf area and relative density of weeds proved more defining variables for predicting yield loses in kala zeera seed yield. These models can also be used to define economic thresholds of weed infestation, but their usefulness often faces concerns about long term effects, such as build up of weed seed bank in the soil or propagation of herbicide resistant weeds when threshold infestation are not controlled.

3.14 PREDICTION OF SEEDLING ESTABLISHMENT IN CORIANDER (*CORIANDRUM SATIVUM* L.) BASED ON VIGOUR TEST

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Coriander (*Coriandrum sativum* L.) is an annual herb (2n=22), which belongs to the family Apiaceae and generally grown in winter season as main crop in India. All parts of the plant are edible, but the fresh leaves and the dried seeds are most commonly used in cooking. This is mainly used as spice for adding taste and flavour in different food stuffs but also possesses some medicinal properties.

The seed vigour is an important aspect of the seed quality which varies even in the seed lot having same germination percentage. The loss of seed viability in storage is preceded by a wide range of symptoms which collectively contribute to the loss of seed vigour. The loss of seed vigour usually reflected in the lack of uniformity and decreased field emergence. Generally, the germination standard alone does not give actual estimate of field performance of any seed lot. So, there is need to have some reliable parameters for evaluation of the seed quality in coriander. In order to assess the seed quality of different varieties of coriander in terms of field performance, the seeds were subjected to a number of tests which can be used reliably to predict crop establishment under the field conditions. In the present study, different seed lots of twenty coriander varieties were evaluated with a view to have substantial information on their vigour parameters. The mean sum of squares due to varieties was highly significant for all the parameters which indicated presence of substantial amount of variability among the varieties. It was found that the field establishment had significant positive correlation with Standard Germination test, Accelerated Ageing test and Tetrazolium test. The regression analysis among seedling establishment and different vigour parameters revealed that standard germination test, tetrazolium test and accelerated ageing test could be used as reliable predictors for seedling establishment. Maximum

R^2 value was recorded for standard germination (0.980) and accelerated ageing test (0.974) followed by tetrazolium test (0.851), endorsing the reliability of tests. Hence, Standard germination, tetrazolium test and Accelerated ageing test was found the most suitable predictors for seedling establishment in coriander.

3.15 ENHACING LIVELIHOOD OF RURAL SHGS THROUGH IMPROVED POSTHARVEST TECHNOLOGY

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Agriculture and allied sectors is the largest livelihood providers in rural India, still Indian farmers (SHGs also) are among the poorest in the world. Agriculture sector is potentially largest employment providing sectors in the country. Among rural SHGs, the food security not only requires an adequate supply of food which also entails availability access, and utilization of the food but also take into consideration postharvest technologies to prevent losses. In the recent years, the horticultural production has increased many folds. Moreover, the postharvest loss has also been 30-40% of total production. Since, almost rural SHGs members involved in agricultural cultivation but due to general lack of education on appropriate postharvest handling practices and technologies, leading to rough handling, mechanical damage, improperly handled mixed loads, and food safety dangers affecting the quality of produce.

Educating the SHGs members and handlers in postharvest sector and investing in simple, low cost improvements, such as gentle handling, sorting and grading, protecting packages, shade and cooling, zero energy cool storage, and cool transport, we can help SHGs and marketers to reduce physical losses, maintain food quality and market value for a longer period of time. All these are grave concerns for most smallholder SHGs farmers of the country to manage their postharvest losses will not only improve their livelihood but food security of their community or country.

3.16 USE OF VERMI COMPOST IN VEGETABLE CROPS IMPROVES THE ECONOMY OF THE VEGETABLE GROWERS

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Cauliflower is the post popular and important vegetable in India. The farmers generally applied cow dung, FYM and chemical fertilizers as nutrients. But the yield of cauliflower is low in spite of application of cow dung and chemical fertilizers. Imbalance use of fertilizers and lack of awareness of new innovative technology farmers are getting loss. So that trial was conducted to assess the response of recommended dose of fertilizers and vermicompost. The data revealed that use of 15 cant load cow dung + (N: P_2O_5: K_2O:140:80:40) recorded yield 295 q/ha and B: C ratio was (1.9:1), while use of vermicompost @1.5 t/ha+ ¾ RDF (N:P_2O_5: K_2O: 120:60:60) obtained curd yield 330 q/ha with BC ratio(2.7:1). Uses of vermicompost improves the soil health and have all kinds nutrients macro & micronutrients which fulfill the requirement of nutrient for the plants. It's reported that attack of disease and insect pest also minimizes by the use of vermicompost. Those farmers were using the vermicompost getting good return and organically produced vegetables having high value in the market. Therefore, it is revealed from the trial that rural livelihood may improve with the help of organic farming.

3.17 NEW RECORD OF *SPODOPTERA EXIGUA* (HUBNER) ON POTATO TUBERS FROM HIMACHAL PRADESH, INDIA

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Soil insect pests pose one of the most difficult problems for potato growers. To a large degree, the difficulty can be attributed to the very persistent nature of these pests. Moreover soil pests often go unnoticed for several years building up their numbers slowly with each successive potato crop. In India, there are many pests which damage potato roots and tubers inside the soil. Whitegrubs, cutworms and potato tuber moth have been reported earlier causing significant economic losses under field conditions. In Kangra valley of Himachal Pradesh, an epidemic of *Spodoptera exigua* (Hubner) occurred on spring crop of potato during 2015 and detailed survey was conducted during April-May, 2015, at the time of potato harvesting in the valley. *S. litura* has been reported to occur on potato as a serious defoliator, but tuber infestation has not been recorded earlier by larvae of this species. The data were recorded at 8 locations namely Malan, Menjha, Nagri, Pathiar, Hatwas, Nagrota, Palampur and Parour and per cent tuber infestation varied from 3 to 15 per cent. The larvae made deep circular holes in the tubers and in case of heavy infestation 5-8 holes were observed on a single tuber. As a result of the infestation, the quality of produce was adversely affected and the tubers were rendered unfit for sale and consumption. In crops such as potato, where the appearance of tubers is important, the presence of holes on the surface of tubers is always risky for the farmers. Several larvae were recorded to feed on a single tuber. The larvae were brought to laboratory for further rearing and identification. In laboratory, observations on its biology were recorded. The eggs were greyish to white and are covered with a layer of whitish scales. The egg is circular in shape and is slightly peaked, tapering to a point. The eggs were laid in clusters which hatched in 2-3 days. The larvae passed through five instars. The larvae were pale green or yellowish in colour having dorsal and lateral stripes which varied in colour and pattern during different instars. Full fed larvae attained a length of 22-23 mm. The full fed larvae constructed a pupal chamber near the soil surface and pupation occurred in soil in the earthen cell. Duration of the pupal stage was 4-5 days. The moths are moderately sized with a wing span of 25-30 mm. The forewings are greyish brown with irregular banding pattern. The hind wings are uniform grey with a dark line at the margin. Adult longevity was recorded to be of 9-10 days.

3.18 LIVELIHOOD PROMOTION THROUGH VALUE ADDITION TO HOUSEHOLD TRADITIONAL *SAL* (*SHOREA ROBUSTA* C.F. GAERTN.) LEAF PLATE MAKING IN JHARKHAND, INDIA

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The study sought to investigate the status of traditional *Sal* leaf plate making, its present livelihood contributions and future prospects through value addition by mechanized moulding among tribal households engaged in the profession in Bundu block of Ranchi district in Jharkhand, India. The sample villages were selected using random sampling technique and all the households owning cottage industries of *Sal* leaf plate making were selected as representative for household survey employing purposive sampling technique. Data on production, seasonality, employment generation (person-days annum^{-1}), income earning (Rs. annum^{-1}) and marketing of *Sal* leaf plates were collected through personal structured interviews and non-participant observations. Results revealed that the traditional *Sal* leaf plate making generated an average earning upto Rs. 25000 annum^{-1} and employment of 400 person-days annum^{-1} among the sample households. The value addition in

traditional *Sal* leaf plate making by mechanized moulding has substantial potential of income and employment generation by Rs. 49100 annum^{-1} and 450 person-days annum^{-1}. Thus, the value addition through mechanized pressing of raw *Sal* leaf plates will boost livelihood promotion of an additional income of Rs. 24100 household^{-1} annum^{-1} (96.40%) and an additional employment of 50 person-days household^{-1} annum^{-1} (12.50%). The livelihood promotion and development among tribal communities is a primary mission of state and central Government for migration check, poverty alleviation, capital security, reduction of resource deprivation and socio-economic improvement, hence, the value addition of traditional *Sal* leaf plate making through mechanized pressing is crucial intervention to accelerate the forest resources based livelihood diversifications, promotion and development.

3.19 MAHUA: A POTENTIAL TREE

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Mahua is also known as Mehwa, Mahuda, Illipe and Ippi in different region. Its botanical name is *Madhuca indica (Syn. Madhuca latifolia)* and belongs to Sapotaceae family. It is an Indian originated tropical tree and found largely in the central and northern Indian plains and forests. It is a large deciduous tree (20 m tall) with spreading habit. In India it is found in West Bengal, Chhattisgarh, Jharkhand, Utter Pradesh, Bihar, Maharashtra, Telengana, Madhya Pradesh, Kerala, Gugrat. In U.P. it is found in sonbhadra, Mirzapur, Chandouli, Varanasi etc. district in wild form. It is an avenue tree. The flowers and the fruits are a source of nutrients for the tribal people. Seed is a source of oil. The main uses of oil are care of the skin, making soap, as a vegetable butter. Fruit is used as a vegetable. Mahua cake is good manure. Bark is used for medicine making. It is an important tree for society. Fuel, furniture, medicines, oil etc. are obtained, and help in generation of cottage industry, resulting boosting rural economy. Knowing the medicinal, ornamental, industrial values, department of forestry and horticulture, govt. of India started campaign for growing and conserving throughout the country.

3.20 FRONTLINE DEMONSTRATIONS AN EFFECTIVE TOOL FOR TECHNOLOGICAL INTERVENTION AND ITS IMPACT ON YIELD AND ECONOMICS OF SOYBEAN PRODUCTION IN HOSHANGABAD DISTRICT

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Hoshnagabad district is lies under Cendral Narmada Valley Zone. During the Kharif soybean is the major crop of the district which occupies an area of about 2.0 lakh ha. During the Kharif season of the year 2008-09 front line demonstrations has been conducted with new high yielding variety JS-9305 with 12 farmers in 5.0 ha area at Ghatli and village of Kesla Block. Selected farmers were trained for improved crop production technology with the use of balanced doses of fertilizer with micronutrients Zinc and Sulpher. Results revealed that improved technology increases the 46.02% increase in yield over farmers practice with 18.18q/ha grain yield. However, the average grain yield under the farmers practice was 12.45q/ha. The major reason of the low yield under farmers practice was due to the use of old variety Ujjain 21. In the year 2009-10 Improved new high yielding variety JS-9305 was demonstrated in Somalwada village of Seonimalwa and at Bamuriya village of Hoshangabad block in 5.0 ha area. In this year variety JS-9305 bagged 18.18 q/ha grain yield under demonstrations as compared to 12.45q/ha under farmers practice. As a result of Front line demonstrations there was 46.02% increase in yield has been recorded during this year. Under oilseed crops new high yielding multiple resistant variety JS-9752 has been demonstrated in the year 2010-11at Bamuriya village of the Hoshangabad block during the Kharif season. In this year new variety increase the 31.62% yield over farmers practice. Variety JS-9752 yielded 21.85q/ha as compared to 16.60q/ha under farmers practice of old variety JS-335.

Bio-diversity and Genetic Resources Management for Sustainable Livelihood Innovative Agriculture.

4.1 NEW CRYOTECHNIQUES FOR CONSERVATION OF HIMALAYAN MULBERRY GENETIC RESOURCES USING WINTER BUDS

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Three new cryotechniques viz., two-step freezing, vitrification and encapsulation-dehydration were standardized for long-term preservation of Himalayan mulberry winter dormant buds as explants. A step by step freezing protocol preceded by desiccation up to 15 to 25% critical moisture content was successfully developed using optimized recovery conditions, including dark incubation and rehydration in sterile moist moss grass for different durations. These recovery conditions after cryopreservation led to higher survival when compared to controls. In vitrification method, descaled winter buds were directly immersed in a vitrification solution (PVS_2) for different duration (20, 40, 60, 90 or 120 min). For encapsulation-dehydration, alginate beads containing descaled bud were dehydrated (24, 48 and 72hrs) in various sucrose concentrations (0.3, 0.5, 0.75 or 1.0 M). Beads were desiccated using laminar air flow for 1-6 h. Following encapsulation-dehydration, treatment of alginate beads with 0.75 M sucrose was more effective in promoting recovery and survival of explants after cryo for 48 h. Re-growth of explants was also observed following vitrification and this reached 50% with increasing duration of the PVS_2 treatment from 20 to 90 min. Overall, the highest recovery and survival was obtained when explants were subjected to encapsulation-dehydration in the presence of 0.75 M for 48 h sucrose dehydration followed by 5 h desiccation. Genetic stability has also been studied in *in vitro* regenerated plants of mulberry (fresh, before and after cryopreservation) genetic resources using RAPD and ISSR molecular markers. Both markers did not reveal any polymorphism among the mother plant and *in vitro* regenerants before and after cryopreservation, suggesting that mulberry germplasm was genetically stable after cryopreservation.

4.2 CONSERVATION OF NATURAL RESOURCES WITH LAC CULTURE: A STEP TOWARDS SOIL, WATER AND FOREST CONSERVATION LINKED WITH INCOME AND EMPLOYMENT GENERATION IN SITAPUR, U.P

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A vast majority of the rural poor continue to be dependent on land and water resources for their meagre livelihoods. Sadly, however, various phenomena including deforestation, drought, soil erosion, low risk bearing capacity of farmers, small holding size, traditional methods of cultivation, poor net-work of transport, lack of marketing avenues etc have resulted in decreased incomes for farming families. Lac, a non-toxic, valuable resin of insect origin was being produced by an insect *Kerria lacca,* cultured on shoots of several species of trees i.e. Palas (*Butea monosperma*), Ber (*Zizyphus mauritiana*), Kusum (*Schleichera oleosa*), Flemingia (*F. semialata*) etc.. The lac insects yields resin, lac dye and lac wax. The district sitapur very rich in lac host plants (*Butea monosperma*, *Zizyphus mauritiana, Schleichera oleosa* etc.) in scattered places but due to lack of knowledge and awakening, farmers ignore host trees and they cut & use for fuel purposes. Krishi Vigyan Kendra-II Sitapur has taken the initiatives on Introduction of Lac Culture technology and its Value added products in the district for income and employment generation in 2013 with technical collaboration of IINRG, Ranchi. The

technology was demonstrated on *Flemingia semialata* and *Zizyphus mauritiana* with the introduction of Kusumi lac life cycle. Lac culture technology started in the district initially on 0.5 Ha area under key monitoring of KVK. Presently the technology of farming been adopted in 8 Blocks of Sitapur district covering 24 Ha Area.

An average income of Rs. 1000/ *Ziziphus* tree and Rs. 50/ *Flemingia* plant is being started with this technology in 6-7 months. This technology was viewed by more than 3000 farmers of Sitapur, Hardoi, Barabanki, and Kanpur Dehat farmers also. The technology was also demonstrated in Kisan Melas organisied by different Universities/ Institutes/ organisations. For sustainable management of the technology, a group of farm women were trained on Lac based value added product management and their product utilization. The harvested Lac were also being utilized by women farmer in making different types of Lac based value added products and they are earning 50-70 Rs./ day in 3-5 hour. The higher attention was due to its market arrangement by KVK itself. KVK established different modules of the farming with greater extent of interventions, higher returns and employment generation. It is generally compatible with existing rural livelihood activities in terms of its labour requirements. Lac Cultivation encourages conservation of host tress and leads to a re-greening of the land and conversation of forest.

4.3 ISOLATION AND CHARACTERIZATION OF ZN-SOLUBILIZING BACTERIA FROM *FLEMINGIA* RHIZOSPHERE

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Lac, the only natural resin of animal origin, is produced by a number of species of lac insects, of which, the most commonly cultivated species in India is *Kerria lacca*. In India, lac production is mainly confined to the states of Jharkhand and Chhattisgarh, and certain pockets of Madhya Pradesh, Maharashtra and West Bengal. Among these states, Jharkhand is the leading producer and contributes about 57.0% of the country's lac production. Globally, a large number of lac host plants have been recorded. However, there are only a few species of lac host plants on which *K. lacca* is able to continue its life cycle, reproduce effectively, and produce lac of commercial significance. Among the different host species,*Flemingia spp*. is gaining more importancenowadays due to its bushy and quick growing nature. Unfortunately, a major portion of the lac growing areas in Jharkhand has acidic soil which is a major growth-limiting factor for plants. Besides the availability of macronutrients, deficiency ofZinc is often a major plant growth constraint noticed in acidic soils. A pH equal to or lower than 5.0 facilitates Zinc solubilization and, in humid zones, it can be easily leached away. This can be overcome by the use of biofertilizers whereby microorganisms enhance the nutrient availability to plants. Keeping these in mind, thirty-three Zn-solubilizing bacteria were isolated from root nodules of freshly uprooted one year old *Flemingia semialata* plants.Amongst them, six isolates were selected on the basis of their Zinc solubilization efficiency. The selected isolates were identified as *Bacillus megaterium* (ZSB 29), *Bacillus megaterium* (ZSB 31), *Bacillus cereus* (ZSB 47), *Bacillus subtilis* (ZSB 34), *Rhizobiumsp* (ZSB 54) and *Rhizobiumsp* (ZSB 55),based on 16S rRNA sequences.

These isolates were subjected to further studies viz., quantitative estimation of Zn-solubilization, influence of the isolates on pH of the YEM, potash and phosphate solubilization efficiency, production of IAA, urease, catalase,siderophore and gluconic acid. *Rhizobiumsp* (ZSB 54) showed maximum solubilization of Zinc and also decreased the pH from 7 to 3.4 of the Yeast Extract Medium (YEM),and recorded highest production of urease and gluconic acid. These results indicate that*Rhizobiumsp* (ZSB 54) may be used as a bio-inoculant for a prospective biofertilizerfor *Flemingia spp.*

Information, Management and Policy for Livelihood Improvement.

5.1 POTENTIAL APPLICATIONS OF A 'SUSTAINABLE LIVELIHOODS APPROACH' TO MANAGEMENT AND POLICY DEVELOPMENT FOR FISHERIES

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The 'Sustainable Livelihoods Approach' (SLA) has been widely applied to inform the design of policy and development interventions aimed at reducing poverty in less developed countries. The paper proposes that livelihood strategies that include diversification and risk-spreading behaviour have been common features of inshore fishing in India, just as they are in low-income countries in the tropical countries. These adaptive livelihood strategies have, however, often been undermined by inappropriate sectorally-based policies. Similarly, a range of 'traditional' informal resource conservation, resource allocation and conflict resolution mechanisms that existed in inshore fisheries have been eroded by lack of recognition in Indian fisheries law. With the trend towards withdrawal of the state from inshore fisheries management and a new Common Fisheries Policy that emphasises regional decision-making and greater participation by fisherfolk, the informal institutional arrangements and livelihood strategies that have survived may now grow in importance and once again emerge to help secure the continued viability of inshore fishing.

5.3 EMPLOYMENT AND LABOUR LIVELIHOOD IN RURAL BIHAR: VILLAGE LEVEL ANALYSIS

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The study analyses the changing employment and livelihood pattern of labour households using panel data. The labour households are those who earned more than fifty per cent income through wage earning in farm and non- farm sectors. A decline in proportion of labour households has been observed during last four yearsbut there is a clear evidence of transition of labour force from farm to nonfarm sector. There was increase in employment for male in both farm and non- farm sector but increase was higher in non- farm sector than farm sector. Women employment in farm sector declined from 69 days in 2010 to 41 days in 2013 whereas there was an increase their employment in non- farm sector. The transition of labour force from farm to nonfarm sector has been fast during last four years. The role of non – farm sector in providing rural employment has increased and strategy to increase non- farm employment may be one of potential pathways for alleviating poverty in Bihar. The trend in real wage rate showed that non- farm wage has grown faster than the farm wage. It has been observed that wage employment in general is superior to self-employment on very small size of farms in rural areas.

Both farm and non – farm sectors witnessed increase in wages of labours during last four years but the increase was much higher in non-farm sector (65%) than farm sector (15%).Wages in farm sector in not only low but it does not provide regular employment whereas wages in non – farm is higher and employment is more regular. Wage determinant analysis revealed that a healthy, educated and land owning adult male labour is likely to get higher wages whereas the caste of labour is not a significant factor for payment of wages in rural Bihar.

Non-farm sector emerged as a major source for providing employment and generating income on labour households. Remittances emerged as the second most important source of income on labour households because migration for gainful employment is one of the important strategies for maintaining in Bihar, particularly on poor households. Analysis of income of poor and non- poor labour households indicates declining trend in income through wages through non – farm on poor labour households but

it observed increasing trend on non- poor labour households, indicating positive effect of non- farm employment in increasing income and alleviating poverty on labour households. Income through employment in agriculture sector is declining but agricultural is still likely to be a key driver of growth even in the non-agricultural economy through linkages. Policies to extend systematic skill and training opportunities will help better opportunities of employment for migrants and non- farm workers which will help reducing poverty and improving livelihood of labour households in rural Bihar.

5.5 QUANTIFYING EFFECTS OF PHYSIOCHEMICAL ATTRIBUTES OF WATER QUALITY ON PLANKTON ABUNDANCE: A CASE STUDY OF NARMADA

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In an endeavour to extract information from secondary data, a critical insight is given on the data available in CIFRI bulletin prepared on the basis of an exploratory survey on the river Narmada. Total river system was divided into four stretches and water samples were collected from 28 sites using standard methodology. One of the objectives was to characterise aquatic environment of the river on the basis of water quality. A total of 13 parameters i.e., Water Temerature (^{O}C), Transparency(cm), D.O. (mgl^{-1}), pH, Total Alkalinity (mgl^{-1}), Sp. Cond (µmhos cm^{-1}) , Ca(mg l^{1}) , Mg (mg l^{1}), Total Hardness (mg l^{1}), Chloride (mg l^{1}), Phosphate (mg l^{1}), Nitrate(mg l^{1}) and Silicate (mg l^{1}) representing physico-chemical attributes of water were studied. All these parameters are normally interrelated in aquatic systems. Characterisations of water quality become very difficult due to such correlated multi parameters. To characterise the water quality in fewer dimension after eliminating correlation, multivariate factor analysis was performed to extract hidden factors. It was observed that four factors cumulatively explain 85% variation and 5 factors cumulatively explain 92% variation of water quality of the river. However, characterisation is restricted to only four factors, considering the tradeoff between ease to interpretation and accuracy. The first factor comprising of Calcium, Phosphate and total hardness of water explains 32.5% variability. It is dominated by the phosphate, a component of nutrient of aquatic system. Second factor, a synthesis of Silicate, Nitrate, pH, sp. conductivity, is dominated by silicate. Since silicate is required for growth of daitoms, we may call this factor as productivity potential of the river aquatic system. Third factor is a differential effect between transparency and Magnesium. It can be renamed a water clarity. The fourth factor represents the pH. Subsequently, these extracted four factors will be use for explaining plankton community structure. The relationship of plankton abundance and zooplankton abundance of Narmada River found positively significant with factor 1 and factor4 and negatively significant with factor3.

5.6 ANTI CANCEROUS ACTIVITY OF TOTAL LIPID ON PROSTATE CANCER (PC-3) CELL LINES: PROLIFERATION AND APOPTOSIS, ROS GENERATION, NUCLEAR CONDENSATION AND CELL CYCLE ANALYSIS

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Cancer known medically as a malignant neoplasm is a broad group of various diseases all involving unregulated cell growth. The increasing rates of cancers particularly Breast, Colon and Prostate etc. in several developing countries such as India and neighboring countries. Prostate cancer is one of the most common cancers in men and in 2008 is projected to account for 30% of the new cancer diagnoses in the United States. Identifying risk factors for prostate cancer is critically important

to develop potential interventions and to expand our understanding of the biology of this disease. Now efforts have been made to develop natural and bio-suitable compounds for the prevention and treatment of cancer. Total lipid may reduce inflammation and in turn decrease risk of prostate cancer development and progression.

5.7 ASSESSMENT OF ECONOMIC IMPACT IN CHICKPEA THROUGH CLUSTER DEMONSTRATION IN GHAZIPUR DISTRICT OF UTTAR PRADESH

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The chickpea is a valuable pulse crop of India was most of the population is dependent for its protein requirements on pulses. This crop is grown in sandy loam soil and can be grown with minimum input in comparison to cereal crops. The present study is an attempt to get an idea about the level of adoption of recommended production technology by the farmers of Karanda Block of Ghazipur district of U.P. The farmers involved in chickpea production were selected and surveyed. It was observed that the majority of farmers (60%) adopted the recommended varieties. Seed treatment and use of fungicides sprayer were not used by most of the farmers. Thus an urgent need to improve the production and quality of chickpea is to increase the level of awareness among the farmers.

5.8 CLIMATE CHANGE AND RURAL LIVELIHOOD SECURITY IN UTTRAKHAND HILLS

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In hilly areas, Uttarakhand is rich in biodiversity. It is seen as profitable activity as it is rich in agro forestry and horticultural crops. Here women mass who sustain and take care of natural property, different agriculture operations, and traditional knowledge all contribute to hill agriculture. In Uttarakhand various agricultural practices are applied to make convenient to farmers so that educated youth take farming as an opportunity and profitable enterprise of earning. Climate change impacts on agriculture are being witnessed all over the world, but countries like India are more vulnerable in view of large population depending on agriculture, excessive pressure on natural resources and poor cropping mechanism. Several models predict that rising temperatures, increased climatic variability and extreme weather events could significantly impact food production in coming years. Hence it is of paramount importance to enhance the resilience of Indian agriculture to climatic variability and climate change. The Indian farmers have evolved many coping mechanisms over time, but these mechanisms are often unable to cope with extreme weather events being witnessed in recent times. Therefore there is need to use modern science combined with indigenous wisdom of farmers to enhance the resilience of Indian agriculture to climate change. Besides undertaking research to develop location specific climate resilient agricultural technologies, there is need to make immediate efforts to transfer the already available climate resilient agricultural technologies to the farmers' field especially in more vulnerable regions. Objective of the work are, to enhance the resilience of Indian agriculture covering crops, livestock and fisheries to climatic variability and climate change through development and application of improved production and risk management technologies. To demonstrate site specific technology packages on farmer's fields for adapting to current climate risks.

5.9 CLIMATIC VARIABILITY, CAUSES, IMPACT AND MITIGATION PLANNING IN CROP PRODUCTION SYSTEM

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At present, throughout the world a significant concern about the effects of climatic changes, as climate is one of the main determinants of agricultural production and it might causes variability in agricultural production system. The anomaly of temperature and rainfall over 30 year decadal running mean weather data of four different location low to high altitude in Kashmir valley have been studied and found that the increasing trend in temperature, however, decreasing trend in rainfall. The magnitude of maximum temperature increases 1^0C but minimum temperature was decrease 0.5 ^{0}C at Srinagar, no variation was observed in Maximum temperature but observed 1 ^{0}C increase in Minimum temperature at Kokernag, while 1.3 and 1.15 ^{0}C at Pahalgam and 6 and 1.6 ^{0}C at Gulmarg ware rises maximum and minimum temperature, respectively. In other hand decadal mean yearly rainfall is decreases about 250 mm, 400 mm, 200 mm and 350 mm at Srinagar, Kokernag, Pahalgam and Gulmarg respectively. When there is significant variation either in the state of climate or in its variability persisting for an extended period is referred as climate change (IPCC, 2007). As climate pattern shifts, changes in the distribution of plant diseases and pests may also have adverse effects on agriculture. At the same time, agriculture proved to be one of the most adaptable human activities to varied climate conditions (Mendelson *et al*., 2001).The green house effect is a natural feature of the climate system. Some gases in the atmosphere are particularly good at absorbing the long wave radiation and are known as the green house gases (GHG). Gases that contribute to the greenhouse effect include: water vapour, Carbon dioxide, Methane, Nitrous Oxide & Chloro-fluorocarbons (Bouwman; 2001). Temperature is an important climatic factor, which can have profound effects on the yield of crops mainly through phenological development processes.

Differential response to temperature change (rise) by various crops has been shown under different production environments (Kalra *et al ;* 2008). The increase in CO_2 concentration could increase the photosynthesis rate and hence enhance the plant growth though the magnitude depends on the crop type as different crops differ in their photosynthetic mechanisms. Since increase in CO_2 is associated with increase in temperature, which can affect crop yield adversely, it becomes necessary to assess the effects of potential effect of both changes of CO_2 and temperature in order to determine the future agricultural strategies that would maintain higher crop productivity (Krishna *et al* ; 2004). The issues of climate change and its potential impact on agriculture production have been a major research, topic in recent times. We need to emphasis on the potential interactions between the effects of climate change and ongoing economic interactions. Global warming is already underway and adapting strategies are now a matter of urging, especially for the most vulnerable poor countries. An appropriate climate policy should be to minimize the effects of climate change at farm, regional, national and international level.

5.10 ON-FARM BALANCING RESERVOIR DESIGN ON THE BASIS OF CANAL WATER AVAILABILITY AND GROUND WATER QUALITY

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Balancing reservoir is an intermediate water storage tank between the watercourse and the

farm. Even in high rainfall areas, agriculture is not sustainable in the absence of water storage structures. Inflow components i.e. water availability of canal water, groundwater and rainfall occurrence over the balancing reservoir. The outflow components mainly water requirements for crops and evaporation from surface area of water balancing reservoir, balance the water storage capacity that mitigates the water demand of the crops and on the basis of balancing components deciding the design of water balancing reservoir. A comparative analysis reveals that the part of this capacity results from a very significant development of balancing reservoir (particularly in the smaller range of sizes) in the time interval, probably as a response to rapidly declining canal supplies. The rainfall trend analysis shows that the rainfall occurrence at probability at 50% chance is 370.8 mm which occurs once at two years of recurrence interval. A fundamental implication is that field 'losses' such as seepage and percolation do not necessary to represent losses at a larger scale.

5.11 REORIENTATION OF AGRICULTURAL EDUCATION- A MULTI DISPLINARY APPROACH FOR SUSTAINABILITY OF MODERN INDIAN AGRICULTURE

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Indian agriculture has come a long way from the situation “living from ship to mouth” to “food self sufficiency”. The agricultural sector is getting more complex due to globalization, impact of climate change, entry of corporate sector in agriculture value chain, expanding demand for processed food and need for postharvest technology. India will need rich human capital of highly qualified, motivated and well trained agricultural scientists to meet these challenges of 21st century. It is the responsibility of the state agricultural universities (SAU's) to provide such human resources. In the first green revolution, SAU's played a key role in generating technology and taking it to end users through effective integration of education, research and extension. India is an agricultural country. At the time of independence our country faced food shortages. Later on due to green revolution we became self sufficient in food grain production despite population increase. One of the important factors in success of green revolution is the role played by agricultural graduates. After independence, state agricultural universities were established in all the states to impart education in the field of agriculture. Indian council of agricultural research, New Delhi regulates and ensures effective dissemination of agricultural education. At the same time as agricultural universities are established by respective state governments, they are controlled by them. Although agricultural universities have done commendable job with but in present liberalized era of world trade organization and general agreement on inbreeding, lack of faculty competence in never areas of agricultural sciences etc. Agricultural education being a professional education, it is necessary to take remedial measures so as to ensure food sufficiency for our growing population. In this context this paper describes the status of agricultural education in India highlighting challenges and suggesting strategies to overcome them.

5.12 ROLE OF KRISHI VIGYAN KENDRA IN RAISING THE SOCIOECONOMIC STATUS OF FARMERS THROUGH SEED VILLAGE PROGRAMME IN SIDHI DISTRICT OF MADHYA PRADESH

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Krishi Vigyan Kendra (KVK) is a noble concept developed by Indian Council of Agricultural Research (ICAR) which was rest upon a solid base of transfer of technology (TOT) from laboratory to

farmer's field with respect to Agriculture, Horticulture, Animal Husbandry, and Floriculture. Krishi Vigyan Kendra, Sidhi is located Madhya Pradesh working under the administrative control of JNKVV, Jabalpur. The village Dadhiya is situated in Sidhi block district. It is located 25 km away from district place and also from Krishi Vigyan Kendra, Sidhi. In the year 2008 KVK, Sidhi has adopted the village Dadhia for its intensive activities of Transfer of Technologies related to agriculture through seed village scheme for increasing agricultural production thereby raise the socioeconomic status of farmers. Before intervention of KVK i.e. up to 2008, most of the farmers were produce grain and sold at normal market rate. From, the data it clearly observed that before 2008, maximum area was covered under grain production. After KVK intervention (2008 onwards), it was noted that the farmers started to produce seed of improved variety. The productivity and economic returns of paddy in improved technologies were calculated and compared with the corresponding farmer's practices (local check). Improved practices recorded higher yield as compared to farmer's practices. The improved technology recorded higher yield of 42.51 q/ha in the year than 28.15 q/ha. In spite of increase in yield of paddy, technology gap, extension gap and technology index existed. The improved technology gave higher gross return Rs./ha with higher benefit cost ratio as compared to farmer's practices. The variation in per cent increase in the yield was found due to the lack of knowledge, and poor socio economic condition. By visualizing the success of innovative farmers of Dadhia, other farmers of adjoining villages are also attracted towards them and ready to adopt the technologies. The socio economic status of this region is changed drastically. Background:Krishi Vigyan Kendra (KVK) is a noble concept developed by Indian Council of Agricultural Research (ICAR) which was rest upon a solid base of transfer of technology (TOT) from laboratory to farmer's field with respect to Agriculture, Horticulture, Animal Husbandry and Floriculture. In India, at present 644 KVKs working in different parts of the country.

5.14 LINE X TESTER ANALYSIS IN TOMATO (*Lycopersicon esculentum* Mill.)

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The present investigation entitled “Line X Tester analysis in Tomato (Lycopersicon esculentum Mill.)” was undertaken at Main Experiment Station, Department of Vegetable Science of Narendra Deva University of Agriculture & Technology, Narendra Nagar, Kumarganj, Faizabad (U.P.). Analysis of variance revealed significance differences among the genotype for all the characters indicating existence of wide variation in the experimental material evaluated. The anylysis of variance for combining ability revealed significance difference due to lines, testers and line x tester interection for all the traits. The indicated that combining ability played vital role in the expression of the traits under study.

5.15 KNOWLEDGE MANAGEMENT IN AGRICULTURE THROUGH ICT TOOLS

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Knowledge management can be defined as the fact or condition of knowing something with a considerable degree of familiarity acquired through experience, association or contact. Knowledge consists of the attitudes, cumulative experiences, and developed skills that enable a person to

consistently, systematically and effectively perform a function (William and Michael, 2005). It is an integration of explicit and tacit knowledge. Explicit knowledge refers to all aspects of formal, systematic, recorded, communicated and shared knowledge that is made accessible through a variety of information delivery systems. Tacit knowledge on the other hand is highly personal, created by doing, trial, error, reflection and revision. Knowledge management encompasses processes and practices concerned with the creation, acquisition, sharing and use of knowledge, skills and expertise and follow a circular flow and a nonstop process that continuously updates itself. Knowledge management in agriculture must embrace the following three objectives (i) identifying how the problem can be solved or opportunities can be exploited (ii) the source of knowledge required for success; and (iii) determination of who would be responsible for taking the actions needed to solve the problem or exploit the identified opportunities

Agricultural information and knowledge created from these sources is stored in various forms before it is disseminated for use. The main repositories of such knowledge include publications, audio visuals, and websites. The stored knowledge and information is then disseminated to users, such as rural farmers, through intermediaries notably during trainings, field visits, exhibitions, publications, and using traditional forms of ICT (TV and radio), modern forms of ICT (internet, mobile phone, etc), and others. The flow of agricultural knowledge and information from creation to end use. Tools of knowledge and information management in agriculture scientific knowledge, Indigenous Knowledge, Knowledge creation Universities Research institutes. Farmers Others Knowledge and information intermediaries Radio, TV Mobile telephony Field visit, exhibition Publication Rural farmers Knowledge and information dissemination Knowledge and information use Knowledge and information storage Knowledge and information repositories Audio-video Website Publications. Farmers can also improve and enrich their existing indigenous (tacit) knowledge not only through the interaction with modern knowledge, but also by sharing experience with other farmers. However, in order to scale up knowledge to other farmers, the knowledge and information needs to be codified, made explicit, and upgraded or modernized with research-based evidence.

5.16 TRADITIONAL WISDOM OF RURAL WOMEN'S ABOUT FLORA KINGDOM AND THEIR USE IN VARIOUS DISEASES

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The history of herbal drug plants in India is very old since times mentioned in the 'rig veda' around 4000-1600 B.C. in the 'Atharva veda' and 'upovedas' the properties of drug is described in details. The sushruta samhita, described 700 indigenous herbal drug plants for their chemical properties and medicinal usage.

According to agricultural and natural resources development defined it as:
“Plants that are recognized by people to have reliable and effective medicinal values are commonly use din treating and preventing specific animals and disease and play an essential role in health care”

This study was conducted in Amanjanj block of Faizabad district. A sample size of 115 rural women (wife of house hold) was selected from the list of families through proportionate random sampling techniques keeping in view the caste system.

The knowledge of respondents was onserved cent per cent in case of medicinal plants viz., anola, bael, neem, papaya, amrud, sahjan, gudhal, herbs seen bayalll the respondents like tulsi, ginger, haldi, and medicinal shrubs like rose, marigold, menthe, datura, behaya etc.

The suggestive measures to overcome the constraints in maintaining and usage of traditional wisdom about flora kingdom promotion of use of medicinal values of plasnts ranked 1st followed by traditional knowledge of plants must be past an generation to generation got rank 2nd.

Interface between research, Industry and farmers for Livelihood Improvement through Innovative Agriculture.

6.1 STARTUPS IN INLAND FISHERIES: CASE STUDY OF *CHAURS* IN SIWAN AND GOPALGANJ DISTRICTS OF BIHAR

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Bihar is one of the sleeping giant in inland fisheries, despite having vast floodplain wetlands like 9000 ha of *Mauns* and 150,000 ha *Chaurs*. These wetlands were hardly utilized under scientific fisheries management and production process. The average yield of these wetlands were 100 kg/ha though the potential of 1000-1500 kg/ha/year.

Start ups means setting something new in motion. In information technology sector a large number of startups have come up over the years. But startups rarely have been seen in fisheries sector and especially in inland open water fisheries sector. This article deals with the start ups in *Chaur* fisheries in Bihar's Siwan and Gopalganj district. Under this case study, four start ups with no prior knowledge of fisheries in four different *Chaurs* of Siwan and Gopalganj district were covered. The methodology used was participatory tools, focused group discussion (FGD) with the four entrepreneurs and their employees. The FGD with the startups was done during last week of December 2015. All the four *chaurs* covered under study were under the ownership of private individuals or group. The four *chaurs* were used only for single paddy crop with poor yield. The first startups started in Chainpur, Siwan, around 15 ha area was used for fisheries first time in 2008 by a five member startup and at present the productivity of this chaur is 2000 kg/ha/year. The second startup took place in Mahmadpur, Gopalganj, where one family startup is now giving productivity of 2.3 tones/ha/year. The other startup started in Sundari and Maharajganj in Siwan district also provided shown excellent productivity increase.

These startups has not only increased the supply of fish in local market but provided permanent and contractual employment to a large number of fishermen and traders. Now in Siwan the fishes are marketed in live condition and fetching good price. These startups have boosted production of fishes, increased employment opportunities and also health consciousness among consumers through the supply of fishes in live condition. It has also resulted in reducing the import of fishes from outside Bihar in these two districts.

6.2 IMPACT OF DIFFERENT TILLAGE PRACTICES IN RICE-WHEAT CROPPING SYSTEM ON SOIL ORGANIC CARBON AND NITROGEN POOL

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Rice (Oryzasativa L.) and wheat (Triticumaestivum L.) grown sequentially in an annual rotation, constitute a rice-wheat cropping system (RWCS) and in a system occupy nearly 13.5 million hectares area in the Indo-Gangetic plains (IGP) of South Asia. Conventional agriculture can result in loss of organic matter (OM), resulting in degradation of cultivated soil.

A study was conducted to assess the impact of different tillage treatments in rice and wheat cropping system on soil organic carbon and nitrogen pool. The experiment was carried out in split plot design with four main plot treatments viz. P_1 (direct dry seeding by zero till drill), P_2 (direct seeding of sprouted rice in puddle condition), P_3 (hand transplanting) and P_4 (transplanting by self-propelled rice trans planter) while the sub plot treatment (for wheat) included T_1 (conventional sowing), T_2 (bed

planting), T_3 (strip till drilling) and T_4 (zero till drilling). Significant variations in SOC and soil nitrogen pool were observed in wheat tillage treatments for D_1 (0-10cm) soil depth. The T_4 and T_3 treatments had significantly higher values of SOC pool as compared to T_1. Similar trend was also observed for soil nitrogen. Rice tillage treatments did not have any significant impact on SOC and soil nitrogen at D_1 or subsequent depths. The summarized depths 0-30 and 0-60 cm did not show any impact of the tillage treatments on SOC or soil nitrogen pools.In rice tillage treatments, SOC pool ranged from 26.06 Mg/m^3 (P_4) to 27.61 Mg/m^3 (P_1) while the range for wheat tillage treatment was 26.30 Mg/m^3 (T_4) to 26.75 Mg/m^3 (T_1). At D_1 depth soil N pool was found to be statistically higher for T_3 and T_4 tillage treatments in wheat, whereas T_2 tillage treatment was found to be statistically at par with T_1. This is because of the presence of higher amount of SOM in T_3 and T_4. A high and positive correlation between SOC and total N was observed because most of the nitrogen present in soil is in organic form.

6.3 NITROGEN, PHOSPHORUS & POTASH REQUIREMENT OF SUGARCANE VARIETIES UNDER DIFFERENT PLANTING DATES

Sarnam Singh*, Lal Singh, AK Singh and SK Saini
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Sugarcane crop sustains second largest agro- industry after textile. Sugarcane is cultivated more than 4.5 million hectare area under varied agro ecological conditions. India is producing more than 300 million tons of cane with more than 18.0 million tones of centrifugal sugar (Shahi, 2002). The productivity of cane in India is low, being 72.0 tons per hectare as compare to other efficient sugarcane growing countries. There are several factors responsible for low cane productivity and production like-large soil and climatic variations, biotic and a biotic stress and injudicious use of chemicals fertilizers. Apart from soil and climate, fertilizers requirement of the sugarcane crop may vary with genotypes and planting dates. Field experiments were conducted at Crop Research Center, GBPUAT, Pantnagar (US Nagar) India. The experimental soil was silty clay loam, rich in organic carbon, medium in available phosphorus (12.5kg) and potassium (270kg/ha) with neutral in soil reaction (pH 7.2).The experiments consisted of three planting dates, three genotypes, and three NPK levels, and experiments was laidout in split plot design. Autumn sugarcane intercropped with mustard gave 16.6% and 39.6% higher cane yield than sugarcane planted after mustard and wheat harvest, respectively. Among the genotypes CoPant 93227was superior than CoPant 92226 and CoPant 90223 in the giving 8.6 and 2.6% more cane yield, respectively. Quality wise CoPant 92226 was superior to rest of the other genotypes. Autumn cane intercropped with mustard required 25% more fertilizers doses (150N: 100P2O5: 50K2O kg/ha) than the spring and late spring sugarcane crop followed by mustard and wheat crops, respectively. Variety CoPant 93227 out yielded CoPant 92226 and CoPant 90223 under autumn planting season.

6.4 MICRO IRRIGATION: A POTENTIAL TOOL FOR PER DROP MORE CROP IN EASTERN INDIA

Ajay Kumar
Sr. Scientist, ICAR-RCER, patna

Eastern part of India has experienced moderate to severe draught in last 10 years and its severity in Bihar is one of the highest. As a result farmers are not able to irrigate their fields sufficiently through conventional methods of irrigation like check basin, border and furrow due to scarce water

resource available on the ground surface or below ground level. Moreover, water productivity of crops grown under conventional methods is as low as 0.3 kg/m^3 for most of the cereals and vegetable crops. Further water application efficiency of these conventional methods of irrigation is below 40%. To cater food and fiber need of ever growing human and animal population in eastern India, it is the need of the hour to produce more crop production per unit of scarce water resource. By application of micro irrigation in this part of country, more than two and half times acreage can be brought under the irrigation with the same volume of water. It will not only harness less explored potential of these modern irrigation technologies like micro sprinkler, drip, LEWA irrigation systems etc but also quality of the product will also be enhanced. Central Government is encouraging micro irrigation in Pradhan Mantri Krishi Sinchai Yojna (PMKSY) for making '*har khet ko pani*'.

6.5 PHYSIO-CHEMICAL AND BIOLOGICAL ANALYSIS OF RADAUR-LADWA STRETCH (WESTERN YAMUNA CANAL)

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This paper deals with the suitability of Surface and Ground water quality of Western Yamuna Canal in Haryana, India for irrigation and other use. The major water use of this canal is for irrigation purpose (94%), domestic water use (4%) and industrial and other uses (2%). A criterion of classification in different class of water is performed through empirical approach following the guidelines of Indian standards provided by CPCB, 2003. The rapid increase in urbanization and industrialization is leading towards deterioration of water quality. In this study, analysis is performed to identify the groundwater and surface water quality in the vicinity of Radaur-Ladwa stretch. Direct disposal of domestic and industrial waste obstructs the flow of Western Yamuna Canal thus water is stagnant at most places and self-purification mechanism of water is occurring no more. This study reveals that the surface water of the Western Yamuna Canal comes under E class of water, which is unfit for domestic use, propagation of wildlife and fisheries. However it is found suitable for irrigational and industrial cooling purpose only. Most Probable Number (MPN) values are high in the ground water, which indicates microbial contamination of water and require immediate action for up-grading existing treatment facilities. The result indicates alarming signs and suggests immediate response for policy along with adaptation and mitigation to bring at full stop to contaminating activities. If water contamination is continued likewise a time will come soon that the water quality of Radaur-Ladwa stretch (Western Yamuna Canal) will be unfit for irrigational purpose too.

6.6 PROTECTION OF FARMERS' VARIETY THROUGH PPV AND FARMERS' RIGHT ACT, 2001 : A CASE STUDY OF NALANDA, BIHAR

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India is among the first countries in the world to have passed legislation granting Farmers' Rights in the form of Protection of Plant Varieties and Farmers' Rights Act, 2001. India's experience important due to its International contribution to negotiations on Farmers' Rights, its position as a

centre of biodiversity, and the complexities of agriculture in India within which the country is attempting to implement rights. India's law is unique not only because of its far reaching rights for farmers, but also in that it simultaneously aims to protect both breeders and farmers. This attempt to evolve a multiple rights system could, however, pose several obstacles to utilization and exchange of plant genetic resources among the farmers. India has framed a unique legislation, but still faces the task of implementation. This should serve as a signal internationally that establishing legislation is insufficient to effectively promote Farmers' Rights. Failing to implement Farmers' Rights in India would be a heavy loss for all the farmers who need to Farmers' Rights to protect their livelihoods, secure their access to resources, protect their rights to seeds, and, above all, lift them out of poverty. With this background the present case study was studied and farmers of Nalanda district were acquainted with Crop biological diversity, land races and Farmers' variety through Krishi Vigyan Kendra Harnaut, (Nalanda). The farmers of Nalanda district were empowered with knowledge to protect their variety through Plant Protection Variety and Farmers' Act , 2001. Twenty five farmers were filled application to office of PPV and Farmers' Right Authority, New Delhi for registration of his traditionally cultivated plant variety. So, the farmers of Nalanda shall be entitle to save, use, sow, re-sow, exchange and share or sell his farm produce including seed of a variety protected under this act in the same manner as he was entitled before the coming into force of this act provided that the farmer shall not be entitled to sell branded seed of a variety protected under this act.

6.7 DIVERSE ROLE OF WOMENS WORKING IN AGRICULTURAL SECTOR FOR EMPOWERMENT AND UPLIFTMENT OF ECONOMY

Sandhya Mure and S.K. Tiwari
Scientist , Krishi Vigyan Kendra, Hoshangabd and Harda, Powarkheda MP
Jawaharlal Nehru Krishi Vishwavidyalaya

Empowerment of women, demands recognition of their rightful place in the decision-making process. Women should have knowledge and resources, greater autonomy in decision-making, greater ability to plan their lives, greater control over the circumstances that influence their lives and free them from shackles imposed by prevailing customs, beliefs and practices. They should become active members in development process rather than mere beneficiaries of programmes and services. The National Agriculture Research System, Indian Council of Agricultural Research and State Agricultural Universities have developed several agro-technologies for reducing drudgery of farm women. Use of these technologies is now disseminated through information technology. Women should also be freed from socio cultural bindings. Technologies which are labour saving, drudgery reducing, income generating and productivity increasing is now being given wide publicity and their use encouraged through pragmatic extension approach through trainings, Demonstrations by **Krishi Vigyan Kendra's** working in every district of the country Women must be provided opportunities to have control over production resources that would lead to better life for their families and their children. Infrastructural facilities like road, electricity, cool chain, etc. must be developed in rural areas for increasing entrepreneurial opportunities. Women mostly work in groups. There is need to organise women's societies for various activities involving group engagement. A strong and effective women's cooperative movement is desirable to boost economic upliftment process of rural women and families.

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