

# VISION 2030



**Birsa Agricultural University**

Ranchi-834006, Jharkhand (India)

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## FOREWORD

The agriculture in Jharkhand is passing through the crucial stage due to weather vagaries. These problems of agriculture and allied sector are of very peculiar nature and demand special technologies/programmes/ policies for the well being. Being dominated by small and marginal farmers and largely tribal population, the growth in agriculture in the state much lower as compared to other states. Presently, problems in agriculture are of multidimensional magnitude like rainfed agriculture, monocropping being acidic soil, poor and degraded ones, inadequate rain water harvesting, very deep ground water table, presence of toxic elements in water, climate change & biodiversity loss, green and dry fodder deficit, poor health of small and big ruminants, low productivity of livestock, nondescript breeds, mining disasters, unsustainable use of natural resource and declining factor productivity etc. Moreover, the tribal population of the state is suffering due to poverty, unemployment/ underemployment, malnutrition, low calorie intake, etc. further aggravating the problems. The undulated topography of the land, low adoption of modern technologies/techniques, meager varietal replacement rate (VRR) and low seed replacement rate (SRR), improper management of forests, silvipasture/grasslands, inappropriate/over exploitation of forest and/or product(s) etc. are the hallmarks of agriculture of the state. Nevertheless, trade related barriers in agriculture, intellectual property rights and their management, patents, transgenics, acts related to varieties, seed, biodiversity, insecticide, environment etc. on one hand, while policies related to land, water, animal and forests on the other hand are the guiding force for future agriculture. Therefore, it is right time to have a vision document of the university having major thrust for tackling the issues through quality research, human resource development, transfer of technologies, and development of entrepreneurship at various levels. To address the challenges and to exploit the opportunities Vision 2030 of BAU has been prepared to address the problems through basic/strategic/applied/anticipatory research and innovations/approaches. The strategies to mitigate the impact of climate change has also been envisioned. Nevertheless, the emphasis has been placed in the vision for the development of quality human resource.

I hope that the Vision 2030 will serve the future course of policy formation, planning and actions to deal with the challenges in agriculture of the Jharkhand state and to harness the opportunities for the well being of the farming communities in order to increase production and productivity on sustainable basis while protecting the biodiversity and environment.

Date : 22/06/2013  
Place : Ranchi

  
(M.P. Pandey)

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## PREAMBLE

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Jharkhand state is broadly classified as low-income or, low-middle income category in Indian parlance. While poverty and hunger remain one of the major challenges before the state, agriculture remains one of the predominant sector of the state economies. A vast majority of population in the state lives in rural areas and depends upon agriculture for livelihood and sustenance. Despite rapid growth of some of the economies in the state due to abundance of natural mineral resources, dependence on agriculture, as primary occupation, has witnessed little decline whereas future growth of agriculture sector is critical to eradication of poverty, livelihood security, reduction in hunger and promoting sustainable and inclusive growth of the state economies. Global as well as Indian agriculture is facing several challenges, threatening its growth and sustainability. The physical and economic environment in which agricultural activities are undertaken is changing rapidly and getting complex. This necessitates preparedness to face upcoming challenges and unfolding new reality.

In an ancient epic entitled, “Manu Samhita” there is description of Jharkhand (Cultural and Pouranic evidence of Jharkhand) by a verse

Ayaskah patre payah panum,  
Sal patre ch bhojanum,  
Shayanum Khajuri patre  
Jharkhande Vidhiwate.

Meaning, the people of Jharkhand drink water in metal tumblers, eat meals on the plates of sal leaf and sleep on the mat of palm leaf. In Imperial Gazetteer of India, it is stated that Jharkhand is “Chotanagpur, including the states of Chotanagpur and Orissa.” The description of Jharkhand for the first time was depicted on the stone writing in 12<sup>th</sup> century by the king Narsingh Deo of Gangraj. This means, the Jharkhand region is very old and it was spread between south part of Orissa to Chotanagpur to Santhal Pargana to eastern part of Uttar Pradesh and Madhya Pradesh (Singh, 2003). The newly created Jharkhand State came into existence on 15th November 2000

as 28<sup>th</sup> State carved out from erstwhile state of Bihar, as per the constitution of India. The major parts of the state falls under schedule V with hilly and difficult terrain covered with forest. Latitudinally and longitudinally, the state lies between 21<sup>o</sup>58' 10" to 25<sup>o</sup>19' 15" North and 83<sup>o</sup>20' 50" to 88<sup>o</sup>4' 40" East, respectively. The total population is approximately 3.29 crores. There has been a marginal decrease in the population growth rate between the periods 1981-1991 (24.0 %), 1991-2001 (23.2 %) and 2001-11 (22.34 %). Jharkhand as a state is known as a vast reservoir of natural resources in terms of forest areas as well as minerals. According to the UNDP report, the state has the highest level of poverty in the country, next only to Orissa (Sharma, 2012). The state is basically tribal dominated having nearly 27 per cent scheduled tribes and 11 per cent scheduled castes (Dalit) population. There are 30 tribal groups in Jharkhand. The Government of India has identified total 75 tribal communities as Primitive Tribal Groups (PTGs) and Jharkhand is inhabited by nine PTGs (Asur, Birhor, Birjia, Hill Kharia, Korwa, Mal Paharia, Sauria Paharia, Parahiya, and Savar). As the PTGs live in more interior pockets which are generally inaccessible and with declining sources of sustenance, they become more vulnerable to hunger/starvation, malnutrition and ill-health. Some of them are even on the verge of extinction. Among all states and UTs, Jharkhand holds 6<sup>th</sup> and 10<sup>th</sup> rank in terms of the ST population and the per centage share of the ST population to the total population of the State, respectively. In the state, the literacy rate improved from about 54 per cent in 2001 to about 68 per cent as per census 2011.

## 1. AGRICULTURE AND SOCIO ECONOMIC SCENARIO

The total geographical area of Jharkhand state is 79.72 lakh ha. and cultivable land for agriculture is approximately 38 lakh ha. The net sown area (NSA) is only 28 per cent of the geographical area of the state due to hilly terrain. The soil is acidic in nature and irrigation facilities are very meagre. Total irrigated area is only 12.77 per cent of NSA and the rain is very unpredictable. The average annual rainfall of the state is 1300mm but due to its inadequate distribution more than 80% water runoff, rainfall occurs around 100 days annually only. Normally, the rain starts from 15<sup>th</sup> June and ends by 25<sup>th</sup> September. The South-West monsoon contributes nearly 85% of rain water. Accordingly, success or failure of crop production is closely linked with the onset, progress and withdrawal of monsoon. Delay in onset, intermittent dry spell (1-3 weeks) and early withdrawal are also usually observed. Failure of Hathia Rain has adverse impact on the reproductive phase of rainy season crops thus crop yield as well as establishment of winter season crops are affected. About 75% area covered under rice production during *Kharif* (rainy) season in Jharkhand remains fallow in the subsequent *Rabi* season due to a number of biotic, abiotic and socio-economic constraints. The main crops of Jharkhand state are paddy, maize, wheat, pulses, oilseeds, potato and vegetables. Besides this, there are good opportunities to raise horticultural crops in the state, the area under fruit crops is approximately 0.72 lakh ha. and under vegetable it is reported to be 2.59 lakh ha. Jharkhand has 62,000 crossbred cattle, 1.1 million non-descript cattle and 0.31 million buffaloes in milk, producing around 1.7 million tones of milk. Milk production per animal is in the range of 0.952 to 2.91 (indigenous cattle) 3.31 to 7.04 (crossbred cattle) and 2.05 to 5.44 Kg per day (Buffalo), respectively. Poultry population of 11.2 million contributing 3962 million eggs per annum. The State also has 6.6 million goats and 0.7 million pigs. The present area under fish production is 1.70 lakh ha. Majority of the farming community (62.6 %) is marginal with average land holding 0.52 ha and small (17.5 %) with average holding of 1.52 ha. Out of the 10.13million working population, 76.86 % are engaged in agriculture. The area under forest is approximately 30 per cent. It feels proud to state that the Jharkhand is first rank holder in tasar silk production in the country.

### **Socio-economic condition**

Jharkhand is very rich in terms of availability of natural resources. It is adorned with some of the richest deposits of iron ores and coals in the world. Despite this, state is confronting challenges of under development, high incidence of poverty, unemployment, malnutrition and ill health. According to the World Bank Report (2007), Jharkhand's key social indicators such as literacy, enrolment, infant mortality and child nutrition were below the all India averages. The composition of the poor has been changing and rural poverty is getting concentrated in the agricultural labour and artisan households and urban poverty is the casual labour households. The extent of deprivation is higher in Jharkhand as compared to the rest of India and higher in rural areas than in urban areas. The average power consumption is only 30 kwh per capita, the lowest in India as compared to 373 kwh per capita as national average. Only 23 per cent of households have excess to electricity compared with all India average of 59 per cent while, in rural Jharkhand areas it is less than 10 per cent. The tribal groups in Jharkhand have the highest poverty intensity in India which is higher than the ST groups in other Indian states. As per Planning Commission (Govt. of India) estimate, the newly formed state Jharkhand has 40.3 per cent population below poverty line in 2004-05 (Sharma, 2012).

According to Multidimensional Poverty Index (MPI), about 645 million people (55%) in India are poor. Unfortunately six out of eight Indian States (Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Orissa, Rajasthan, Uttar Pradesh and West Bengal) have 421 million MPI poor belonging to eastern India. The MPI reveals a vivid spectrum of challenges facing the poorest households. MPI considers 10 sharp indicators, namely Education (child enrolment and years of schooling); Health (child mortality and nutrition) and Standard of living (electricity, drinking water, sanitation, cooking fuel, flooring and assets) (Patel, 2011). Employment in agricultural sector is limited and a large proportion of the population still remains below the poverty line and suffers from malnutrition. On the basis of socio-economic conditions, Planning Commission has identified 150 disadvantaged districts in the country and the highest number of backward districts are confined in eastern region (69 nos.) (RCER, 2011). Poverty is concentrated in the poorer states, and in terms of absolute numbers. In Jharkhand 35 lakhs families are below poverty line out of the total number of about 69 lakhs households (Planning Commission, 2013).

### Agro-Climatic Zones

The state consists of three sub-zones. It comes in the 7<sup>th</sup> (eastern plateau and hill regions) of 15 agro-climatic zones as classified by NARP. The state is divided into three sub zones namely; North Eastern Central Plateau, Western Plateau and South Eastern Plateau. The features of each sub-zone are mentioned below:

Features	Central and north eastern plateau zone (Zone-IV)	Western plateau zone (Zone-V)	South eastern plateau zone (Zone-VI)
Districts	Dumka, Deogarh, Godda, Sahebganj, Pakur, Jamtara, Giridih, Bokaro, Dhanbad, Koderma, Hazaribagh, Chatra, Ramgarh and part of Ranchi	Palamu, Garhwa, Lohardaga, Gumla, Latehar, Khunti, Simdega & part of Ranchi	East Singhbhum, Saraikella Kharsawa and West Singhbhum
Major rivers	Damodar, Ajay, Mayurakshi	Koel, Sankh, Auranga, Amanat, Kanahar	Subernrekha, Baitarni North Karo and Phulijhar
Climate	Humid and sub-humid Tropical Monsoon	Sub humid to sub-tropical	Humid to sub-humid tropical
Altitude (m above msl)	275-670	222-1142	250-1000
Latitude	23°25' -25°30'N	22°30' -24°30'N	21°28' -23°36'N
Longitude	84°25' -87°40'E	83°22' -85°06'E	85°05' -86°54'E
Annual Rainfall	1282.8mm with highest in Ranchi and lowest in Giridih. Nearly 80% rainfall received between Mid June to 1 <sup>st</sup> Wk. of October.	1030.6mm 75% rainfall received from July to September. This zone is drought prone as the pattern of rainfall is very erratic and unpredictable.	1199.7mm varies from 1250 to 1500mm. Nearly 80% of annual rainfall received from last week of June to September.
Break of Monsoon	2 <sup>nd</sup> week of June in Normal year	Monsoon starts from last week of June and continues up to Mid of September	Monsoon breaks in the last week of June
Soil Type	Neutral (Rajmahal) to Moderately acidic (Koderma, Hazaribagh and Ranchi). Soil fertility is poor	Shallow to medium deep, reddish yellow to yellow in colour and moderately acidic to neutral in reaction and poor in fertility.	Red soils are common soils found all over the granite and gneissic plateau of Singhbhum. Upland soils are red in colour and acidic in reaction (pH 5-6)

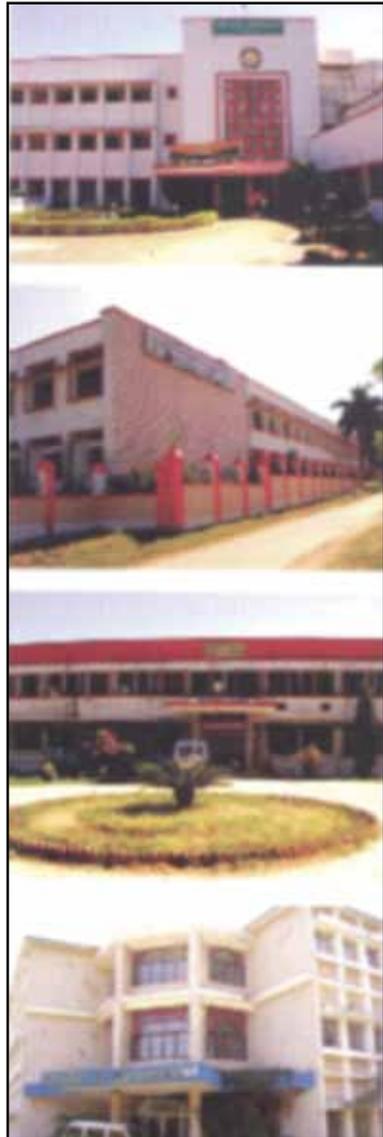
*Continued*

Features	Central and north eastern plateau zone (Zone-IV)	Western plateau zone (Zone-V)	South eastern plateau zone (Zone-VI)
Assured Irrigation	9-10% of cultivable area in <i>Rabi</i> . Major area of the Zone is rainfed	12% of cultivable area in <i>Kharif</i>	13-14% of cultivable area in <i>Rabi</i>
Major Crops	Rice, Maize, Arhar, Kulthi, Niger, Til, Linseed, Wheat, Moong, Gram, Marua and Vegetables.	Rice, Maize, Gram, Barley, Mustard, Wheat, Arhar, Lentil, Urd.	Paddy, Vegetables, Maize, Linseed, Niger, Wheat, Moong, Gram, Urd and Arhar
Cropping System	Rainfed single cropping Double Cropping: Paddy-Paira crops of Gram/ Linseed Paddy-Gram Paddy-Mustard Paddy-Wheat Irrigated ( <i>Kharif-Rabi</i> -Summer): Paddy-Potato Paddy-Potato-Vegetables; Paddy-wheat; Paddy-Mustard; Paddy-Vegetables; Vegetable-Vegetable-Vegetable	Rainfed single cropping Double cropping: Paddy-Gram/Oilseed Paddy-wheat (irrigated cond.) Maize-Arhar Maize-Gram Maize-Oilseed Arhar-Til	Rainfed Single cropping- Paddy/Paddy/Arhar, Maize/Arhar, Moong/ Urd/Niger/Ragi, Groundnut/Til/Kulthi Double Cropping- Paddy-Linseed, Paddy-Gram, Paddy-Mustard Irrigated <i>Kharif</i> - Paddy-Potato-Vegetable Paddy-Groundnut Paddy-Mustard, Vegetable-Vegetable-Vegetable

## 2. AGRICULTURAL EDUCATION, RESEARCH AND EXTENSION SYSTEM

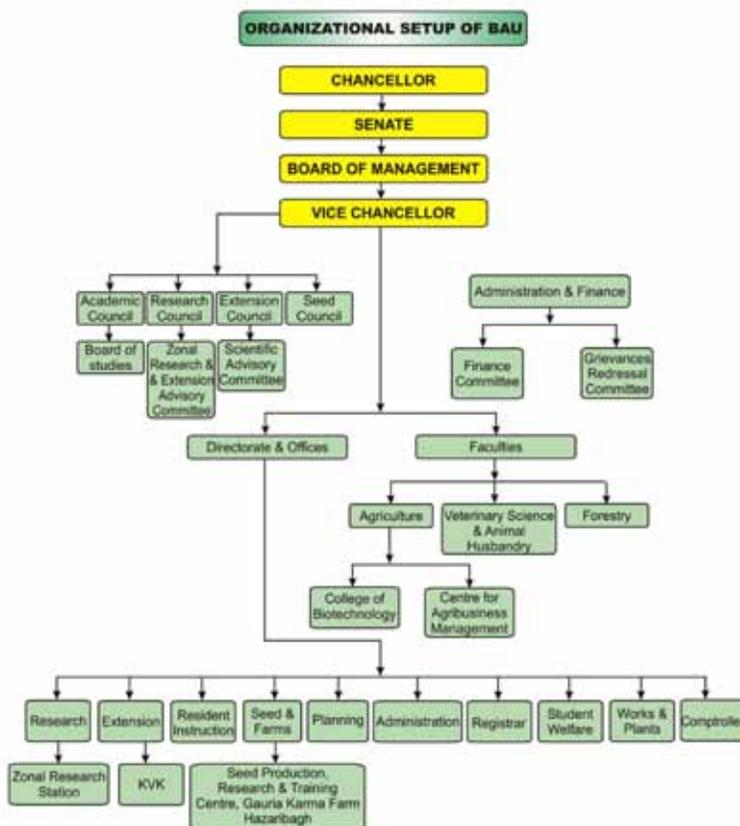
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In India, systematic agricultural research began in 1905 at Imperial Agricultural Research Institute at Pusa, Bihar. At that time Bihar was part of Greater Bengal (Bengal, Bihar, Jharkhand, Orissa, and Bangladesh) under Bengal Presidency. In 1912, Bihar got separated from Bengal, and in 1936, Orissa was separated from Bihar. In 2000, Jharkhand was carved out from Bihar. In 1912, three research stations in Bengal Presidency were established, one at Sabour for Indo-Gangetic flood plains, Ranchi for plateau region, and Cuttack for coastal region. Thus Kanke, Ranchi has the long history of research in rice and other crops. In 1956, an agriculture college was established at Kanke, and in 1972, it became part of Rajendra Agricultural University, Bihar. In 1981, Birsa Agricultural University (BAU), Ranchi was established through an act of the legislature of Govt. of Bihar on 26th June, 1981 after its formal inauguration by the then Prime Minister of India Smt. Indira Gandhi which was later adopted by the Government of Jharkhand. The University was named as Birsa Agricultural University (B.A.U.) in the honour and memory of the outstanding and well known freedom fighter, Birsa Munda, who rendered remarkable



selfless service for the benefit of poor tribal people. This University was established in the predominantly tribal belt of eastern India with the primary objective of upliftment of economically backward classes & other inhabitants of Jharkhand through education and development of the modern practices in the field of Agriculture, Animal Husbandry and Forestry. This is the lone Agricultural University of newly created Jharkhand State.

Presently, the University has three faculties i.e. Faculty of Agriculture, Faculty of Veterinary Sciences & Animal Husbandry and Faculty of Forestry. The university is also decorated by six numbers of Directorates namely; Directorate of Research, Directorate of Extension Education, Directorate of Seed & Farms, Directorate of Planning Implementation & Monitoring, Directorate of Works & Plant and Directorate of Administration. At university head quarter, the area under different Faculties/Directorates/Units is 259 ha. A new course programme on Agribusiness Management has been started in the Centre of Agribusiness Management and course of biotechnology under Faculty of Agriculture. Two new departments, namely Department of Aquaculture under Veterinary faculty and Department of Home Science under Agriculture faculty has been created for Diploma and certificate programmes. To cater the need of entrepreneurship development the unit of Business Planning and Development (BPD) has been established recently with the support of the ICAR. The university is also having one hospital, five libraries and one ATIC at head quarter. The state Government has sanctioned seven new colleges (three colleges of Agriculture at Godda, Deoghar and Garhwa; 1 College of Fishery at Gumla; 1 College of Horticulture at Saraikella; 1 College of Agricultural Engineering at Ranchi and 1 College of Dairy Technology at Hansdiha, Dumka). Under the Directorate of Research, there are three Zonal Research Stations created under NARP, viz., Zonal Research Station (ZRS), Chianki, Daltonganj (Medininagar), Zonal Research Station, Dumka and Zonal Research Station Darisai (East Singhbhum) and in the Directorate of Extension Education 16 KVKs are functioning in the state. In 2005, Govt. of Jharkhand has further transferred to BAU, 859 hectare land for seed research, production and training farm at Gauria Karma, Hazaribagh which is the centre for seed production programme. Altogether, the university is having 1200 ha of land for different research, academic, extension, livestock and seed production activities. The administrative establishment setup of the university is depicted in the following chart:



## 2.1. Mission

To develop human resources in agriculture and allied sciences, and generate appropriate technology to reduce poverty and hunger through enhanced food and nutritional security, income generation and ecological sustainability.

## 2.2. Mandate

- ❖ Develop academically qualified human resources through U.G., P.G., Ph.D. and other academic programmes.
- ❖ Conduct basic, strategic and need-based area-specific applied research in Agriculture, Veterinary Science and Animal Husbandry, Forestry and Fisheries to develop technologies relevant to farming community for livelihood security and higher farm income.

- ❖ Help the State to optimize the use of inputs and exploit the genetic potential of crops, forestry and livestock resources.
- ❖ Promote the application of modern agricultural technology through entrepreneurship development and for improving the agricultural situation of the state and socio economic status of scheduled tribes and other weaker sections of the society through various extension programmes.
- ❖ Organise need based training programmes for officials, extension functionaries of State Departments, farmers and other organisations.
- ❖ Develop collaborative linkages with Government Undertakings and National and International Organisations for sharing and improving university resources.
- ❖ Help and provide technical guidance to the State Govt. for development of agriculture in the State.

### **2.3. Goal**

To develop and evaluate improved technologies through basic, strategic, applied and adaptive research to enhance production, productivity, nutritional superiority and profitability and minimize losses in agriculture, veterinary and animal husbandry, fishery, forestry, biotechnology and allied sectors through disciplinary and multidisciplinary team approach, and national and international collaboration without any adverse impact on the natural resources and environment.

### **2.4. Faculties and Directorates**

#### **a. Faculty of Agriculture**

The foundation stone of Ranchi College of Agriculture was laid on 15 August, 1955 by Sri Anugraha Narayan Singh, and got inaugurated on 29 January, 1959 by the then Chief Minister of Bihar, late Shri Sri Krishna Singh. Later, after the establishment of Birsa Agricultural University in 1981, it was upgraded as Faculty of Agriculture and having 14 departments. It has PG in 8 departments. The UG and PG lecture halls are equipped with e-learning facilities. This college has been premier institution for Agricultural education and research in the country.

**b. College of Veterinary Science & Animal Husbandry**

College of Veterinary Science & A.H. was established in 1961 as a constituent college under Ranchi University and functioned under State Animal Husbandry Department till 1970. College became a constituent College of Rajendra Agricultural University (RAU), Pusa in 1971. This college was established for U.G. teaching only till 1971. P.G. courses were started in six departments from 1972 with further strengthening in all major disciplines from 1977 onwards. It became a constituent college of B.A.U. in 1981 and Ph.D. programme also started from 1981. Presently, the faculty has 17 departments as per norms of Veterinary Council of India (VCI).

**c. Faculty of Forestry**

The Faculty of Forestry started initially as Department of Forestry under Ranchi Agriculture College under erstwhile Rajendra Agricultural University, Pusa in 1979. It became a full-fledged Faculty in 1981, at the time of creation of Birsa Agricultural University. This Faculty holds the credit of being the pioneer Faculty in the country to start undergraduate education in Forestry, which was later upgraded to post graduate level in three out of seven Departments. The Faculty caters to the need of Forestry education and research of Jharkhand State. Subsequent upon the implementation of ICAR guidelines and as per IV<sup>th</sup> Dean's Committee Report, seven departments of Faculty of Forestry, were restructured into five departments namely silviculture & Agroforestry, Natural Resource Management, Forest Products & Utilization, Basic Sciences & Humanities and Forest Biology & Tree Improvement. The main objective of the Faculty is to create human resource development to augment the potentials of Natural Resources (especially Forests) to meet the challenges of local tribal and other weaker sections of the society, by raising their socio-economic status through integrated teaching, research and extension in the field of Forestry. Adoption of some villages for development of Eco-Villages based on 'Green Economy' concept to bring rural self reliance in all needs of the community through sustainable use of natural resources is given priority.

**d. College of Biotechnology**

College of Biotechnology (earlier called Biotechnology Centre) was established with the financial assistance of the World Bank under Bihar

Plateau Development Project in February, 1997 and Post Graduate teaching and research programmes were started with the assistance of Department of Biotechnology, Ministry of Science & Technology, Government of India from August 1999. The college offers Master's Programme only and imparts education in six departments viz., Biochemistry, Bio-informatics, Embryo Transfer Technology, Fermentation Technology, Molecular Biology and Microbiology and Plant Tissue Culture. It also conducts regular short trainings in different fields of Biotechnology to the sponsored graduates and post graduate students of different Universities of the Country.

**e. Directorate of Research**

The Directorate of Research is responsible for development of technologies suitable for the state in addition to coordinate various AICRP projects. At Ranchi head quarter it has established high class research facilities related to crops, soil, animal sciences and forests. The Department of Soil Science & Agro-chemicals was declared as centre of excellence. In addition, to meet the specific need on zonal basis in 1986 under NARP, three zonal research stations were established at Dumka, Darisai and Chianki to carry out zone specific research & development and dissemination of the technologies for three agroclimatic sub-zones of the State. These centres are responsible for both forward and backward technological development and interventions. Sub-zone wise the major thrust areas are as follows:

<b>Central and north eastern plateau zone ZRS Dumka (Zone-IV)</b>	<b>Western plateau zone ZRS Chianki (Medininagar) (Zone-V)</b>	<b>South eastern plateau zone ZRS Darisai (East Singhbhum) (Zone-VI)</b>
Dumka falls under north-eastern part of state and represents Santhal Parganas region. This zone is having highest tribal population. It has higher rainfall as compared to Palamu region. It focused on the development and refinement of location specific technologies. The total area under ZRS is 8 ha while the area transferred to KVK Dumka is 10 ha. The major thrust areas of ZRS Dumka are as under: <ul style="list-style-type: none"> <li>• Development of backyard poultry system including piggery component for small and marginal farmers.</li> </ul>	The topography of land in this region is also flat. The area under ZRS Chianki 33 ha. while 10 ha area has been transferred to KVK Palamu. The rainfall is declining in this zone and focus is on developing appropriate technologies for dry land system. The major thrust areas are as under: <ul style="list-style-type: none"> <li>• Development of suitable rainfall and dryland farming system technology based on soil and water conservations and recycling for utilization of limited water resource of the zone.</li> </ul>	Darisai represents south eastern Kolhan region of the state. Soil in this zone is having problems of copper and boron deficiency. The area under ZRS Darisai is 50 ha. Out of which 20 ha area has been transferred to KVK. The major thrust areas of ZRS Darisai are as under: <ul style="list-style-type: none"> <li>• Development of suitable technology for cultivation of upland and lowland rice in rice-based cropping system</li> </ul>

<ul style="list-style-type: none"> <li>• Development of suitable integrated farming system for tribal farmers.</li> <li>• Design and development of suitable hand tools and animal drawn implements for agricultural operations.</li> <li>• Development of technology for growing fruits e.g., Jackfruit, Mango, Litchi, custard apple and lemon.</li> <li>• Development and testing of Leucena based agro forestry based models.</li> </ul>	<ul style="list-style-type: none"> <li>• Evolving short duration varieties of oilseed crops (sesame, mustard, linseed and safflower) and pulses (Chickpea, Arhar, Lentil, Moong and Urd) suitable for shallow depth soil.</li> <li>• Identification of most promising dryland crops and their varieties for Kharif and Rabi seasons and development of suitable package of practices.</li> <li>• Development of suitable agro techniques for increasing production of dry land fruits viz., guava, papaya, custard apple, ber, aonla, lemon and sweet lime.</li> <li>• Testing of early maturing rice varieties and hybrids and its production technologies for medium and lowland transplanted rice.</li> <li>• Identification of inter crops in newly planted orchards before bearing to ensure additional income to farmers.</li> <li>• Testing of varieties of potato and evolving its appropriate package of practices.</li> <li>• Development and testing of suitable agro forestry models.</li> </ul>	<ul style="list-style-type: none"> <li>• Introduction and management of oilseeds, pulses and wheat crops, especially in light of water available through the development of multipurpose Subarnarekha Project in this zone.</li> <li>• Development of suitable agro-forestry technology and farming system based on livestock and crops especially for small and marginal farmers.</li> <li>• Development of suitable water management technology for Kharif and Rabi crops.</li> <li>• Development of suitable hand tools and implements for crop production.</li> <li>• Survey and study of pest complex of major field and horticultural crops of the region.</li> <li>• Development of low cost Pest Management Technology.</li> <li>• Development and testing of Leucena under agro forestry based models.</li> </ul>
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## f. Directorate of Extension Education

In order to carry out the extension mandates of the University, there is one Directorate of Extension Education. The Directorate has Units like training, information and communication (ATIC) and KVK Monitoring Cell. The ATIC has the facilities of community radio, agricultural museum, video-conferencing, Kisan Call Centre and a small press.

KVKs have been established in 22 districts of Jharkhand. The KVKs are responsible for assessment, refinement and dissemination of technologies as per location specific problems and needs. Out of 22 KVKs, 16 KVKs (West Singhbhum, Palamu, Pakur, Lohardaga, Bokaro, Dumka, Giridih, Sahibganj, Dhanbad, Chatra, Garhwa, East Singhbhum, Jamtara, Latehar, Simdega and Seraikela-Kharsawan) are under the administrative

control of the university. Apart from this, the university has been assigned the task by ICAR to monitor as well as to provide technological backstopping to other 6 KVKs under control of NGOs, State Govt. and ICAR Institutes which are situated in the districts of Deoghar, Ranchi, Gumla, Koderma, Godda and Hazaribagh.

The Directorate undertakes the programmes like on-farm trials, front line demonstrations, on campus and off campus training, information dissemination through regular and occasional publications, newspaper, radio, television, exhibition, kisan gosthi, field day, field visit and farmers' fair and advisory services to farmers, entrepreneurs and organizations including business and non-government organizations.

#### **g. Directorate of Seed & Farms**

The Department of Agriculture, Govt. of Bihar established Government farm in 1914, prior to the establishment of Rajendra Agriculture University (RAU) and it was managed by the Department of Agriculture, Bihar itself. The Central Farm which was transferred to Rajendra Agriculture University in the year 1971 was further transferred to Birsa Agricultural University in the year 1981. The Directorate of Seed & Farms has been provided 859 ha of land for seed production, research and training at Gauria Karma, Hazaribagh. In addition the following facilities under Directorate of Seed & Farms have also been created:-

***Seed testing and training facilities:*** The mission of the seed laboratory is to provide complete seed testing services to farmers and producers and to document the quality of their product and empower them to make sound decisions on the disbursement of their seed. The state - of - art DNA finger printing facility has also been created in addition to seed receiving and registration facilities and seed training hall with all the modern facilities.

***Seed processing facilities:*** The University has established five seed processing units located at Ranchi, Gauria Karma, Dhanbad, Darisai and Chianki of varying capacity ranging from 1 TPH to 4 TPH along with the generator sets. For seed storage, though inadequate but workable facilities have been established.

***Establishment of Mother Plant Nurseries (MPNs):*** Jharkhand State is bestowed with excellent climate for all types of fruit culture except temperate ones. Government has adopted the policy to increase area under

fruit crops. However, the major limitations is the availability of good quality planting materials. Directorate of Seed & Farms, BAU Ranchi has established 16 nos. of mother plant nurseries of 1-4 ha size in different ZRS/KVK in 16 districts of Jharkhand representing the all three sub zones of the state. Twelve fruit crops and 65 varieties of fruit plants have been incorporated in mother block considering the location specific requirements. Efforts have been made to bring all the varieties of 12 fruit crops from their source of origin to avoid any contamination in future.

#### **h. Business Planning & Development (BPD) Unit**

Business Planning & Development (BPD) Unit at Birsa Agricultural University was established in 2010 for catalyzing Agribusiness growth in Jharkhand. It was established for commercialization of agricultural technologies and also for promotion of entrepreneurship in agribusiness and allied fields. It provides consultative services for livelihood promotion, technology commercialization, capacity building and entrepreneurship development through preparation of business plans, financial institutional linkage, Govt. Machinery support, market linkage and networking. Over the last three years, BPD Unit at BAU has helped over 200 entrepreneurs to establish ventures in dairy, poultry, piggery, medicinal plants, integrated farming systems etc. benefitting hundreds of farmers.

#### **i. Collaboration and Linkages**

Birsa Agricultural University has established linkages at National and International level for research, academic and human resource developmental activities. Presently, at National level the University has collaboration with 21 Indian organizations viz., Ministry of Agriculture, Govt. of India, Indian Council of Agriculture Research (ICAR), New Delhi, Indian Agricultural Research Institute (IARI), Central Institute of Medicinal and Aromatic Plants (CIMAP) etc. and at International level the University has collaboration with 13 International institutions/organization/centres viz., Asia Pacific Association of Agricultural Research Institute (APAARI), Thailand, CIMMYT, Mexico, IRRI, Philippines, ICARDA, Syria, ICRISAT, Hyderabad etc.

## 2.5. Research Programmes

Research projects funded by the Indian Council of Agricultural Research (ICAR), Department of Science & Technology (DST), Department of Biotechnology (DBT), National Oilseed & Vegetable oils Development Board (NOVOD), National Medicinal Plant Board (NMPB), National Rainfed Area Authority (NRAA), Protection of Plant Varieties & Farmers' Rights Authority (PPV&FRA) as well as international organizations like Rockfeller Foundation, IRRI, CIMMYT, ICRISAT and ICARDA are being implemented by this University. The University is operating six international projects out of which two projects are from ICRISAT.

### Externally funded projects:

Being part of the National Agricultural Research System (NARS), the university conducts various research and coordination programmes under the aegis of ICAR. Out of 46 ICAR funded projects, 37 projects (32 Agriculture, 3 Veterinary & Animal Husbandry and 2 Forestry) are All India Coordinated Research Projects and 4 Network Projects, 2 Mega Seed Projects and 3 NAIP projects are being operated by the University (details mentioned in table). NICRA projects under AICRP-AM and AICRP-DLA have been made operative during 2010-12.

### Externally Funded Projects:

Details of sixty-one outside funded projects including 37 All India Coordinated Research Projects have been presented below:

#### RESEARCH PROJECTS IN OPERATION

Source of Funding	Faculty	Title of Project	Year of Starting	Budget 2012-13 (Rs. in lakh)
(A) AICRPs				
ICAR	Agriculture (32)	AICRP on Agro Meteorology	01.04.1987	38.93
		AICRP on FIM	01.04.1980	103.73
		AICRP on Floriculture	01.04.2001	20.93
		AICRP on Long Term Fertilizer	01.04.1972	24.90
		AICRP on Wheat Improvement	01.04.1982	39.76
		AICRP on MULLaRP	01.04.1976	66.50
		AICRP on Groundnut	01.04.2001	6.67
		AICRP on Soybean	01.04.1975	15.15

Source of Funding	Faculty	Title of Project	Year of Starting	Budget 2012-13 (Rs. in lakh)
ICAR	Agriculture (32)	AICRP on Small Millets	01.04.1975	91.35
		AICRP on Sesame-Niger	01.04.1971	24.52
		AICRP on Oilseed-Linseed	01.04.1971	21.60
		AICRP on Under Utilized Crops	01.04.1985	14.80
		AICRP on N.S.P.	01.04.1987	15.20
		AICRP on Chickpea	01.04.2001	27.33
		AICRP on Dryland Agriculture	01.04.1971	35.13
		AICRP on Weed Control	01.04.1987	24.68
		AICRP on I.F.S.	01.04.1983	106.32
		AICRP on A.P.A.	01.04.2004	35.30
		AICRP on Tuber Crops	01.08.1987	22.08
		AICRP on Forage Crops	01.04.1971	50.53
		AICRP on Rice Improvement	01.04.1980	82.00
		AICRP on Maize	01.04.2005	15.44
		AICRP on Utilization of Animal Energy	01.06.2009	26.11
		AICRP on Post Harvest Technology	01.08.2009	16.92
		AICRP on Renewable Sources of Energy	01.05.2009	14.00
		AICRP on Pigeon Pea	01.05.2009	13.62
		AICRP on Honeybee & Pollinators	01.04.2001	9.31
		AICRP on Cashew	01.04.2009	22.60
		AICRP on Spices	01.04.2009	1.10
		AICRP on Micro & Secondary Nutrients & Pollutant Elements in soils & Plants	01.04.2009	16.50
AICRP on Tropical Fruits	01.04.2009	7.12		
AICRP on Rapeseed-Mustard	01.04.1987	30.00		
	Veterinary (3)	AICRP on Pigs	01.11.1987	58.00
		AICRP on Poultry	01.04.2008	47.80
		AICRP on Goat	01.04.2009	26.27
	Forestry (2)	AICRP on Agro-Forestry	01.04.1987	40.13
		AICRP on Medicinal & Aromatic Plant and Betdvine	01.04.2008	12.56
<b>Total</b>	<b>37</b>			1224.89

<b>(B) Network Project</b>				
<b>ICAR</b>	<b>Agriculture (3)</b>	All India Network Project on Soil Biodiversity - Biofertilizer	01.04.2009	25.30
		Network Project on Organic Farming	01.04.2009	8.73
		Scaling up of Water Productivity in Agriculture	01.04.2008	28.50
	<b>Veterinary (1)</b>	Outreach Programme (Monitoring of Drug Residues and Environment Pollutants)	01.04.2007	7.00
<b>Total</b>	<b>4</b>			69.53
<b>(C) Mega Seed Project</b>				
<b>ICAR</b>	<b>Veterinary (2)</b>	Mega Seed Project on Pig	01.12.2008	30.00
		Mega Sheep Seed Project	01.04.2009	29.25
<b>Total</b>	<b>2</b>			59.25

<b>(D) NAIP</b>				
<b>ICAR</b>	<b>Agriculture (3)</b>	Developing sustainable farming system models for prioritized micro water sheds in rainfed areas in Jharkhand	2007-08	43.763
		Rice Knowledge Management Portal	01.04.2009	2.10
		Business Planning Development Unit	01.04.2009	26.8796
		Integrated Farming System for enhancing sustainable rural livelihood security in Sahibganj and Pakur district of Jharkhand (G.V.T.)	2007-08	5.4855
<b>Total</b>	<b>3</b>			78.2281

**(E) GOVERNMENT OF INDIA FUNDED PROJECTS:**

<b>NMPB</b>	<b>Agriculture</b>	Facilitation Centre for Medicinal Plants	01.04.2008	8.75
<b>Total</b>	<b>1</b>			8.75
<b>DBT</b>	<b>Agriculture</b>	DBT-India – IRRI Network Project – From QTL to variety-marker Assisted Breeding of Abiotic Stress tolerant Rice Varieties with major QTLs for Drought	01.04.2009	8.40
<b>Total</b>	<b>1</b>			8.40
<b>DST</b>	<b>Agriculture (2)</b>	Gene Campaign	01.04.2010	5.7376
		DST - Rice- Fallow – Enhancing the income of source poor farmers through introduction and expansion of improved chickpea production Technologies in Rainfed Rice Fallow Land	01.04.2009	15.00
<b>Total</b>	<b>2</b>			20.7376

<b>NRAA</b>	<b>Agriculture (1)</b>	Pilot Study on capitalizing Opportunities of Rice Fallow for Sustainable Livelihood Development (Dumka / Palamau / Ranchi)	01.04.2009	17.49
<b>TOTAL</b>	<b>1</b>			17.49
<b>Ministry of Agriculture, New Delhi</b>	Agriculture (2)	National Horticulture Mission Spices	01.04.2007	34.17
		Precision Farming Development Centre (PFDC)	01.04.2009	15.00
<b>Total</b>	<b>2</b>			49.17

**(F) INTERNATIONALLY FUNDED PROJECTS:**

IRRI	Agriculture (3)	BMG Funded project - tolerant rice for poor farmers in Africa and South Asia for drought tolerant activities at BAU.	July 2009	0.52750
		GCP – funded project – connecting performance under drought with genotypes through phenotype associations.	Nov. 2008	13.50
		Developing and Disseminating Resistant and Productive rice varieties for drought prone environments in India at BAU	March 2009	1.00
<b>Total</b>	<b>3</b>			15.0275
ICRISAT	Agriculture (2)	IFAD Grant No. 954	01.04.2010	1.41926
		IFAD – EC – CECG – 44	01.04.2011	5.00
<b>Total</b>	<b>2</b>			6.41926
IPNI	Agriculture (2)	Site Specific Nutrient Management in Maize – Wheat Sequence	30.06.2009	3.56
		Assessment of agronomic and economic benefits of fertilizer use in maize production system under variable farm size, climate and soil fertility condition in Eastern India	10.08.2012	4.50
<b>Total</b>	<b>2</b>			8.06
IPI	Agriculture (1)	Effect of Potassium Application on yield in Vegetable based Cropping System	30.06.2011	3.92
<b>Total</b>	<b>1</b>			3.92
Grand Total	61			1569.872

## 2.5.1 Significant Achievements

Since its inception, BAU has done excellent work in the field of technology generation, policy formulations and transfer of technologies to the farming community. Some of the technologies have been successfully adopted not only by the farming community of the state but also in the neighbouring states. A brief description of technology generation, policy formulation and technology transfer is given below:-

### 2.5.1.1 Technology generation

#### 2.5.1.1.1 Agricultural Sciences

##### Crop Improvement

**Varieties:** Birsa Agricultural University has developed and released 40 varieties in 15 major field and horticultural crops for cultivation in the state. Similarly, a large number of promising lines are in the pipeline/in the stage of testing/releasing/notification for their cultivation in the state (details mentioned in table). Some of the varieties developed by BAU have become popular and adopted in some other states e.g. Birsa Bold (groundnut), the size of the kernel is very bold and at the same time it is resistant to Aflatoxin. Due to the bold size of kernel and aflatoxin resistant quality this variety is very popular in Gujarat for confectionary purpose. In 2013 nine varieties of cereals, oilseed, pulses and sugarcane namely, Rice (Birsa Vikas Dhan-203, Birsa Vikas Dhan-111, Lalat, Birsa Vikas Sugandha-1), Soybean (Birsa Safed Soybean-2), Wheat (Birsa Gehun-3), Groundnut (Birsa Munghali-4), Sugarcane (BO-147) and Chickpea (Birsa Chana-3) have been released by Jharkhand State Seed Sub Committee and are in process for their notification. The university also maintains 5539 numbers of germplasm and attempts are made to produce Breeder seed as per the indent.



**M335(NC)**

**Birsa Bold**

**ICGS 76(ZC)**

*Comparison of Birsa Bold groundnut variety with check*

**Finger millet:** Plant type and white seeded ragi var. JWM-1 with yield potential of 25-30 q/ha is shown below :



**JWM-1**

### Popular varieties

Sl.No	Crop	Variety
1.	Rice (16)	Upland : Birsa Dhan 108 , Birsa Vikas Dhan-109 ,Birsa Vikas Dhan-110 Medium land (don 3& don 2) : Birsa Dhan 201 , Birsamati` , Naveen, IR-64, Lalat Low land(don 1) : BPT-5204, MTU-7029 Hybrids for medium & low land : Arize Tej, PHB-71, Sahbhagi, Arize 6444, PAC-801, KRH-2
2.	Ragi (2) Gundli (1)	A404, Birsa Marua-2 Birsa Gundli-1
3.	Pigeonpea (5)	Birsa Arhar-1, NDA-1, Asha, Bahar, UPAS-120
4.	Moong (2)	Pusa Vishal, SML-668
5.	Urad (2)	Birsa Urad-1, Pant U-19
6.	Lentil(1)	KLS-218
7.	Pea (2)	Prakash, HUDP-15
8.	Niger (5)	Birsa Niger-1, Birsa Niger-3, JGP-76, Birsa Niger-2, Pooja
9.	Groundnut (3)	Birsa Grounut-4, Birsa Bold, ICGV-91114
10.	Wheat (4)	K-9107, W-2036, K-8027, DBW-39
11.	Mustard (3)	Shivani, Kranti, Pusa Bold
12.	Toria (2)	P I303, Panchahi
13.	Yellow Sarson (1)	Binoy
14.	Chickpea (4)	KWR-108, KAK-2, KPG-59, HK-94-132
15.	Linseed (3)	T-397, Sweta, Shekhar
16.	Soybean	Birsa Soybean-1, Birsa Soybean-2, RKS-18, JS 97-52

### Experimental lines in advance stage of testing

Sl.	Crops	Experimental lines
1.	Rice	BAU-389-02 (1)
2.	Ragi	JWM-1 (White seeded), BBM-10 (2)
3.	Pigeonpea	BAU PP-09-22 (1)
4.	Urad	BAUU-3 (1)
5.	Mung	BAUM-2 (1)
6.	Soybean	BAUS-40, BAUS-96, BAUS-27 (3)
7.	Niger	BNS-120, BAU-10-5, BAU-10-2 (3)
8.	Groundnut	BAU-26, BAU-28 (2)
9.	Mustard	BAUSM-92-1-1, BAUM-09-17-7, BAUM-09-46-5 (3)
10.	Chickpea	Birsa Chana-3 (3)
11.	Linseed	BAU-06-03, BAU-10-08(2)
	Total	20

### Registration of varieties/Germplasm done

Registration of four varieties of rice namely Birsa Dhan-108, Birsa Vikas Dhan-109, Birsa Vikas Dhan-110 and Birsamati has been done with the Protection of Plant Variety and Farmers Right Authority, (PPV&FRA, New Delhi). The registration number of all the four varieties are-

- i) Birsa Dhan-108, 12 of 2011
- ii) Birsa Vikas Dhan-109, 61 of 2011
- iii) Birsa Vikas Dhan-110 59 of 2011
- iv) Birsa mati 60 of 2011

Similarly one variety of maize i.e Birsa Vikas Makka-2 has also been registered in PPV&FRA. The registration of one variety of Indian mustard namely Shivani has also been applied to PPV&FRA.

In Soybean crop, Birsa Safed Soybean-2 has also been registered with NBPGR having registration no. IC546536

### Most significant basic/strategic research findings

**Rice:** In DBT-INDIA-IRRI funded project, back cross seeds of IR-64 sub-1, has been received from IRRI. Earlier IR-64, Sub-1 was tolerant to submergence condition and it is able to tolerate water logging to the extent of 10 to 12 days without reduction in yield. Fortunately, the same IR-64 sub-1 has also two QTL's for drought tolerance namely DTY-3.1 and DTY-9.1 has

been identified which are also responsible for conferring drought tolerance. The subsequent back crosses both in wet & off season (CRRRI Cuttak) is being carried out for knowing the presence of both the QTLs' in subsequent back cross generation. Subsequent back crossed populations were used for DNA analysis and it was revealed that both the QTL's are present in the subsequent generation. The genotyping of the population have been carried out for ascertaining the QTL's for drought tolerance.

The population will be advanced till homozygosity is not achieved. It has been observed that IR-64 NIL is tolerant to drought.

## **Plant Tissue Culture**

### ***Establishment of Micropropagation protocol***

The university has been successful to develop protocol for mass propagation of Bananas (var. Robusta, Grandnain (G-9), Behula, Martaman) through tissue culture (disease free). Large scale tissue culture generated plants are being supplied to the farmers of the state. In same way the university is trying hard to develop protocol for mass multiplication of other horticultural (Tropical orchids, *Gerbera*, *Carnation*) medicinal (*Withania somnifera*, *Adhatoda vasica*, *Eclipta alba*, *Andrgraphis paniculata*, *Phlogacanthus thyrsoiflorus*, *Stevia rebaudiana*, *Aloe vera*, *Rauwolfia serpentine*, *Cymbopogon flexuosus*, *Celastrus paniculatus*, *Colchicum luteum*) and forest species (*Dendrocalamus strictus*, *Dendrocalamus asper*, *Bambusa vulgaris*, *Gmelina arborea*) and got success to develop protocol for such species which will bear great impact in future. More than a lakh tissue cultured plantlets of profitable crops, like, banana (varieties Robusta, Behula, Giant Governor, Martaman and Malbhog) and bamboo (*Dendroclanous asper* and *D. strictus*) have been supplied to the farmers of Jharkhand and adjoining states through Dept. Agriculture, Govt. of Jharkhand and Tripura.

### ***Agrobacterium mediated transformation***

Virulence of ATCC 15834 and MTCC 532 of *A. rhizogenes* was tested for hairy root induction of *Phlogacanthus thyrsoiflorus* Nees, a valued medicinal plant. MTCC 532 was found more effective than ATCC 15834 showing highest transformation frequency (93.33%) and highest number of roots /explants (20.00). So far the co-culture period is concerned, best result was obtained at 2.45 hrs. in MTCC 532 in contrast to 3.45 hrs. in ATCC 15834.

Phytochemical analysis of hairy roots induced through two different strains and *in-vivo* grown roots was done through RP-HPLC with Photo Array Detection at 225 nm. The active component was identified using isocratic solvent system consisting of methanol and Milli Q water (68:32) at flow rate of 1.0 ml/min. at 40°C using C18 reverse column. Chromatogram showed distinct peak in 3 different samples at same wavelength and almost same retention time.

Out of two different strains tested, MTCC 532 was found more effective for induction of hairy roots of *Stevia rebaudiana* L. Bertoni than ATCC 15834. While highest transformation frequency (91.60%) as well as maximum number of roots/ explants (20.66) was observed with ATCC 15834 after 48 hrs. co-culture, only 3 hrs. co-culture with MTCC 532 induced roots at 94.33% transformation frequency and 24.33 mean number of roots/ explants.

Comparative HPLC analysis using C18 separating column with isocratic mobile phase revealed presence of active component at 210 nm in hairy roots induced by ATCC 15834 and MTCC 532 and *in-vivo* grown roots of *Stevia rebaudiana* L. Bertoni.

#### **“Proteomics” and “Molecular Characterization” of *Rhizobium* Strains collected from the acid soils of the state of Jharkhand:**

As per the mandate of the on-going research project, funded by ICAR, a collection of *Rhizobium* isolates collected from acidic soils of the state of Jharkhand from various crops (“*Kharif*” and “*Rabi*”) is being maintained in the “*Proteomics Laboratory*”, College of Biotechnology, BAU. High resolution / detailed “*Proteome Maps*” of various *Rhizobium* isolates of Arhar have been developed and repeated to confirm the protein spot patterns. Analysis of *Rhizobium* isolates of chickpea and soybean (from acidic soils of the State of Jharkhand and vertisols soils from the State of Madhya Pradesh) were also performed at “*Proteomic Level*”. “*Differential Protein Expression*” was documented amongst various *Rhizobium* isolates analysed from various abiotic soil regimes, and protein spots were marked to carry out the Mass Spectrophotometry (MS) analysis for candidate gene identification in the near future. Optimization of various parameters to obtain high quality MS data initiated in the laboratory and is going on at present. Furthermore, by using the 16SrDNA Ribotyping analysis, *Rhizobium* samples of arhar, soybean and chickpea were analysed and the identification was established for the strains at the “*genus*” and “*species*” level. The registration of the identified *Rhizobium* strains is under the process with the competent authorities.

## Genomics

Finger printing of finger millet (*Eleusine coracana*) has been done and is ongoing with the help of DNA based molecular markers viz. RAPD, PCR-RFLP and SSRs. SCAR markers have also been developed for JWM-1 and VL-149 genotypes. Sequencing of unique fragments has revealed presence of bacterial endophytic genes for aspartame glutamate racemase and NAR Q receptor protein involved in nitrate uptake. Five accessions numbers have been issued by the international gene bank for these sequences (Genbank accession numbers KC020190, KC020191, KC020192, KC339678 and KC339679). Further investigations are underway to elucidate the function of these genes.

Drought phenotyping of finger millet varieties is being carried and promising results have been found. Genotypes JWM-1 and OUAT 2 have shown recovery from complete yellowing and are at present in the pre-flowering stage.

*Unique amplicons obtained in finger millet using heterologous rice SSRs for drought and submergence.*

Sl No.	Primer Name fragment amplified	Unique amplicons	Gel photograph
1.	RM219 (202 bp)	IE5066, JWM1, OUAT2 and GPU67	
2.	RM316 (192 bp)	A404	
3.	RM23911(269 bp)	JWM1 & OUAT2	
4.	RM23805 (400 bp)	IE 5165, OUAT2, VL 149 , A404. 400bp in all	

## Ongoing Projects

1. All India Network Project On Soil Biodiversity-Biofertilizers. Funded by ICAR.
2. From QTL to Variety: Marker assisted breeding of abiotic stress tolerant rice varieties with major QTLs for drought, submergence and salt tolerance. Funded by DBT, India – IRRI as Network Project

**Productivity enhancement:** For increasing productivity a number of technologies have been generated and are being promoted, such as:

- Development of pest & disease resistant improved crop varieties:
  - ❖ Number of pest and disease resistant improved crop varieties has been developed in different Kharif and Rabi crops grown in Jharkhand. As given under crop improvement earlier.
- Water saving and improved rain water management technologies :

Water is a scarce commodity. Water saving as well as enhanced crop production and increase in area of crop especially in Rabi season can be achieved using efficient method of irrigation. By improving surface method of irrigation by creating leveled check basin & furrows can increase the water use efficiency upto 45-55%. Further, where electric supply is not a constraint, micro irrigation can efficiently be used for water saving. Drip Irrigation technology with fertigation in vegetable & fruit crops have a potential to save water up to 60% and increase the yield by 20-40%. Further water saving up to 20% and increase in yield up to 15-20% can be affected by use of mulches.

Rain water harvesting & recycling in Rabi season is very important for improving cropping intensity. Techniques for *in-situ* rainwater harvesting are (i) Compartmental bunding (ii) Vegetative barriers on bund (iii) Bench terracing (iv) Summer Ploughing.

The techniques for *off-situ* rainwater harvesting are *Dobha* in low lands, percolation tanks in uplands, water harvesting tank, dugout pond and diversion drains.

- Site & farmer specific farming system: There is need for revival of rainfed farming systems as it provide an opportunity for development and integration of multiple components of agricultural system such

as crops, horticulture, livestock, fishery, agro-forestry with agro-based income generating activities and value addition.

- Integrated plant nutrient management for crops: In Jharkhand lack of fertilizers is still the main constraint to have a higher productivity. Integrated Plant Nutrient Management needs to be promoted in a more rational way (yield-targeted, site-and soil specific); understanding the interrelation of different nutrients; use combinations of mineral and organic fertilizers; provide nutrients on a cropping-system/rotation basis; and use on-farm and off-farm waste through recycling.
- Long term effect of manures & fertilizers on soil health and crop productivity: There are two on-going long term experiments viz., Permanent manurial Trial (PMT since 1956) and Long term Fertilizer experiment (LTFE since 1972) with maize-wheat and soybean-wheat cropping systems, respectively at Kanke have provided valuable information on integrated and balanced use of fertilizers, manure and lime.

These experiments are used as an educational tool to demonstrate the impact of continuous cropping & application of fertilizers, manure and lime on crop productivity, sustainability and soil Health.

The results of the above experiments have clearly been summarised as follows:

- ❖ Continuous cropping with Imbalanced use of N or N& P fertilizers i.e. use of urea or/and DAP had a deleterious effect on both crop productivity and soil health.
- ❖ Continuous use of balanced NPK chemical fertilizers resulted in plateau in crop productivity. Increase in crop productivity, sustainability and maintenance of soil health can be achieved through application of FYM or Lime along with recommended dose of fertilizers.
- ❖ Supplementing FYM @ 10 t/ha along with chemical fertilizers for legume-cereal cropping system while substitution up to 50% NPK through FYM and remaining 50% through chemical fertilizers for a cereal-cereal based cropping system is a suitable proposition.
- ❖ Application of FYM/lime along with chemical fertilizers favours for better physical, chemical and biological properties of soil.

- Development of improved agro-forestry models for the State: Development of Horti-Silvi-Pastoral Agroforestry model (i.e. intercropping of horticultural and fodder crops with trees)
  - ❖ Intercropping of leguminous and shade loving crops with multipurpose tree species is most profitable.
- Improved nursery management techniques for forest tree species: Technique of production of quality planting material of bamboo & other multipurpose tree species for establishing their plantation has been evolved.

### 2.5.1.1.2 Natural Resource Management

- a. District level soil resource inventory for the State:* Soil in Jharkhand state have numerous problems like acidity, deficiency in soil organic contents (SOC), deficiencies of micronutrients (boron & molybdenum) etc. in addition to serious problem of soil erosion due to runoff water during rainy season which removes the top soil. To raise successful production and increasing productivity, the soil health has to be maintained properly. The University has done most commendable work in preparation of District level soil resource inventory for the State. It will help not only to the policy planners, administrators, and those involved in its implementation in the state to supply not only the macro nutrients (NPK) but also to the farmers to apply all nutrients including micro ones in appropriate quantity only.
- b. Technologies to manage acid soils:* The University has been pioneer in the country in developing, testing, validating and recommending various technologies to manage acid soils like lime application, the application of the recommended dose of fertilizers, the conjunctive use of lime and fertilizers and most appropriate tolerant crop/varieties. These technologies have great impact to ameliorate the sick soils of both the state and the country.



*Response of groundnut to Ranchi, Jharkhand*

## **Crop Protection :**

### **Entomology**

- ❖ Bio-control laboratory produces *Trichogramma* spp.
- ❖ Utilization of *Trichogramma* spp. has been found very effective in controlling rice stem borer, leaf folder & maize stem borer.
- ❖ Early sowing of Chickpea (1<sup>st</sup> week of November) was found suitable to minimize the pest incidence as well as receiving highest grain yield.
- ❖ Intercropping of linseed, mustard, coriander with chickpea (1:1) has been effective in reducing the pod borer incidence as well as enhancing the prevalence of natural enemies.
- ❖ Bio-pesticides viz. Bt. and *Neem* based insecticide were found effective against gram pod borer.
- ❖ Alternate row spraying with insecticide in pigeon pea has been effective against insect pest and reducing cost of insecticide.

### **Plant Pathology**

- ❖ Morphological characterization of *Rhizoctonia*, *Fusarium* and *Sclerotium* in pulses have been carried out.
- ❖ Location specific disease management modules in various crops have been worked out through curricular researches.
- ❖ Plant health clinic caters to the needs of farmers since 2006.
- ❖ Mushroom production unit is generating income through spawn production, fresh mushroom and imparting training to farm youth and farm women.
- ❖ Antagonistic microorganisms have been exploited against various soil borne diseases in various crops.

## **Social Sciences :**

### **Economics**

- ❖ The department of agricultural economics examined the crop livestock production system for sustainable development in various zones of Jharkhand and suggested that the most important production system are local cow plus crop production in the zone

IV, while in zone V buffalo plus crop production and in zone VI, goat plus crop production in the rural area of the Jharkhand.

- ❖ The contribution of crop enterprises, livestock and forestry in farm economy was studied and found higher contribution of crop followed by livestock and forestry, respectively.
- ❖ In forest, Bamboo is having most potential enterprises in the Jharkhand region.
- ❖ The department has also examined the extent of adoption of high yielding varieties of rice in the villages of Kanke Block, and observed that there is huge gap in adoption of high yielding varieties of rice at a farmer's level. The farmers were very much interested to adopt hybrid rice varieties.
- ❖ The department has also examined growth rate of area, production and productivity of vegetable and fruits in the state and found that there is substantial increase in the production, productivity and area of these crops in the state.

### **Agricultural Extension**

- ❖ Developed innovation in information dissemination under the project on “Web-enabled Access of Agricultural Information through personal computer and mobile devices”. The system has been developed for information access by farmer through internet, mobile, Interacting Voice Response System (IVRS) and Learning Content Management System (LCMS). The project has been recognized by Manthan Award Organization for SAARC countries in the year 2011-12.
- ❖ BAU center is recognized as excellent centre in Institution Village Linkage Programme (IVLP).

### **Department of Agricultural Engineering**

- ❖ Development of improved bullock drawn implements for tillage, puddling and sowing for Jharkhand conditions.
- ❖ Low cost water harvesting techniques in the form of *Dobha* for life saving irrigation.

- ❖ Development of low cost polyhouse for round the year cultivation of vegetable & seed nurseries.
- ❖ Development of methods for minimizing post harvest losses in cereals & legumes.
- ❖ Standardization of water requirement of okra, cauliflower through drip irrigation system.
- ❖ Large scale training to farmers/officers/entrepreneurs on improved implements, drip irrigation & polyhouse cultivation.

### 2.5.2 Animal sciences

#### **Improved T & D breed of pig for high profit developed:**

This pig developed by B.A.U. in the year 1989 has been proving a boon to pig farmers as it adapts very well in varied agro-climatic conditions and it has become popular in other parts of the country particularly the poor farmers in North-East Indian states also. Rearing of these pigs is 4-5 times more remunerative than desi pigs.

**Fast growing beetal half breeds in goat developed:** Extensive work on genetic improvement of local Black Bengal goat through crossbreeding with Beetal and Jamunapari bucks under AICRP was undertaken. On the basis of findings during 1976-1993, the university recommended the Beetal halfbreeds to be much more suitable for Jharkhand due to reason that castrated males of Beetal halfbreeds attain 15 Kg body weight at 6 month of age against 7-8 Kg weight of Black Bengal at same age.

Some other important breakthroughs of the faculty are:

- Garlic, Mullethi and satawar tested for treatments of Mastitis.
- Therapeutic regimen against blood protozoan disease standardized.
- Cryo surgery for management of oral, ocular and proctogenital lesions in dogs.
- Package developed for control of paramphistomiosis, fasciolosis and G.I. nematode.
- Developed package for tick and lice control and desired time parturition technique for sow.
- Improved technique for induction of parturition in goat–synchronization

of parturition have been applied by the use of prostaglandins and other hormonal preparations.

- Technique for percutaneous transfixation of long bone fracture developed -Thesis has been submitted and paper published.
- Non-conventional locally available feeds like seed cake of Karanj, Niger, Sal, Kusum, Madua, and Tamarind Seed developed as livestock feed.

### **2.5.3 Significant achievement Faculty of Forestry:**

- ❖ In the Agri-silvicultural system, the yield of shade loving crops viz. *Turmeric colocasia* are profitable up to 6 years of Multipurpose Tree (MPTs) plantation.
- ❖ Gamhar (*Gmelina arborea*) tree is suitable for bund plantation
- ❖ Dinanath and Guinea grasses are suitable for Silvi-Pastoral System
- ❖ Subabul, Akashi and Chakundi are fast growing tree species and suitable for plantation in degraded land.

### **2.6 Policy/planning formulation**

- i. The university has successfully drafted the agricultural policy for Jharkhand state.
- ii. Livestock breeding policy for Jharkhand state has been formulated with the technical support of B.A.U. and adopted by the Jharkhand Government. Provision of utilization of Sahiwal semen for upgrading local cattle has been included in it. This is being done by the Animal Husbandry Department and Department of Dairying, Government of Jharkhand directly and also through NGO like Bharatiya Agro Industries Foundation (BAIF).
- iii. The Directorate of Seed & Farms has formulated rolling plan for seed production of field & horticultural crops for Jharkhand state for the XII<sup>th</sup> Five Year Plan. On the basis of the same the Department of Agriculture & Cane Development, Govt. of Jharkhand has organized its seed production plan. The target of Seed Replacement Rate (SRR) have been fixed i.e. 33% for self pollinated crops, 50% for cross pollinated crops and 100% for hybrids as per National Seed Plan 2005. Regarding variety

replacement rate (VRR) emphasis has been placed to introduce newly released varieties into commercial seed chain. The major thrust is to increase both SRR and VRR. The state has achieved self sufficiency status of SRR (41.21%) as against the norms fixed (33%) in wheat only.

- iv. The University has advocated need and implementation of national Agroforestry policy.

## **2.7 Technologies transferred and adopted successfully by farmers of the state**

- i. Promotion of SRI & Hybrid Rice Cultivation in the State through on farm trials and training to farmers. SRI has been able to save the water to the extent of 40% in comparison of traditional transplanted rice. The rate of hybrid rice in SRI is 5 kg/ha and productivity of hybrid rice varieties with SRI is 20-25 % more to traditional transplanting of rice. The maximum yield of rice has been harvested with Arize -6444 (plus) SRI which has given up to 100q/ha.
- ii. Use of improved farm implements such as conoweeder, plastic drum seeder, multi crop vertical reaper, zero seed drill etc.
- iii. Cultivation of Groundnut/Ragi in the alley of *Senna siamea* (Chakundi)- An Agroforestry System for grain crop cultivation with suitable short rotation tree species.
- iv. **T&D Pig – Pride of Jharkhand:** This breed has been developed by B.A.U. as early as 1989 by crossing Desi Sow and Tamworth Bor. It has lustrous black skin colour which is preferred by the tribal farmers as compared to local pigs whose productive and reproductive performances are much inferior as compared to exotic and crossbreds. Educating the farmers of the locality by bringing them to our farm and personal visit of the scientists at farmers' door besides the distribution of improved piglets in the village through various programmes and other efficient pain taking extension education programme of the University has led to large scale popularization of this breed among local population. Now, the farmers of Jharkhand and other states like West Bengal,

Bihar, Odisha, Assam, Meghalya, Mizoram etc. have fully adopted our technology of pig breeding and management. There is a heavy demand for improved seed (T&D Pigs) by the farmers. The demand of improved seed is so high that the university is finding great difficulty to meet them.

### T & D HYBRID PIG: Pride of Jharkhand

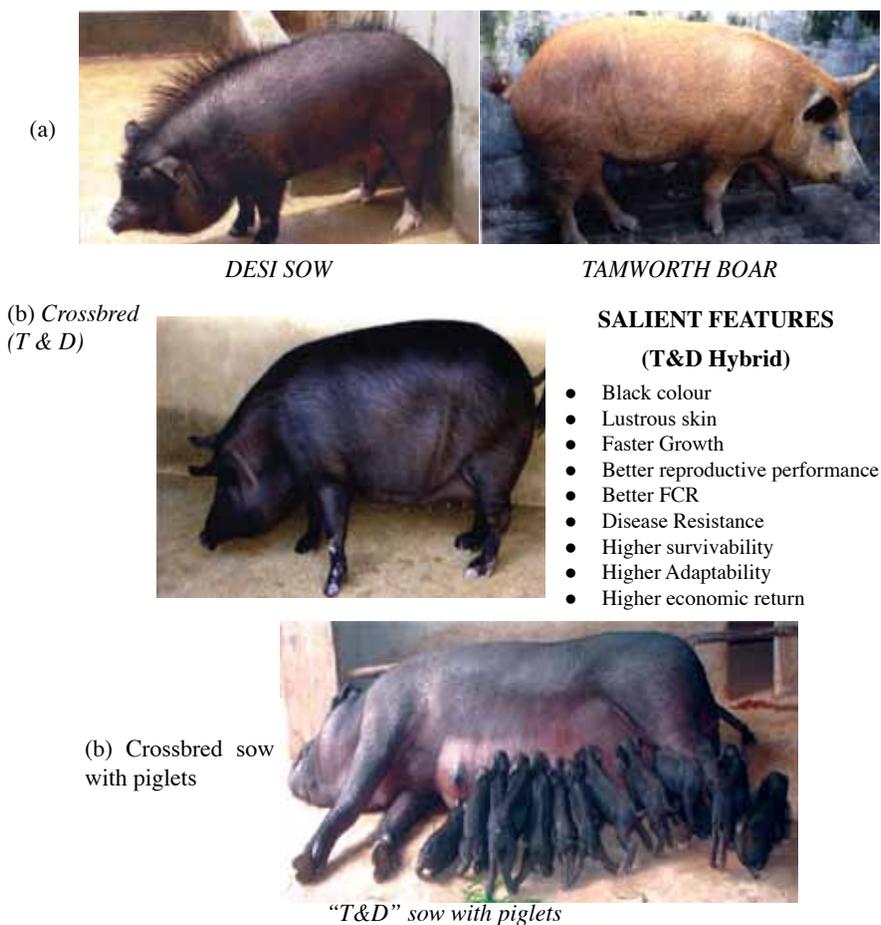


Figure 1: (a) showing parents (b) crossbred (T&D) and (c) T&D sow with piglets

- vi. Development of a suitable genotype of goat for meat production with higher rate of growth accompanied with technologies on feeding, housing, disease control measures and meat characteristics have largely been instrumental in large scale adoption by goat farmers

of this state. Scientists of BAU associated with Goat Research in activities like age of castration (2-month) for better post-castration gain in weight. Slaughter of animals for meat after attaining 15 Kg body weight gives higher dressing per centage and low bone content in the carcass. Twice mating / A.I. during heat period (10-12 and 24-26 hour of oestrous) results in better conception rate. Semi intensive system of management with 4-6 hours of grazing daily minimizes expenditure on feeding etc.

### **Black Beetle X Bengal Goat**

- ❖ Pure Black Bengal Female goats mated with pure Beetal male to produce crossbred.
- ❖ The (Beetal X Black Bengal) goats having higher body weight gain than black Bengal goats.
- ❖ Suitable for Jharkhand.



*BLACK BENGAL DOE*

*HYBRID*

*BEETAL BUCK*

## **2.8 Overall impact of university through extension and other services in the state**

As per analysis of the impact of extension activities carried out by the Krishi Vigyan Kendras and other extension units during the year 2008-09, the major outcomes were increase in area under cultivation of improved varieties/hybrids (14-77%), production (32-321%) and productivity (20-50%) of major crops including rice, wheat, maize, pulses oilseeds and vegetables, cropping intensity (150-200%), pig population (13.06%), fish production (62.87%), food security (2-4 month), B:C ratio of usable technology (1.25-6.00), acceptance of intervened technologies by farmers (40-80%), rate of adoption (25-80%) and enhancement in family income (25-40%).

## **2.9 Birsa Agricultural University & Partnership**

*Progress through partnerships*

### **2.9.1 Crop improvement technology development**

Birsa Agricultural University established partnerships with a number of both public and private institutions/NGOs at various levels to get better and fruitful results. One of our such public-private partnership involving Gramin Vikas Trust (GVT) an NGO, the University of Bangor (United Kingdom) and Birsa Agricultural University resulted into development of two drought tolerant varieties, Ashoka 228(BVD-109) and Ashoka 220 F (BVD-110), which got released and notified for upland ecologies of the state.

### **2.9.2 Input service**

#### **2.9.2.1 Value added seed farming in public-private mode**

“Seed village” concept in the country has empowered states to mitigate the shortage of seeds. It is a viable concept for improving seed replacement rate essential for accelerating farm production and poverty alleviation. To do this 22 seed villages in the field crop seed production and 14 in vegetable seed production have presently been established with the help of Government. In addition, under the umbrella of the Directorate of Seed & Farms, BAU, KVK Dhanbad and Chatra have also established several seed villages engaging farmers for this value added farming. Nevertheless, two new seed villages were also established in East Singhbhum district with the help of NABARD Bank and Business Planning and Development Unit (BPD-BAU) during 2011-12. At each KVK seed production of the most popular varieties of crops is being taken to make quality seed available at affordable prices to the farmers locally. Through such a public private partnership mode, more than 17500q of certified seed with the help and support of KVKs and BPD unit have been produced in 2012-13. About 9500q seed has been processed by the Seed Processing Plant established at different seed producing centres under the university since 2008-09.

#### **2.9.2.2 Seed Replacement Rate (SRR) increase – vital for food security**

Food security is linked to the seed security. To bridge the yield gap, the supply of quality seed in adequate quantity at right time is mission of

Directorate of Seed & Farms. The impact can be measured in terms of increase in seed replacement rate and accordingly the progress is mentioned below.

**a. Progressive status of seed replacement rate (SRR %) in Jharkhand**

Crop	Norms	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
Paddy	33	7.63	14.61	23.42	25.13	17.12	22.39
Maize	50	2.02	7.63	19.18	14.28	7.27	13.64
Wheat	33	-	-	-	27.63	31.92	41.21
Lentil	33	-	-	-	13.98	6.86	6.25
Gram	33	-	-	-	2.41	1.29	2.92
Arhar	50	-	-	-	11.66	23.58	21.61
Mung	33	-	-	-	-	21.21	19.03
Urd	33	-	-	-	-	6.98	5.05
Pea	33	-	-	-	17.41	9.42	10.17
Horsegram	33	-	-	-	23.68	7.55	8.75
R/mustard	50	-	-	-	72.06	20.5	34.38
Niger	50	-	-	-	-	-	39.34
Toria		-	-	-	58.31	-	-

Source: Zonal seed review meeting for Kharif 2010 (North-East Zone) dt. 11.2.2010, MOA-GOI Zonal seed review meeting for Rabi 2011-12 (North-East Zone dt. 12.9.2011), Rabi 2012-13 dt. 14.9.12, MOA-GOI

**b. Overall impact of quality seed**

- ❖ The average productivity of major field crops (paddy, wheat, maize, pulses and oilseeds) increased from 1507 kg/ha in 2006-07 to 2156 kg/ha in 2011-12 (30.10%).



Hybrid maize seed production plot

- ❖ During same period production of major field crops (paddy, wheat, maize, pulses and oilseeds) increased from 37.23 lakhs MT to 62.43 lakh MT (40.36%).
- ❖ The number of seed villages established increased from seven in 2006-07 to 27, these seed villages are developed for field crop seed production together with the Govt. of Jharkhand, university and NABARD Bank. Since beginning, the foundation seed (FS) to all seed villages has been supplied by the Directorate of Seed & Farms, BAU. In 2011, more than 90,000q quality certified seed was produced by these villages.

- ❖ Majority of the state farmers belong to ST, SC and backward communities with small and marginal holdings. After knowing the importance of quality seeds in rice (the only predominant crop of the state) some of them are switching to cultivate hybrids which is a positive sign. In 2011 (*kharif*), more than 2 lakh ha. area has been covered under hybrid rice particularly in the medium and lowland situation. The popularity of hybrids mostly in rice and maize is gaining momentum.
- ❖ To fulfill its commitment to the social cause, the seed production, research and training farm, Gauria Karma, Hazaribagh is also working for the social upliftment of the society by providing work to at least 400 labourers per month on an average basis.

## 2.10 Product Development

### (i) Herbal medicines developed and filed patents

**BIRSOL:** Process for formulation of herbal liniment/oil for topical application

**Patent filed No. :** 209/KOL/2010

**NBA clearance no. for IPR:** NBA/Tech Appl/9/416/10/12-13/1788

Herbal based liniment/oil for topical application. The synergistic properties comprise with many potential medicinal plants in the formulation of liniment/oil. The liniment/oil does not cause any harm to the skin. Aromatic and pleasant smell. Effective in local inflammation. Regular massage/topical application of BIRSOL twice a day is highly effective in chronic joint pains and inflammation.

**BIRSIN:** Process for *Vitex peduncularis* based formulation

**Patent filed No. :** 210/KOL/2010

**NBA clearance no. for IPR:** NBA/Tech Appl/9/417/10/13-14/811

Purely Herbal Formulation, prepared from the leaves, stems and root barks of 'Charaigorwa' (*Vitex peduncularis*) are useful as antipyretic and analgesic. It is an invention to preserve their activity for product by using novel composition of herbal preservatives selected from edible ingredients which enhanced their activity and the formulation has been preserved for

use of long period. Any synthetic/chemical preservatives has not been used. 10 ml of BIRSIN thrice a day gives relieves from fever and bodyache.



## (ii) Evolution of improved crop varieties

### Birsa Dhan 108

- Notified by CVRC vide Notification Number 1572 (E) dated 20.09.2006.
- Suitable for Rainfed Upland
- Extra early maturing (75 days)
- Intermediate plant type
- It is a tolerant to blast & brown spot, a stem borer & Gundhi bug.
- White grained
- Average Yield : 20 q/ha
- Yield Potential : 25q/ha



### **Birsa Bold Groundnut**

- Notified by CVRC vide Notification Number 636(E) dated 02.09.1994.
- Evolved from (Asiriya Mwitunde x BG-1) x M-13
- Suitable for upland
- Crop duration : Medium (125 days)
- Aflatoxin resistant
- Bold Kernel
- Yield potential 20-22 q/ha and Oil content 47 to 49 %.



### **Birsa Niger 1**

- Composite having four components and notified vide Notification Number 1(E) dated 01.01.1995 by CVRC.
- Suitable for upland
- Duration 100 days
- Drought tolerant
- Oil content 41.7%
- Yield potential : 7 q/ha



### **(iii) Products with value addition in minor millets**

#### **Importance of Ragi in food**

- Rich in calcium and iron compared to other day to day consumed cereal.
- Offers opportunities for diversified Utilization.
- Good for diabetic and heart patients.
- Rich source of sulphur containing amino acid.

- Has excellent malting characteristics

### **Ragi based baked products**

- Value added products
- Excellent Ready to Eat (RTE) product for all age groups
- Micronutrient dense
- Easy to digest

### **Ragi based pasta products**

- Convenience food
- Low cost
- High sensory appeal
- Long shelf life
- Increased consumer preference.



### **3. VISION 2030**

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The university has been accomplishing its teaching, research and extension education mandates for more than 30 years for development of largely poor farmers and agriculture of the state. With its involvement with state Govt. functionaries, institutions, organizations, NGOs, SHGs etc. and the farmers, the university has identified the strengths, weaknesses, challenges and opportunities for overall development of the university and agriculture and allied sectors in the state. Accordingly, it has formulated strategies for implementation by the state of Jharkhand in the form of vision 2030.

#### **3.1 CHALLENGES**

- i. These are to raise and sustain agriculture growth; ensure food and nutrition security; face the challenge of climate change; adjust to changes in energy scenario; maintain bio-safety and bio-security; make sustainable use of natural resources and protect bio-diversity. The new opportunities lie in trade, marketing, bio-technology, shifting demand preferences in domestic and global market, technology sharing, resource-sharing and investments in research, extension and infrastructure.
- ii. Jharkhand is suffering from man-resources-technology syndrome. This has resulted in varied pollution sources and the water quality and aquatic biodiversity have been deteriorating considerably. Moreover, due to anthropogenic interference and pollution some streams and ponds have become seasonal which used to be perennial ones, causing a decline in aquatic fauna.
- iii. The challenge is to upgrade the technological and social disciplines on a continuous basis and integrate all the disciplines to suit the agricultural ecology of the state and the farm families in a manner that may ensure increased production with stability, ecological sustainability and equitability.

- iv. The challenge for Jharkhand agriculture now is to integrate smallholders into value chains, maintain their competitiveness, and close the urban–rural income gap.
- v. Sustaining productivity gains, enhancing smallholder competitiveness, and adapting to climate change are becoming increasingly urgent concerns across all production systems. There is recognition of the limitations of the first Green Revolution (GR) and therefore, need for alternative solutions that correct for those limitations and unintended consequences. The second GR must also focus on improving tolerance to stresses, both abiotic and biotic (weeds, pest and disease).
- vi. Public and private research programs have traditionally neglected drought-prone, un-irrigated lands because of the problems and cost of developing improved technologies for these areas as compared to regions with irrigation or more favourable ecosystems.
- vii. Jharkhand state relied on rain-fed agriculture was also the slowest to benefit from the GR, contributing to widening inter-regional disparities and an incidence of poverty that still remains high. Technologies often bypassed the poor for a number of reasons.
- viii. Migration from less-favored rural areas has been cited as a strategy for poverty reduction. However, when migration out of rural areas occurs faster than the growth in employment opportunities, only a transfer of poverty results rather than true poverty reduction associated with agricultural transformation (Pingali, 2012).
- ix. Where crops are grown near their maximum temperature tolerance and where dryland, non-irrigated agriculture predominates, the challenge of climate change could be overwhelming, especially on the livelihoods of subsistence farmers and pastoral people, who are weakly coupled to markets, stressing the need to generate new/standardize the existing technologies to mitigate the impact of climate change.
- x. As population continues to increase with increased income, changing food habit and life style, the absolute demand for food will also increase. But as diets change, demand for the types of food will also shift radically, with large numbers of people going through the nutrition transition. In India, the increasing price of pulses has been associated

with a consequent decline in pulse consumption across all income groups (Pingali, 2012). As a result of these transitions towards calorie-rich diets, obesity, hypertension and type II diabetes have emerged as serious threats to health. The demand for fruits, vegetables and spices in raw as well as in processed form is bound to rise and therefore, more emphasis has to be placed to meet the growing demand and even to export the surplus produce.

- xi. Feed and fodder resources in Jharkhand mainly constitutes crop residues (rice straw), grazing resources from pastures and other grazing lands, viz., forests, miscellaneous tree crops and groves, cultivable wastelands and fallow lands.
- xii. The key Millennium Development Goals (MDG), 2000 show that the state's key social indicators such as literacy, enrolment, infant mortality and child nutrition, are below the all India average. The process of liberalization and economic reforms in India has a mixed impact on the states especially on the mineral rich state of Jharkhand.

### **3.2 STRENGTH**

- i. Varied agroclimatic conditions, the state has been divided into three agroclimatic zones in which different type of climatic conditions do exist for different kind of farming system enterprises.
- ii. The state receives approximately 1300 mm rainfall annually. Lot of scope exists for rainwater harvesting to increase the cropping intensity.
- iii. The average value of solar radiation in Jharkhand is **18.3 MJ/m<sup>2</sup>/day** (as calculated from the hours of bright sun-shine at our observatory at BAU campus). The radiation is sufficient throughout the year which can be utilized effectively through some innovation to produce energy in rural areas by developing cost effective technology.
- iv. The pulse productivity in the state (912 kg/ha) is higher than the national average (689 kg/ha) in 2010-11, which can further be enhanced by reducing the yield gap and through cultivation of hybrids in pigeonpea.
- v. Suitability for horticultural crops, since the topography of the state is highly undulated and suits for the promotion of high value agricultural crops.

- vi. Presently, Jharkhand is surplus in case of vegetable production and need to be further enhanced for production as well as productivity, *vis-a-vis* the establishment of agro processing industries.
- vii. Presently, in Jharkhand the underutilized perennial fruit crops viz., custard apple, jackfruit, mahua and bael which are native to the state can be expanded vertically and horizontally in integrated manner.
- viii. The climatic conditions of the state are ideally suited for the promotion of floriculture. Jharkhand is bestowed with excellent agro-climate condition for promotion of floriculture industry in this State. After the inception of NHM during the year 2005-2006, the State is gearing for fast development of Floriculture. The main crops of economic value for the farmers are Cut Roses, Gerbera, Gladiolus and *Tagetus* i.e. Marigold. Except Marigold, other flowers like Cut Roses, Gerbera and Gladiolus can be grown in inside culture so that under Hi-Tech. Culture all the three flowers have immense potentialities in the State.
- ix. The tribal farmers of the state practices agriculture with low input and average NPK use in the state of Jharkhand was 68 kg/ha as compared to the national average of 144 kg/ha during the year 2011-12. Therefore, the state is organic by default.
- x. The state has great potential for organic milk/dairy/poultry produce.
- xi. Jharkhand is considered as mega biodiversity state. Moreover, tribal people are having deep indigenous technical knowledge regarding uses/utilization of different forest products.
- xii. The state has forest approximately 30 per cent (23,60,500 lakh ha). The whole area could be brought under joint forest management (JFM) to increase the availability of green/dry fodder for enhancing cattle productivity while sustaining the environment.

The total recorded forest area in Jharkhand state is 23,60,500 lakh ha. (2.36 m. ha), which is 29.61% of the total geographical area. The area of Reserved Forest, Protected forest and unclassified forest are 4,38,700 (5.50%), 19,18,500 (24.07%), 3,300 (0.04%) Lakh ha., respectively

### Recorded Forest area in Jharkhand

Type of Forest	Forest Area ( In Lakh ha.)
Reserved Forest	4,38,700
Protected Forest	19,18,500
Un classed Forest	3,300
Total Forest Area	23,60,500
Total Geographical Area	79,71,400
<b>% of Forest Area to Total Geographical Area.</b>	<b>29.61%</b>

- xiii. Availability of labour (skilled and unskilled) round the year can be utilized effectively and productively through enterprises integration.
- xvi. Presently, Jharkhand ranked number one in tasar silk production and in the same way it was rank holder in case of lac production. By developing suitable agroforestry models and their integration, the productivity could further be enhanced.
- xv. The state of Jharkhand is very rich in mineral resources. After mining the land could be effectively utilized for increasing fish and aquaculture production.

In sum, the Jharkhand state is having flagship in case of tasar silk production, pulse productivity in the state, more area under forest cover as compared to national level, rich in agrobiodiversity and indigenous technical knowledge. Undulated topography, high rainfall, higher solar radiation make the state ideal candidate for the promotion of agri-horti sector. In the same way the state has huge potential for organic agriculture to generate employment opportunities, income generation and export potential. In recent past the area under hybrids of field crops particularly rice is increasing. In crops like maize and pigeonpea through proper policies and their execution, more area could be brought under hybrids to increase and/or sustain production and productivity.

### 3.3 WEAKNESSES

#### *3.3.1. Poor management of natural resources*

Most of the upland soils of the state are acidic in nature. Soil acidity does not create any problem for the growth and productivity of rice due to water stagnation during growth and nature of the crop. Since rice is being

cultivated predominantly as mono crop, neutralization of acidity by liming was not a priority in the past. However, advocacy of growing vegetables, oil seeds and pulses into rice fallow land would certainly require management of acidity to raise productivity and profitability. In Jharkhand there is practice of imbalanced fertilization, and soil is deficient in organic carbon content. Fertilizer use efficiency is far below i.e. half from the national average, the soils are having low water and nutrient retention capacity with high rainfall results in susceptibility towards leaching of N and soil related problems like phosphorus fixation. Use of fertilizers is less than 50% as compared to the national average and Fertilizer use efficiency also follows the same trend or at lower level. Less use of phosphatic and most negligible use of potassic fertilizers is very common. The soil of the state generally requires sulphur, but state lacks in availability of sulphur-based fertilizers. Micronutrient deficiency especially that of boron and molybdenum is common in the Jharkhand soils. Ground water utilization in the state is very meagre and water productivity is very low (0.21-0.29 kg/m<sup>3</sup>) in most states of eastern region (RCER, 2011). In some districts of the state, arsenic in ground water above the permissible limit of 0.01 mg L<sup>-1</sup> has been reported. Although, iron is an essential element for plant growth, detrimental high concentration of iron in ground water has been observed in localised pockets of the state.

### **3.3.2 Degraded ecosystems**

Millennium Ecosystem Assessment Team of the United Nations (MEA) assessed that out of the 24 ecosystem services, 15 are considered to be seriously degraded at global level. Similar situation do exist for Jharkhand also. The biodiversity loss, climate change and the imbalanced use of fertilizers are the major threat. The inefficient use of some of the farm inputs has, however, led to considerable environmental harm. Approximately 30–80% of nitrogen applied to farmland escapes to contaminate water systems and the atmosphere as well as increasing the incidence of some disease vectors. The costs of these environmental problems are often called externalities as they do not appear in any formal accounting systems. The slowdown in yield growth that has been observed since mid-1980s can be attributed, in part, to the above degradation of the agricultural resource base.

### **3.3.3 Poor adoption rate of technologies by the farmers**

The university has developed a number of technologies but except a

few, the adoption rate is not encouraging due to several reasons. Example, though a large number of varieties has been released but the adoption rate is not satisfactory. The varieties developed by the scientists are input responsive and due to lack of proper inputs, the rate of adoption is poor. Also, there are differences in the choices for the traits (farmers preference and breeder selection) such as, scientists usually go for high harvest index (HI) while, the farmers choice is high straw as in traditional agricultural system farmers practiced mixed farming and livestock component is very important for livelihood security in rainfed agriculture. Moreover, in these areas adoption rate is strongly and positively correlated with irrigation.

### **3.3.4 Waste and Mine land**

As tribal areas are rich in mineral resources, the mining projects proposed in Jharkhand threaten the very existence of tribal people. For decades too, widespread mining activity has led to forest degradation and mining over-burdened destroying cultivable land and environment as a whole. Due to mining large scale displacement of people is there and the cost of rehabilitation is higher monetarily and still higher sentimentally for the local people. Mining is major industry of the state, which is a factor of desertification in the country. This is especially with unplanned open cast mining and dumping of mine refuse in the vicinity of agricultural lands. Despite guidelines and regulations for undertaking adequate environmental measures, mining operations, open cast mining is largely practised by small scale entrepreneurs who do not take up post mining operations. Consequently, such areas gradually turned into wastelands.

### **3.3.5 Low input-output marginal environments**

Marginal environments can be defined as areas where agriculture is dominated by variations in agro-ecological and socio-economic conditions, such as heterogeneous soil conditions, variable topography, and erratic climatic conditions, resulting in complex stresses and high production risks. There usually is a high genotype environment (GxE) interaction. This suggests that in order to maximize performance under crossover conditions and heterogeneous environments, it is necessary to plant diverse genotypes.

### **3.3.6 High yield gap between potential and actual yield**

Poor rice productivity in eastern India, five constraints estimated

to account for 59% of the differences between actual on-farm yields and the attainable yield using available technologies to rainfed lowland rice in eastern India (Widawsky & O’Toole, 1990). Technology plays an important role in improving the yields. The National Commission on Farmers indicates that there is a large knowledge gap between the yields in research stations and actual yields in farmers “fields. The yield gaps given by the Planning Commission (GOI, 2007) range from 5% to 300% depending on the crop and state (Dev, 2012). The condition is more alarming in Jharkhand.

### **3.4 OPPORTUNITIES**

#### ***3.4.1 Ensuring food and nutritional security in Jharkhand***

Food security is the outcome of food production system processes all along the food chain. Climate change will affect food security through its impacts on all components of global, national and local food production systems, which is projected to affect all four dimensions of food security. Rice and wheat cultivation are expected to be affected in terms of cultivation patterns and yield reduction. Such a scenario calls for urgent and strategic interventions towards adaptive agricultural measures that while ensuring a continued food production to an ever growing population, will buffer populations against the threats of climate change. Jharkhand, a substantial grower of minor millets in the world, the cultivation of these small seeded millets, has declined steadily over the past few decades due to their lower economic competitiveness with major commodity cereals. Millets including pearl millets, sorghum and barley have much wider genetic adaptation and are able to grow successfully in diverse soils, varying rainfall regimes, diverse photoperiods and in marginal, arid and mountaineous terrains where major cereals have low success. These crops have the potential to thrive with low input and can withstand severe edapho-climatic stresses, thus being the best candidates to replace commodities like wheat and rice in areas where such crops may gradually become lesser competitive due to climate change. These qualities are combined with excellent nutritional values and opportunities for strengthening income generation through value addition (Padulosi et al. 2009).

### **3.4.2 Participatory approach**

Participatory research has made an important contribution to plant breeding, usually referred to as PPB. These are a host of approaches and methods characterized by many different potential forms of interaction between farmers and scientists involved in breeding. These include not only plant breeders but also other scientists involved such as plant physiologists, plant pathologists, entomologists, molecular biologists, and increasingly social scientists such as economists and anthropologists as well that are designed to shift the focus of plant genetic improvement research towards the local level by directly involving the end user (farmer/consumer) in the breeding process.

### **3.4.3 Plant genetic resource conservation**

The Food and Agriculture Organization (FAO) estimates that about 75 per cent of the genetic diversity of agricultural crops has been lost during past century. In developing countries, the Green Revolution is being criticized on the grounds that marginal and smallholder farmers could not afford intensive use of external inputs, increased irrigation and mechanization of labour. It increased landlessness, and resulted in loss of income for women, inappropriate technology, environmental degradation and, in places, even the elimination of small farmers. It is estimated that just a few decades back, Indian farmers grew more than 30,000 different varieties of rice, but in next 15 years, this enormous diversity will be reduced to no more than 50 varieties, with the top ten accounting for over three-quarters of the subcontinents' rice acreage (Mooney, 1983). On-farm conservation is distinguished because it is dynamic, decentralized, and aimed at conserving dynamic crop evolutionary processes rather than a static inventory of crop types. *In-situ* conservation preserves evolutionary processes which will yield new germplasm in the future.

### **3.4.4 Secondary agriculture and value addition**

Jharkhand state produces lot of minor millets, vegetables and fruits like Jackfruit, Bael, Ber etc. Processing is becoming increasingly important to help these farmers in realizing a better price; it has been identified as a priority sector for bank credit and certain fiscal concessions. Minor millet are both health and nutraceutical foods. Their low glycemic index makes them appropriate health food for diabetic and obese people. There is a

great need to develop and disseminate appropriately processed whole grain products from minor millets to meet modern consumers' needs and tastes. Value-addition to millet grain offers good opportunity to rural and tribal women farmers for income generation. This opportunity can be realized with the availability of appropriate and relevant low cost technology. Skill development to rural and tribal women for developing value added millet products, maintaining acceptable hygiene standards, packaging, labeling and marketing is as important as the technology for processing. Considering the recent increase in the consumption of refined wheat flour-based bread and bakery products in urban India, their nutritional load could significantly be enhanced by blending minor millets flour in appropriate proportions suitable to the baking industry.

The state is known for vegetable cultivation and contributes large quantities of vegetables like tomato, radish, cauliflower, cabbage, potatoes etc and fruits like Jack fruit, Ber, Jamun etc. for domestic consumption and export. The state has lot of scope for its further expansion and production. However, due to lack of good market structure and cold storage, post harvest loss is quite high and farmers do not get remunerative price for their produce. The unmarketable surplus of fresh produce can be preserved and processed into value added products such as pickles, Jams, chutneys, soups and purees. Market survey demonstrates the potential for semi processed and dehydrated fruit and vegetable products. If appropriate technologies are used by farmers for the improved handling and processing of produce in rural areas, it may provide the income they desire.

Product profile being developed in India at present is limited to few fruits and vegetables e.g. Mango, pineapple, grapes, tomato etc., but there is wider potentiality for processing of Jack fruit, Aonla, guava, papaya and other minor fruits. Jharkhand produces substantial quantities of Jack fruit. A major chunk of it is wasted in the absence of scientific processing and preservation. Processing of Jackfruit into products like canned/bottled pieces, dehydrated Jackfruit, Nector, Jam, Pickle, Chips and candy will not only result in better utilization of this perishable fruit, but also bring considerable value addition and economic prosperity to tribal community of Jharkhand. Similarly, there is great scope for processing of cauliflower, cabbage, garlic, onion, etc. into semi-processed, dehydrated and ready – to – eat products. Value addition of vegetables can convert the surplus

vegetables into nutritionally rich processed products with wider acceptance. Minimally processed vegetables will reduce the time of cooking with various health benefits and ready to eat vegetables will provide varied taste and convenience of time with extended shelf life.

### **3.4.5 Entrepreneurship development**

After the implementation of new economic policies and due to liberalization and globalization lot of opportunities are emerging in agricultural and allied sectors. One of the most difficult task is to change the mind set of tribal/dalits farmers regarding the changing of the status of agriculture from the pastoral, subsistence to an industry. Among rural youth and school dropouts, the entrepreneurship need to be enthused to make them economically self reliant and also to ease out the alarming burden of unemployment. Opportunities now exist in the field of high value agricultural crops, organic farming, livestock production and management, dairying, processing and value addition, seed production, processing and marketing etc. through trainings/visits/other learning schemes. The skill development need to be made for successful entrepreneurship development in the respective field. In spite of very good theoretical knowledge imparted by the Birsa Agricultural University in Jharkhand, there is no provision for internship programme to put graduates on a sound footing for seed production technology and quality assurance.

### **3.4.6 Emphasis on public private partnership**

The importance of the formal sector is often overestimated. The availability of the quality inputs can also be increased by the Public Private Partnership (PPP) in the input industry which can exploit the strengths that exist in these two sectors. While the public system has the competent scientific manpower and equipped with basic and strategic knowledge, the vast modern infrastructure facilities and large manpower, the private sector is lagging behind. However, the private sector has expertise in applied research and some high tech research like the development of genetically modified crops and its seed production.

### **3.4.7 System of crop intensification**

System of Rice Intensification (SRI) represents a paradigm shift for the agricultural sector, from an external input-dependent approach,

revolving around genetic improvements or modifications, to more of an ecological perspective and strategy. By 2011, the number of countries where SRI methods have been validated has reached 42. SRI has been shown to work in tropical, subtropical, and temperate environments and across dry, subhumid, and humid moisture climates. The impacts of SRI management have been reviewed by various workers and several advantages have been recorded e.g. it increases yield (50-100%), water saving (25-50%), reduced cost of production (10-20%), resistance to biotic stresses (pests and diseases), abiotic stresses (drought, storms, heat spells, cold snaps) and higher milling outturn (10-15%). Evidence from SRI experience over the past decade suggests that making certain changes in crop management can greatly enhance the productivity of available land, labour, water, nutrient, and capital. It is noteworthy that the principles and practices of SRI are now being adapted to a variety of other field crops such as *wheat*, *sugarcane*, *millet*, *maize*, and even some *legumes* and *vegetables* (Uphoff, 2011). In Jharkhand state also practices of crop intensification has been initiated in paddy and wheat under Govt. of India sponsored project “Bringing Green Revolution in Eastern Region”. Technology has successfully been demonstrated at farmers field and large number of farmers have benefited and it is becoming popular. Hybrid paddy is also becoming popular in SRI mode in the state.

### **3.4.8 Component integration**

Livestock is the best complementary enterprise with cropping, especially during the adverse years. Pigs are the unique components that can be reared with the wastes which are unfit for human consumption. In rainfed farming, sheep and goat rearing form an integral part of the landscape. Sericulture can be introduced in rainfed farming, provided the climatic conditions permit it. Agro-forestry (Silviculture and silvi-horticulture) are the other activities which can be included under rainfed conditions. Integration of different agriculturally related enterprises (fisheries, duckery, poultry, sericulture and honeybee) with crops provide ways to recycle the products and by products of one component as input to another and reduce the cost of production and increase the total income of the farm.

### **3.4.9 Improvement and popularization of underutilized horticultural crops in Jharkhand**

Wide range of bio-diversity of horticultural crops is available in the state of Jharkhand particularly Chhotanagpur and Santhalpargana regions which can be harnessed for improvement programme of these crops as well as for production by area expansion. Germplasm collection, evaluation, maintenance and exploitation - as there are wide range of variations observed in these fruit crops; systematic exploration and germplasm improvement will be mandatory and all the variations of germplasm available in the state as well as those from other states and abroad has to be explored. For example, jackfruit (*Artocarpus heterophyllus*), mahua (*Madhuca indica*), sahan (*Moringa oleifera*), jamun (*Syzygium cumini*), bael (*Aegle marmelos*) etc. Moreover, the post harvest management and processing including value addition of these underutilized but important crops need to be taken at priority.

### **3.4.10 Medicinal and Aromatic Plants (MAP) for Pharmaceutical potentials**

In Jharkhand forest wealth covers about 29% of the total geographical area. The forest has also vast varieties of medicinal and aromatic flora and fringe dwellers comprising mostly tribal community largely dependent upon the medicinal and aromatic plants for cure of common diseases as well as a means for livelihood support. The Socio-economic upliftment of these communities are significantly related to non-timber forest products especially medicinal and aromatic plants. Till date, systematic scientific information is meagrely available on total number of species of MAP found in the different regions of the Jharkhand. Information is also lacking about the extent of exploitations and phenological behaviour, agronomic practices, active ingredients, and their use in scientific herbal formulations. Thus, there is acute need of holistic and multidisciplinary approach having different stakeholders. The tribal and rural people residing adjacent to the forests have rich native tradition and ethnic knowledge about vegetation and forest which could be utilized even for biodiversity management.

### **3.4.11 Bridge the yield gap**

Farmers generally apply sub-optimal doses of fertilizers, insecticides and limited irrigations for pulses and oilseeds only after meeting first the

requirements of wheat, rice and vegetable crops. Wide gaps therefore, exists between yields realized in experimental plots, frontline demonstration plots and farmers' fields. Large-scale on-farm demonstrations conducted in the last five years at BAU have clearly shown superiority of new technologies over the local practices. Adoption of these technologies can increase pulse production by at least 13–42% in the country (Ali and Gupta, 2012). Specialized dryland management practices such as water harvesting and reduction of soil moisture loss can increase yields by an additional 5–15% on average. In case of wheat, average productivity varies from 1.54 t/ha in Jharkhand to 3.0 t/ha in eastern UP indicating that wheat productivity is 30% less in eastern region than the national figures (RCER, 2011). The data generated by the Directorate of Oilseeds Research, Hyderabad during the last 22 years in the farmers' fields across various crops, seasons and situations clearly indicate the possibility of enhancing oilseeds production to a great extent. There exists a commercially exploitable yield reservoir to the tune of nearly 73% of the national production, which can be harnessed by the adoption of currently available improved technologies (Hegde, 2012).

### **3.4.12 Human resource development (HRD) through quality education**

India is endowed with diverse kind of climates, cultures, needs and preferences. Furthermore, due to globalization and export earnings we require quality manpower who is well trained in the respective field of agricultural sciences/technologies, dairy technology, wine technology, food and beverages, meat technology, fruit technology etc. to cater the need of textile, tobacco, agro-processing, packaging, pesticides, fertilizer, fibre, fisheries, biotechnological/pharmaceutical, sugar and seed industries. The graduates from agricultural university should have deep knowledge of farmers' difficulties, consumer preferences, and industrial demands in order to meet the demand of both farming communities and consumer preferences while at the same time they should be having upto date knowledge of industrial requirement. Here lies the serious drawback in certain sectors like food sector which is growing @ 15% annually but it is less than 0.1% of agricultural graduates.

Agriculture is not mere farming anymore. It is now 'Agribusiness' – a generic term that encompasses the businesses involved in food production,

including farming, seed supply, agrichemicals, farm machinery, wholesaling and distribution, processing, marketing, trade and retailing. The scene has changed and it requires a continuous stream of charged, motivated and enlightened professionals. This breed of Agribusiness Managers with their learned skill set can set in motion another wave of revolution in Jharkhand—the one that is aimed at overhauling the idyllic and rustic way of agriculture in Jharkhand. There is need of other agro-based industries to develop in India in the same fashion. Opportunities are emerging globally in primary and secondary agriculture and allied sectors and India has tremendous resources in terms of research and development infrastructure, large pools of quality teachers, varied agroclimatic conditions and favourable business/trade environment. In the same way, Birsa Agricultural University is determined to develop high class human resource in this sector. Therefore, we require that the graduates from agricultural universities should be competent enough to address the problems of farmers, consumers and industry as well.

#### **3.4.13 Diversification through high value agricultural (HVA) crops for increasing system productivity, income and employment opportunities**

Agricultural diversification is an important instrument for economic growth. Introduction and diversification of *rabi* crops in the state may increase cropping intensity in this backward, poverty-ridden and deprived state. Rice-based farming systems are crucial for strengthening livelihoods and alleviating hunger and poverty in rural area. They also provide a range of poverty-escape mechanisms for poor smallholder families and for rural landless-labourer families. The monsoon crop is rice and the main subsequent crops (where conditions and circumstances allow) are rice or wheat. Vegetables, pulses, millets and other high value agricultural (HVA) crops are safe options for diversification of cereal based cropping system to ensure food, nutrition and livelihood security. The vegetable farming is one of the best options for small farmers in the urban and peri-urban areas. Presently, in Jharkhand the share of total condiments and spices is virtually nil. Greater employment opportunities result in greater incomes for poor households. Labour demands also arise in the post-harvest sector, since sorting, grading, cleaning, packaging and transports are all labour-intensive

activities. The relative profitability of horticultural crops compared to cereals has been shown to be a determining factor for crop diversification into horticultural production in India (Joshi et al. 2003). The demand for fruit and vegetables and meat is expected to rise rapidly with economic growth and this will change many farming systems.

### **3.5 Faculty wise Vision-2030 of BAU, Ranchi**

#### **Faculty of Agriculture**

##### ***Priority Areas***

1. Germplasm collection, evaluation, conservation and exploitation of all important crops, fruits and vegetables.
2. Crop improvement for Marginal environment
3. Water and fertilizer use efficiency
4. Molecular Techniques for production of disease free planting material
5. Integrated farming system approach
6. Cropping system Research
7. Agro-ecological approach
8. Agro-ethno biological research
9. Climate resilient Agriculture
10. Watershed Management
11. Precision farming
12. Organic farming
13. Improvement and popularization of underutilized horticultural crops
14. Medicinal and aromatic plants
15. Fruit and vegetable preservation and value addition

#### **Faculty of Forestry, BAU, Ranchi**

##### ***Priority areas***

1. Development of region specific agroforestry models for the various Agroclimatic zones of Jharkhand.
2. Large scale production of quality planting materials for Jharkhand.
3. Standardization of nursery techniques for the important tree species.

4. Development of soil and water conservation models through forestry.
5. Development of forest business management plan for reinforcing state economy.
6. Development of mines reclamation strategies using forestry component.
7. Identification of threats on the wild medicinal and aromatic plants.
8. Development of conservation plan for the plant biodiversity.
9. Bio-prospecting of various medicinal and aromatic plants.
10. Researches on value addition and post harvest technology package development for important forest products of the state.
11. Large scale production of quality planting materials of important medicinal and aromatic plants for encouraging their farming in the state.
12. Development of Ecotourism plan of the State.
13. Identification of major factors affecting the status of various endemic wild flora and fauna for conservation strategy formulation.
14. Development of Clonal Orchards for tree improvement of endemic species of timber, fuel, fodder to augment the deficiency of these forest commodities in the State.
15. Development of gene bank of major threatened economically important forest plants.
16. Development of farming system based on economically important insect (Tassar, Lac & Honey).
17. Development of strategies for reducing man-animal conflicts in the state;
18. Development of seed banks of important tree species of this state.

### **Faculty of Veterinary Science and Animal Husbandry**

#### ***Priority areas***

1. Residual analysis of environmental pollutants with special reference to heavy metal and chemotherapeutic agents in meat, milk and other animal's product.
2. Genetic mapping of domestic animals of Jharkhand.
3. Development of disease resistance species of animals including birds.
4. Development of tests to assess intracellular bacterial killing for selection of most appropriate antimicrobial agents in different type of infection.

5. Development of protocol for assessment of proliferative behaviors of different type of tumors.
6. Development of antibiotics against disease producing microorganisms.
7. To develop suitable techniques for treatment of urolithiasis in animals.
8. Development of techniques for identification of adulterated cooked meat.
9. Development of Veterinary pharmacovigilance for monitoring adverse drug reaction in animal from different sectors of Jharkhand.
10. Assessment of different botanicals having immune-stimulant properties.
11. Development of new vaccines with respect to emerging diseases.
12. Development of preventive measures against anestrus and repeat breeders in animals of Jharkhand.
13. Development of protocols for value addition in meat and milk product.
14. Strengthening of seroepidemiological surveillance and disease forecasting systems for taking earlier preventive measures in Jharkhand.
15. Development of simple technique for early detection of pregnancy in animals at farmers door /rural areas.

## **College of Biotechnology**

### ***Priority Areas***

#### *General*

- ❖ To impart quality education in the field of Biotechnology.
- ❖ To develop human resources through imparting training to the graduate and post graduate students of different faculties.
- ❖ To start Doctoral degree programme.

## **Plant Science**

### (a) ***Agricultural Crops***

- ❖ Abiotic stresses (drought, acidity and micronutrient deficiency/toxicity in major cereals, pulses and vegetables)
- ❖ Molecular breeding for terminal heat in wheat.
- ❖ Production of haploids and double haploids to bring quick homozygosity in cereals and pulses so as to hasten the release of new HYVs.

- ❖ Production of tissue cultured plantlets of fruit plants, flowers, medicinal/aromatic plants, forest trees at large scale so as to provide farmers the elite genotypes for better return.
- ❖ Production of transgenic plants through *Agrobacterium tumefaciens*.
- ❖ Induction of hairy roots on valued medicinal crops with a view to enhance secondary metabolites production as well as germplasm preservation.
- ❖ Molecular characterization of various crop varieties, germplasms, landraces of the region for their registration as well as for future breeding programmes. This shall also help in safeguarding the plant variety protection and Farmers' Rights.
- ❖ Identification and isolation of novel stress proteins resulting from biotic and abiotic stresses for use as markers and ascertaining the genes responsible for production of such stress proteins.
- ❖ Characterization of identified isolates of Rhizobium strains from acidic soil regime of Jharkhand.
- ❖ Identification and isolation of alkaloids/aroma from important native herbs/shrubs.
- ❖ Extending technological support of this *neo*-technology to breeders/plant protection scientists of the University in overcoming their research problems which are hitherto difficult to achieve through conventional means.

(b) ***Veterinary Science & A.H.***

- ❖ Molecular characterization of cattle wealth of the state.
- ❖ Molecular characterization of goat, sheep, poultry and pig before taking up any genetic manipulation.
- ❖ To further strengthen the college with respect to faculty, laboratories etc.

**Directorates**

**Directorate of Research**

- Since Jharkhand is dominated by the small and marginal tribal farmers who apply less input to raise crops, therefore, the need of the hour is to develop varieties for low input (nutrient & water, etc.).

- The soil of the state is problematic being acidic in nature having pH value from 4.5-6.5. Stressing means the requirement of the varieties which can be grown successfully under poor soil conditions i.e. breeding for resistance to toxic elements/ions as well as responsive to elements which are available in reduced quantity.
- Since the majority of the farmers grow major crops as intercrop in order to sustain and maintain food and livelihood security and therefore, special emphasis needs to be placed for developing varieties/ genotypes of major field crops, specifically suited for intercropping conditions only.
- In order to enhance the productivity to sustain the ever increasing pressure of population growth, there is an urgent need of hybrid development in major field crops (paddy, maize, pigeonpea & R&M) with the following activities
  - ❖ Diversification of already existing and highly adaptable CMS lines
  - ❖ Improvement in the *per-se* performance of the parental lines
  - ❖ Identification and incorporation of resistance and good grain quality traits in the parental lines of the adapted and high yielding hybrids
  - ❖ The development of high yielding and stable CMS lines (female parent)
  - ❖ Increasing seed yields from production plots.
- In Jharkhand around 90% of land remains fallow after *khari* and in order to increase cropping intensity, and to get higher productivity per unit area, there is an urgent need to develop extra early maturing cultivars (65-85 days) which can be grown on fallows in order to capture the residual moisture.
- As predicted, the major impact of climate change will be in eastern region of the country and therefore, in order to mitigate its impact there is an urgent need to develop varieties of field crops having major abiotic stress tolerance (drought, heat and submergence, etc.).
- In Jharkhand the problem of hidden hunger is spreading like wild fire

in the form of malnutrition among women and kids. As such there is need to develop varieties of different crops having rich minerals/salts/proteins/ vitamins etc. and at the same time bringing further improvement in nutricereals like ragi, gundli, etc.

- Majority of crops in state grown under rainfed conditions and presently major emphasis has been placed on the development of the cultivars in cereals only so in order to increase food security, emphasis needs to be placed on the development of cultivars in leguminous and oilseed crops for kharif as well as rabi season.
- The adoption rate of newly released varieties is very poor due to various reasons, stressing the need of participatory approach of plant breeding involving farmers in order to identify the genotypes with ideal traits preferred by farmers. For example, commercial plant breeder develop rice varieties with high yielding capacity ignoring the farmers need of straw which is very important for farming community in order to sustain the cattle population raised by them. As such trait selection is very important and until and unless we don't involve the farmers for their choice/preferences in terms of straw/quality/cooking quality etc., the variety developed by commercial plant breeder will not see light of the day (poor adoption).
- Farmers use primitive cultivars/landraces/traditional varieties to meet their requirements. The farmers varieties (FV's) also contain useful traits in terms of quality/biotic/abiotic stress tolerance so there is need to conserve farmers varieties and characterize them for specific traits and utilize them in regular breeding programmes.
  - ❖ Broadening of genetic base is of paramount importance in order to mitigate the stress inflicted by the virtues of climate change and different requirements of the consumers/farmers.
  - ❖ The need of the hour is to involve biotechnological approaches for faster development of varieties with trait(s) of interest using new approach, like, marker assisted selections (MAS breeding) in order to focus specifically on particular trait with great accuracy (precision breeding) in collaboration with College of Biotechnology.
  - ❖ The scientific advancements made in the fields of genomics/phonemics/metabolic/proteomics need to be studied and exploited.

- Transgenic crops are the order of the day and sooner or later they will be introduced into the system. Therefore, the department of Plant Breeding & Genetics with the collaboration of college of Biotechnology have to prepare themselves for:
  - ❖ Scientific studies on transgenic crops for environmental security i.e. studies on gene flow as Jharkhand is one of the mega biodiversity centres of the country and so many crops and their wild relatives are present in the state.
  - ❖ The studies on transgenic crops for their performance for multiple biotic and abiotic stress tolerance.
  - ❖ New approaches in terms of generation of the technology for the cost effective mass multiplication/production of potato, like, true potato seed and micro tuber as well as micro propagation of sugarcane etc.
- Partnerships which are already existing needs to be strengthened further and at the same time new partnerships have to be developed involving NGO's, private institutes (BIT Mesra, Institutes of ICAR & likely to be established Indian Institute of Agricultural Biotechnology (IIAB) at Ranchi by ICAR in order to develop the technologies related to farmers.
- In case of rice the partnership needs to be strengthened further with IRRI Philippines and in case of pigeonpea, groundnut, chickpea, millets, the partnerships between the university and ICRISAT/ICARDA has to be developed.
- Finally, the end users of the technologies generated by Deptt. Of Genetics and Plant Breeding and College of Biotechnology are the farmers who themselves have contributed significantly in terms of variety development known as farmers varieties, their spreading, the rights of farmers and protection of the varieties developed by them is the need of the hour in order to avoid bio-piracy. Therefore, the protection of farmers right is of paramount importance and every effort shall be made to protect the right of our cultivator so as to bring prosperity, increasing productivity and food & nutritional security.

## **Directorate of Extension Education**

### **Priority areas**

#### **A. Training**

- ❖ Vocational training for rural youth & women
- ❖ Construction of training workshop
- ❖ Developing a band of paraprofessionals
- ❖ Use of multimedia

#### **B. Information communication**

- ❖ Establishment of communication centre
- ❖ Video-conferencing system
- ❖ Distance learning centre
- ❖ Publication of extension literature
- ❖ Preparation of multimedia CD/DVD
- ❖ Establishment of VSTA
- ❖ Developing and updating website
- ❖ Establishing info. Kiosk at KVKs & panchayats
- ❖ Formation of Mobile Agricultural Schools

#### **C. Supply & Services**

- ❖ Strengthening ATIC for services as single window
- ❖ Provision of seeds/fertilizers/pesticides in ATIC and at Mobile Agricultural School
- ❖ Agro-Met services
- ❖ Soil & water testing
- ❖ Clinical services
- ❖ Custom services

#### **D. Field extension**

- ❖ Undertaking participatory methods with resource poor farmers
- ❖ Due place to ITKs in overall technology recommendation

- ❖ Extension of sustainable technologies like IPM, INM etc.
- ❖ Emphasis on water management technologies
- ❖ Extension of organic farming for high value crops
- ❖ Gender mainstreaming of extension programmes
- ❖ Promotion of vegetables, fruits, forestry, medicinal & aromatic plants
- ❖ Establishing model villages in all the districts
- ❖ Promotion of appropriate Farming system models for sustainable livelihoods

#### **E. KVKs**

- ❖ Establishing KVKs in remaining 2 districts
- ❖ Organizing orientation and refresher courses for KVK scientists
- ❖ Establishing Mother Plant Nursery and Rural Technology Parks
- ❖ Providing ICT facility
- ❖ Strengthening linkage of KVK with ATMA, line Department, NGOs Private Sector Business Organizations, Farmers' Organizations
- ❖ Linkage with Block Development Officials
- ❖ Developing linkages with PRIs
- ❖ Identifying and developing linkages with villagers/VLWs/Kissan Mitras
- ❖ Promoting video conferencing linkages between KVKs Gram Panchayats

#### **F. Institutions**

- ❖ Establishing farm women study and development centre
- ❖ Establishing tribal agriculture study and development centre
- ❖ Value Addition Centre

#### **G. Others**

- ❖ Strengthening intra-institutional linkages
- ❖ Developing and strengthening linkages with development Department, Financial Institutions, NGOs, Private Sector Business Organization and other National and International Organizations

- ❖ Capacity building of faculty members and staff in extension methodology and support services respectively
- ❖ Organizing exhibition and farmer fairs at district level at least twice in a year
- ❖ Organizing seminar/symposia/workshop
- ❖ Moving towards charging fees for services rendered
- ❖ Paid consultancy services

### **Directorate of Seed & Farms**

Food security is heavily dependent on the seed security of the farming community. It is estimated that all other factors remaining the same, the use of quality seed of high yielding varieties increases crop yield by 15-20% and in some cases where still very old and obsolete varieties are cultivated, yield increase may be 40-50%. The potential benefit of increasing the use of quality seeds is to increase food security through enhanced crop productivity. Though the seed is critical, its cost in farmer's total price of inputs is low as compared to other input factors (fertilizer, agrochemicals, irrigations and post harvest management etc.). With small increase of seed cost, the yield enhancement could be in the range of 20% to 100%. Presently, approximately 75% of the seed used by farmers is farm saved seed (FSS). Therefore, much more emphasis needs to be placed to improve the quality of FSS to enhance productivity of major field crops. In the State of Jharkhand, the productivity of major crops is very low in comparison to the average productivity at national level due to various socio-economic and land topographical situations.

### **Priority area**

1. "Plant breeding is a cumulative science and the seed accumulates all innovations". Therefore, to take advantage of the newly developed cultivars/hybrids, an urgent need is to increase varietal replacement rate (VRR) and seed replacement rate (SRR) as their impact on crop productivity can be seen from the following table in case of maize. Moreover, greater emphasis would be placed to increase coverage under hybrids since hybrid technology is scale neutral. However, the use of hybrids is not uniform in all crops.

2. There is an urgent need to improve the productivity of hybrid rice released through public sectors which can be done by the improving the performance *per se* of the parental lines.
3. Since seed has become commodity, its trade and flow at international level requires the harmonization of various international seed certification schemes (OECD, quality declared seed system of FAO, AOSCA) and seed testing procedures (ISTA, AOSA etc.). To increase seed trade, the effective management of intellectual property rights (UPOV, patents and other sui-generis kind of PVPs) and sanitary and phytosanitary certificates in addition to management of trade barriers are of prime importance for the growth of seed industry. Since India have joined OECD seed schemes by becoming 56<sup>th</sup> OECD participating country in 2009, the similarity/differences between Indian Seed Certification System and OECD varietal certification system vis-à-vis seed testing standards and procedures need to be spelled to the stakeholders.
4. To develop seed entrepreneurship among farmers to meet the ever growing demand of the seed and for export potentials. Presently, export/import are governed by EXIM policy of 2002-07 issued by the Ministry of Commerce. Under EXIM Policy, provision is made to import, which is governed by the New Policy on Seed Development, 1988 read with Plant Quarantine Order, 2003 and amendments made thereon.
5. Farmers participatory seed production and on farm seed management and with the help of farmers more emphasis would be given for the seed production in alternative/new area and in the off season with special reference to hybrid rice and maize. Moreover, much greater emphasis needs to be placed in seed production of climate resilient varieties by adjusting crop calendar. Similarly, improvising/refining hybrid seed production techniques through continuous research and identification of suitable regions/seasons for seed production, would greatly enhance the prospects for large scale hybrid rice seed production in the state.
6. The innovative molecular marker techniques for testing the genetic purity of hybrid seed need to be developed and adopted. More emphasis is to be given on seed health testing, quick seed viability testing, x-ray

analysis, coated seed testing and GM seed testing etc.

7. The time lag between the release and farm level adoption of the new varieties need to be reduced which can be made possible by the promotion of seed cooperatives/seed growers associations and NGOs etc. and the establishment of close coordination with input agencies like KRIBHCO, IFFCO, NABARD etc. to reduce the yield gap and quick popularization of new varieties/hybrids.
8. Production and supply of quality planting materials/seedlings/saplings of horticultural crops to cater the need of the state. Nevertheless, emphasis is also to be given on spices seed production suited to Jharkhand state.
9. Since agriculture in Jharkhand is more or less traditional by virtue of lesser use of inorganic inputs (fertilizers, fungicides, insecticides etc.), there is possibility of organic agriculture in some selected areas. To attain this objective, the need would be to place emphasis on organic seed production.
10. Safe seed storage is the critical aspect of seed production technology. More efforts are needed in studies on safe seed storage by using indigenous traditional knowledge, its refinement and improvement with cost effective measures at farmers' level.

## **4. STRATEGIES**

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### **EDUCATIONAL, RESEARCH, MANAGEMENT AND EXTENSION**

**A**griculture is fast becoming more knowledge-intensive, market-oriented and demand-driven. Extension is thus required in a systemic perspective from production to consumption in a value chain mode. Conventional systems of technology-transfer are inadequate in the fast evolving agriculture. Diversified nature of farming demands, against economic liberalization and globalization, is radically changing the spectrum of service providers to farmers. Indeed, the private sector farmers' organizations, cooperatives, self-help groups, para-professionals, non-governmental organizations, input suppliers and small agri-business are increasingly engaged in providing information and services. Increased reliance on private sector extension, however, does not imply a complete withdrawal of the public sector – which must continue to finance public goods' extension and information services and coordinate extension activities. There is a need to have a re-look at the basic extension strategy considering the strengths of both public and private sector. The extension system has to capitalize on the complementarities and harness coherent synergies between public and private sector. Further, educational, research, management and extension needs to be in a continuum.

#### **4.1 Education**

The Birsa Agricultural University will be central to all agricultural development in the State and should be fully supported for all its relevant development proposals. Globally, science and technology are developing at a very rapid pace. Agricultural development, which includes crops, livestock, fisheries, forestry and all terrestrial development, has benefited immensely by the progress made in basic and fundamental sciences and technological advances made in applied areas like engineering and space research. Adaptive research to utilize these technologies requires considerable investment for modern equipments and facilities, and this may be quite expensive. Resources provided to the BAU for the development

of such facilities should be considered as a long term investment for the progress of science, and the state should not flinch such support. However, it is imperative that the university needs to establish at the national level its presence as an institution striving to excellence. Its faculties should be encouraged to participate at National, Regional and State level Meetings and Conferences as well as Professional Society meetings and interact with peers in their area of work. This will not only equip them to develop self-confidence and share their views and work, but also help for cross-fertilization of ideas that will promote professional contacts. Such participation opportunities should not be limited to senior faculty, but also promising junior members as such exposures help to build confidence and try new ideas. Participation of the faculty in International Conferences should also be encouraged where deemed necessary.

## **4.2 Research**

### **4.2.1 Crop improvement for marginal environment**

One lesson that has been learnt over the years, however, is that in subsistence and semi-subsistence agricultural systems, farmers are interested in multiple traits and yield is a contextual rather than an absolute factor. The productivity gains from crop germplasm improvement alone are estimated to have averaged 1.0% per annum for wheat (across all regions), 0.8% for rice, 0.7% for maize, and 0.6% and 0.5% for millets and sorghum, respectively. Crop genetic improvement focused mostly on producing high-yielding varieties, but the decrease in time to maturity was also an important improvement for many crops, allowing for an increase in cropping intensity.

### **4.2.2 Increasing water and fertilizer use efficiency**

The Intergovernmental Panel on Climate Change (IPCC) projects that changes in water quantity and quality due to climate change are expected to affect food availability, stability, access and utilization (OECD-FAO, 2009). With hotter temperatures and changing precipitation patterns, controlling water supplies and improving irrigation access and efficiency will become increasingly important. The efficiency of fertilizer use in India is rather low being 40-45 per cent in the irrigated areas and less than 35 per cent in the rainfed areas (Raman, 2005). Fertilizer use efficiency is very important factor that needs to be considered in crop production as inefficient use of fertilizers

leads not only to economic loss but also may cause environmental hazards. Watershed management is now an accepted strategy for development of rainfed agriculture. Use of smart sensor network along with GIS, remote sensing, simulation modelling and ICT opens up new opportunities for developing intelligent watershed management information systems. The water productivity could further be increased using micro irrigation system.

#### **4.2.3 Diagnostic Molecular Techniques for production of disease free planting material**

Use of healthy and quality planting material is the key to improving production of horticultural crops—especially those propagated vegetatively. Several diagnostic methods for detection and identification of plant viruses, viroids and phytoplasma are available, each with its own particular advantages and disadvantages. Other molecular tools to detect these pathogens include hybridization, ds RNA analysis, peptide mapping, single strand conformation polymorphism, gene sequencing etc. Leaf analysis, particularly in perennial crops, offers a means of assessing nutritional requirements. This needs to be intensified to ensure economy in fertilizer use through optimised application.

#### **4.2.4 Diagnosis of Livestock diseases and vaccine development**

BAU is extending livestock development programme by distributing goats and pigs of improved germplasm but disease diagnosis and proper treatment has been a great bottleneck at the farmers level. Country including Jharkhand is losing more than Rs. 6,000 crores every year due to mastitis, more than Rs. 18,000 crores every year due to FMD which can be reduced to a certain extent by proper diagnosis and treatment. Cattle are suffering from tuberculosis which is communicable to man also. Development of proper diagnostic facilities and vaccine production units shall help in proper treatment of animals & birds (domestic and wild) and disease prevention, respectively.

#### **4.2.5 Integrated farming system approach**

Integrated Farming System (IFS) seems to be the possible solution to the continuous increase of demand for food production, stability of

income and improvement of nutrition for small and marginal farmers with limited resources. Farming system is a resource management strategy to achieve economic and sustainable agricultural production to meet diverse requirements of the farm household while preserving the resource base and maintaining high environmental quality. Population pressure on land leading to division and fragmentation of land holdings necessitates identification and adoption of suitable farming systems. Research studies carried out in different situations viz. lowland, irrigated upland and uplands have demonstrated the technical feasibility and economic viability of the integrated farming systems. Component analysis, cropping system research and agro-ethnobiological research should be an integral part of IFS approach and IFS should be developed on agro-ecological approach (Crops, livestock and Tree species).

Integrated farming system focuses around a few selected interdependent, interrelated and often interlocking production systems. Normally, they are based on crops, livestock, and related subsidiary professions. This integrated nature involves the utilization of primary and secondary produces of one system as basic input of the other systems, making them mutually integrated as one whole unit. This incidentally helps to reduce the dependence on procurement of inputs from open market, making the system sustainable on long term basis in the development of sustainable farming system models, the concepts of intensification, diversification and value addition must be kept in view. The interaction would also help to improve productivity in various activities. The cost benefit ratio of each component needs to be worked out.

### **4.3 Management**

#### **4.3.1 Nutrient management**

Substantial increases in yield are possible in rainfed systems with application of appropriate (macro) nutrients, especially if used in conjunction with cultivars adapted to the targeted environment. The provision of micronutrients like sulphur, zinc and boron can help to increase yield by over 50 per cent in dryland farming areas. Many legumes are relatively unproductive in acid soils because nodulation is limited by poor availability of molybdenum (Mo). In particular, chickpea is known to respond to added Mo (Kumar Rao et al., 2004). Balanced fertilizer application doubled the

crop productivity (Wani, 2006) with the amendment of micronutrients such as zinc, sulphur and boron, crop yields increased up to 63 per cent for pigeonpea, 65 per cent for maize and 50 per cent for castor.

#### **4.3.2 Rehabilitating degraded lands through biodiversity conservation**

Collection and conservation of diverse germplasm especially of forages has an important and yet unrealized role in rehabilitating the degraded rangelands. Ecosystem degradation can be reversed by selected replacement of species adapted to specific situations. The overgrazed grassland/rangelands may be improved by reintroducing the indigenous species in the system. Intensive field surveys and germplasm collection of multipurpose native species are urgently needed for rehabilitation of degraded lands by the introduction of these species.

#### **4.3.3 Strengthening of weather forecasting system**

As farmers deal with climate changes due to more variability in weather, history becomes a less reliable guide. Under these conditions there is greater payoff to improvements to forecasts of weather events and inter seasonal weather probabilities. Farmer with prior knowledge of such events can respond by planting more appropriate crops and varieties eg. say smaller millets and pulses rather than maize if a dry year is expected. Such improved forecasts would also affect planting even in regions unaffected by the weather fluctuations in response to price expectations and opportunities for trade. Thus major innovations in response to climate variability will take the form of improved information through global monitoring and forecasting. These improved interpolations could lead to improved short term forecasts, which could be disseminated via SMS using rapidly spreading cell phone networks. Better and more timely information can also help to forecast impending 'slow onset' weather events such as drought more effectively and thereby improve response times and adaptation. Forecasting climate change is imperfect, complex, important, and often controversial. For agriculturally important agroecological zones, higher level forecasting of daily weather extremes (frosts, the intensity and form of precipitation, extreme temperature, etc.) is crucial but even more demanding. The detrimental effects of climate crisis are not just a matter of geographic vulnerability-but also depend on a region's ability to pay for adaptation measures.

#### **4.3.4 Establishment of agro-ecologically suitable silvi-pastoral systems**

The livestock population graze freely after paddy harvest in Jharkhand and thus creating problems for area expansion during *Rabi* crops. In the absence of adequate grazing land, nearly a third of the fodder requirement is met from forests in the form of grazing and cut fodder for stall-feeding. Overgrazing and over extraction of green fodder, both lead to forest and land degradation through a loss of vegetation and physical deterioration in the form of compaction and reduced infiltration, and increase in soil erodibility. Forest area is currently under Joint Forest Management (JFM) programmes in the state and be managed by the communities, after the government notification in 1990. Currently, a dry grass production of 1-2 tons/ha is estimated in these areas. Assuming the trend in expansion of area under JFM continues, the area could be expected to increase in the future. With participatory management and better technical support, a dry grass production of 4 tons/ha can be achieved. Establishment of agro-ecologically suitable silvi-pastoral systems in these forest areas will be beneficial both environmentally and economically. The involvement of communities and the modes of usufruct sharing also augurs positively for social equity.

#### **4.3.5 Post harvest technology and management**

In the eastern region, minimizing the post harvest losses by 15%, there will be a surplus of about 28.35 million tonnes of vegetables in the region by 2030. This will warrant intensive post harvest management activities for maintaining the profit level of vegetable growers in the region (RCER, 2011). The anticipated benefits accrued from the said scheme are (i) reduction in on-farm production losses (ii) on-farm primary processing (iii) on-farm value addition of produce (iv) ensuring fair price for the produce and mopping up surpluses at farm level (v) higher employment and income for rural population due to diversification of activities in the production catchments and (vi) proper residue management.

#### **4.3.6 Climate resilient agriculture**

Climate change is all about increase in temperature of earth surface, change in precipitation pattern and more recurrence of extreme events. Eastern regions including Jharkhand are predicted to be most impacted by increased temperatures and decreased radiation, resulting in relatively fewer grains and shorter grain filling durations. On average basis, 50%

yield losses in crops are caused by abiotic factors, mostly shared by high temperature (20%), low temperature (7%), salinity (10%), drought (9%) and other forms of stresses (4%) (Thielert, 2006). Climate change may potentially be one of the most severe threats to pollinator biodiversity (Kerr, 2001). Weather risks play an important role as more than 60 to 80% of the yield is determined by the adequate quantity and proper distribution of rainfall. Magnitude of impact varies greatly by region. Major impacts will be on rainfed crops. Under rainfed/dryland conditions, drought and heat stresses often occur in combination.

#### **4.3.7 Intellectual Property Rights in Agriculture**

Intellectual Property Rights (IPR) is recognized as an asset and means of harvesting the fruit of agricultural research and development. Recognition of IPR provides a viable mechanism of protecting and rewarding innovators. The essence of IPR regulation by law is to balance private and public interests.

With new emerging scenario, the regional biodiversity of Jharkhand needs to be protected. The state is bound to benefit from an organized IPR system due to their inherently rich biodiversity, and therefore, should capitalize on such opportunities. Realization of the gains, principles of equity, and the need for a level playing field is a real challenge. In keeping with the spirit of the inter-governmental agreements, applications of IPR and also maintenance of equity and social justice must effectively be addressed at the state level.

Competitiveness coupled with increased production should be the target for various agricultural commodities having export prospects. In the state of Jharkhand, fortunately rich biodiversity exists, particularly in terms of high value commercial crops, animal breeds, medicinal and aromatic plants. This rich diversity of the region should be protected, before this existing rich gene pool gets high-jacked.

Time has come to fix high priority to generation, evaluation, protection and commercial utilization of tangible products of intellectual property in agriculture. Recognizing the need to capitalize on the State's bio-resources and capabilities to attain and sustain IPR advantages locally, regionally and globally with timely action, the area of IPR in agriculture need to be addressed in conjunction with traditional rights and indigenous knowledge.

Rights to equitable sharing of benefits must be appropriately balanced with the rights to IPR protection wherever applicable. The issues relating to IPR in Agriculture in the Jharkhand should, therefore, be addressed along the following:

- Protectable subject matter in Agriculture
- Protection of Plant Varieties and Farmer's Rights
- Strengthening the institutional mechanisms, viz.
  - ❖ To establish vibrant IPR unit at university
  - ❖ Introduce PG course on WTO (IPR, SPS, AOA, PPV&FR, etc.)
  - ❖ Voluntary or concessional legal advice
  - ❖ Strengthen linkages and cooperation
  - ❖ Awareness generation and literacy in IPR and
  - ❖ IPR education, training, and competence building (HRD)

#### **4.4 Extension**

##### **4.4.1 Increasing cropping intensity**

Rice fallows can be used to grow an additional crop to utilise the moisture still retained in the soil. This technology, comprising short duration chickpea (as a model rabi crop), early sowing, minimum tillage, 'on-farm' seed priming, IPM and protection from grazing has been adopted widely in the Barind and is highly cost-effective (Saha, 2002; Socioconsult, 2006). This technology can be applied in 12 m ha rice fallows in India spread in MP, Orissa, Jharkhand, West Bengal and Chattisgarh (Wani, 2006). If one tries to see the prospects regarding the expansion of area under fruit crops in the state, it appears that barren and cultivable waste land area 5.74 lakh ha, agricultural waste land 2.74 lakh ha, other fallows 6.74 lakh ha and area under current fallow is 8.87 lakh ha. Therefore, if we total this area becomes to 24.1 lakh ha. area could be brought under different kinds of horticultural crops which is a great sign for horticulture expansion in the state.

##### **4.4.2 Promotion of organic/ecological farming**

In traditional rain-fed agriculture, organic farming has the potential to increase the yield. Stolze et al. (2000) showed that out of 18 environmental

impact indicators, organic farming systems performed significantly better in 12 and performed worse in none. Jharkhand state is partially organic by default and ideally suited for practicing organic agriculture if proper training, certification and marketing facilities are created. Organic farming requires over 15% more labour than traditional farming and, therefore, provides rural job opportunities (Pimental et al., 2005). Ecological agricultural approaches allow farmers to improve local food production with low-cost, readily available technologies and inputs, without causing environmental damage. In 1992, the official report of the Rio Earth Summit concluded “there is deep concern over continuing major declines in the mineral values in farm and range soils throughout the world”. This statement is based on data showing that, over the last 100 years, average mineral levels in agricultural soils had fallen worldwide, by 72 per cent in Europe, 76 per cent in Asia and 85 per cent in North America. Pesticides and herbicides can also reduce the uptake of minerals by plants, as they kill certain kinds of soil fungi that live in symbiosis with plant roots (called mycorrhiza). The micorrhiza symbiosis give plants an access to a vastly greater mineral extraction system than is possible by their roots alone (Seedling, 2009). Under the right circumstances, the market returns from organic agriculture can potentially contribute to local food security by increasing family income (Ramesh et al., 2005).

#### **4.4.3 Indigenous technical knowledge (ITKs)**

India is among the leading countries regarding its climatic, biotic and cultural diversities. Jharkhand has a vast treasure of tribal diversity and traditional knowledge. Additionally, it is mega centre of biodiversity. Sustainable agriculture often focuses on the use of traditional knowledge and local innovation. Locally adapted breeds and crop varieties coupled with their social structures to manage and conserve common resources, can support strengthen stability in agriculture. A balanced use of indigenous knowledge with appropriate information added from outside would drive sustainable agriculture to enrich itself. Crops are the direct product of human selection on wild plant diversity. In traditional farms, there is actually more diversity of staple varieties than non-staples, indicating traditional agriculture cultivates variation and difference at the farm and community levels (Javris et al., 2008). Industrial agriculture, commonly understood, intensifies inputs to maximize outputs. Traditional agriculture conserves agrobiodiversity and safeguards reservoirs of genetic diversity and local

ecological knowledge and need to be protected, preserved and promoted.

#### **4.4.4 Information and communication technologies (ICTs)**

Need for using modern ICT tools in the formal educational process and non-formal life long learning of farmers are necessary to emphasize innovation and development of new technologies and building capability and competence of rural communities. Cultivating electronically mediated knowledge and skill revolution is a highly potent strategy to reach with speed and goals of productive, profitable, stable and competitive agriculture. Need is for a well developed dynamic information infrastructure and effective agricultural innovation system. Both high end technology and innovation are fundamental to build knowledge economy, which means creation, acquisition, addition and effective and efficient application of knowledge for bridging the divide between knowhows (researchers/extension agents) and do-hows (farmers/entrepreneurs/landless workers).

#### **4.4.5 Increasing area under hybrids**

There is a very little focus on the hybrid seed research and production in public sector although the private sector companies have taken a lead in this direction. In India, the penetration of hybrid seeds for paddy is meagre 5.0% (approx.) as against 80% for Cotton, 60% for pearl millet and 55% for Maize. Between the years 2000 and 2010, the yields of maize in the country increased upto 2.5 t/ha due to increase in the acreage under hybrids. In India, paddy yield (3.38 tonnes/ ha) is much lower than that of our neighbors such as China (6.55 tonnes/ha), Bangladesh (4.18), Indonesia (5.01) and Vietnam (5.32) as per FAO estimates for 2010. Hybrid Rice Area in Eastern region (Bihar, Jharkhand, Chhattisgarh and Uttar Pradesh) the major yield gains have been reported from stress areas, with an average yield of 4.8 tonne/ha hybrid rice has potential to leap frog development in the Eastern Region (State of Indian Agriculture, 2012-13). Productivity for rice in India has been stagnant at 3.3 ton/ha (paddy) which is less than half that of China due to low SRRs (Seed Replacement Rates) and varietal replacement rates (VRRs). Although, the area under hybrid rice is increasing particularly for lowland ecologies but at the same time hybrids in other crops i.e. maize and pigeonpea need to be increased.

#### **4.4.6 Strengthening system of input supply**

For smooth farm operations simple machineries are needed which are not in adequate supply. The drudgery of farm labour, especially women in the villages is still a pathetic sight. So, farm machinery gap is yet another feature that has impact on overall production potential. The success of agriculture depends on availability of all the essential inputs at the right time, in right quantities and at right place. Right quality seeds/ planting materials need to be supplied to farmers in adequate quantity on time. However, the actual supply is far from the potential requirement of seeds, creating avoidable ‘gap’. Late distribution of seeds normally results in shifting the critical sowing dates, leading to unpredictable yield levels. ‘Seed gap’ is linked to ‘yield gap’ both of which reflect on the quality and quantity of produce harvested. The ‘fertilizer gap’ is yet another situation that affects crop growth and yield (Rajagopal, 2012).

##### **4.4.6.1 Seed - ‘vehicle’ of new technologies**

Seed security is key to the attainment of household food security among resource poor farmers in the state. Food security is heavily dependent on the seed security of the farming community. It is estimated that all other factors remaining the same, the use of quality seed of high yielding varieties increases crop yield by 15-20% and in some cases where still very old and obsolete varieties are cultivated, yield increase may be 40-50%. With small increase of seed cost, the yield enhancement could be in the range of 20% to 100%. Presently, approximately 75% of the seed used by farmers is farm saved seed (FSS). Therefore, much more emphasis needs to be placed to improve the quality of FSS to enhance productivity of major field crops. In the State of Jharkhand, the productivity of major crops is very low in comparison to the average productivity at national level due to various socio-economic and land topographical situations.

##### **4.4.6.2 Use of Biofertilizers and Biopesticides**

Naturally fixation of nitrogen needs to be encouraged with the use of micro organisms. Similarly, blue green algae (BGA) and *Azolla* have been found effective in certain rice growing areas. Biofertilizers are associated with the liberation of growth substances which promote germination and plant growth. In case of P, several P solubilising bacteria are known to

mobilize the significant quantities of soil phosphates that would otherwise not be available to the plant, but their effectiveness is variable and not predictable. However, unlike mineral fertilizer, use of the biofertilizers is crop and location specific due to competition with native soil microbes, poor aeration, increased temperature, soil moisture, acidity, salinity and alkalinity and presence of toxic elements etc. Also it needs careful handling and storage. Nevertheless, biological control has emerged as an alternative choice to overcome the side effects of the chemical intensive approach. This method basically comprises of live sources for the management of plant problems. These living entities are diverse ranging from microorganisms (viruses, bacteria, fungi, bacterial agents etc.) to plants (neem, turmeric, garlic etc) which in one form or the other help in bringing down the population of the pest. At present, only eight biopesticides are registered in India. The use of multi microbial biopesticides (e.g. *Trichoderma*, *Bassilus Bevaria*, Bt. etc.), botanical extracts and combinations (e.g. neem, karanj etc.) should be encouraged.

#### **4.4.6.3 Enhancing farm mechanization**

Farm mechanization level mainly depends upon the size of operational holding, land topography, cropping pattern, credit availability and nearness to market which in term control the cropping intensity and productivity of the region. It is also known that the farm operations such as weeding, irrigation, harvesting and threshing need to be carried out in the timely manner to avoid losses due to shattering, quality and deterioration resulting in improved income from the sale of produce. In India, improved agricultural tools and equipment are estimated to contribute to food and agricultural production by saving in seeds (15-20%), fertilizers (15-20%), time (20-30%), and labour (20-30%); and also by increase in cropping intensity (5-20%), and productivity (10-15%) (Pandey, 2011). The scope for increasing mechanization exists today across the entire agricultural value chain from tillage, seeding and planting, to crop protection, harvesting and trash management. While mechanization would augment the agricultural productivity by 10-15%, post harvest management could add another 5-10% by reducing losses (Mal, 2011).

#### **4.4.6.4 Promotion of plastic culture in agriculture**

ICAR started All India Coordinated Research Project (AICRP) on

Application of Plastics in Agriculture (APA), which was strongly supported by National Committee on Plastics in Agriculture (NCPA) to undertake research and extension activities pertaining to water management, protected farming, post-harvest produce management, etc. The significant contributions in the area of developing and adopting low cost polyhouse for off-season vegetable production under varied agro-climatic conditions, which showed considerable enhancement of yield, quality of produce and reduction of maturity periods as well as benefits of off-seasonality. A number of subsidized schemes are available under National Horticulture Mission (NHM) to promote plastic culture in agriculture.

#### **4.4.6.5 Promotion of resource-conserving technologies**

There are several types of resource-conserving technologies and practices that can be used to improve the stocks and use of natural capital in and around agroecosystems. These are as follows:

- (i) IPM, which uses ecosystem resilience and diversity for pest, disease and weed control, and seeks only to use pesticides when other options are ineffective (Bale et al., 2008).
- (ii) Integrated nutrient management, which seeks both to balance the need to fix nitrogen within farm systems with the need to import inorganic and organic sources of nutrients and to reduce nutrient losses through erosion control (Moss, 2008).
- (iii) Conservation tillage, which reduces the amount of tillage, sometime to zero, so that soil can be conserved and available moisture used more efficiently (Hobbs et al., 2008).
- (iv) Agroforestry, which incorporates multifunctional trees into agricultural systems and collective management of nearby forest resources (Leakey et al., 2005).
- (v) Aquaculture, which incorporates fish, shrimps and other aquatic resources into farm systems, such as into irrigated rice fields and fish ponds, and so leads to increases in protein production (Bunting, 2007).
- (vi) Water harvesting in dryland areas, which means formerly abandoned and degraded lands can be cultivated, and additional crops can be grown on small patches of irrigated land owing to better rain water retention and improving water productivity of crops (Morison et al., 2008).

(vii) Livestock integration into farming systems, such as dairy cattle, pigs and poultry, including using zero-grazing cut and carry systems (Wilkins, 2008).

## **4.5 Recommendation**

### **4.5.1 Education**

Keeping in view the rising unemployment and market forces due to globalization the agricultural graduates should not be mere degree holders, instead must be professionals who could devise remedial solutions through interpretation of problems.

- The laboratories/class room and other physical facilities in the colleges/ research stations by and large needed strong financial support in order to bring the same not only on par with other colleges/universities in the country but make up the university as one of the leading agricultural universities of the country. In this respect finances may be obtained from the ICAR, Central Govt., International Institution, Private Organisation apart from the State Govt.
- Human resource development by agricultural education should be such that the present day needs as well as having innovative competence for future needs, the course curricula must be revised regular to include relevance and utility of education through reengineering of traditional syllabus and introductions of new subjects, to attract youth in the farming system.
- The focus of change should devise agricultural education to produce graduates who can create their own employment by skill development through hands on training in all aspects of enterprise and do not depend on public sector jobs.
- Priority emphasis should be on self employment scheme on Agri-business and Agri-clinics thus taking extension services to the door of the farmers. Entrepreneurship courses should also be developed to meet the demands of diversified and emerging global market.
- Centre of excellence should be established to enhance competitiveness of graduates taking into account new opportunities.
- The centres of excellence should help in building component of human resource in the field of new schemes.

- Design the curricula keeping in view the relative role of women in farming so as to enable them to get equally empowered technologically in the State where women are dominantly engaged in handling of food to ensure quality control.
- Develop the system of recognition to farm graduates to provide extension and other services as registered farm practitioners.
- Encourage the students to access the internet and download study materials through provision of computer along with high speed broad band connectivity in the hostels.
- Focus needs to be given to the development of skill of design of farm machine and farming system.
- Introduction of modules relating to public speaking, presentation skill, utilizing Audio-visual tools and exposure to practicing professionals from industry will greatly help the student in developing greater self confidence.
- Ensure that farm graduates get well versed not only in the areas of agricultural production but also imbibe knowledge of emerging areas in the entire production, marketing, value addition export chain etc.
- Introduction of vocational courses in animal husbandry, dairy technology, fisheries, forestry, horticulture, vegetable, floriculture, primary processing, loss free storage and food preservation, sericulture, maintenance and hiring of farm machinery, seed and nursery propagation require priority attention.
- High tech agriculture including precision agriculture and organic farming offer potential to create productive, profitable and stable employment in agriculture.
- In order to produce world class human resource to meet the demands of global competitiveness in rendering professional agricultural service, it has become imperative to infuse excellence in quality of agricultural education.
- Programmes should be organized to expose the teachers to comprehensive development process and equip them to coordinate

entrepreneurship development related activities.

#### **4.5.2 Research**

- The need now is for developing a holistic system to attain sustainable development of agriculture. Low cost high benefit yield technology has become more crucial in view of growing number of small and marginal farmers and shrink in land holdings.
- Special attention for development of horticulture in the state through intensified research needs to be given. It may include increasing productivity of present horticultural crops, introduction of new crops, value addition and product diversification.
- Emphasis upon development and promotion of eco-technologies based on the principles of economics, equity and unemployment is needed.
- In view of the decline in availability of quality factors determining the agricultural production and the continuous rising demand for food, it has become imperative to shed some of our conventional approaches and take recourse to modern and efficient approaches.
- There is a need to develop holistic system to attain sustainable development of agriculture, including environment management through resource conservation and efficient management of technologies and practices specially in the rainfed regions.
- In the context of a holistic agricultural development ensuring household food security, role of frontier sciences like biotechnology and information technology etc. has become essentially much more important and vital than ever before.
- The conventional breeding methods will have to be complemented by an array of biotechnology tools in a variety of ways such as tissue culture, DNA finger printing, molecular breeding, genomic, diagnostics or development of transgenic etc. Needed support is required for exploiting the gene revolution (biotechnology), benefiting from information and communication technology revolution, and promoting knowledge based precision farming system, intensification and diversification.
- The accent on horticulture, livestock, fisheries, forestry, specialty enterprises, value-added products, precision farming, organic

farming, biomass recycling and energy farming and market-driven diversification should further be intensified.

- The needs and prospects of rainfed and other noncongenial areas must be addressed on priority basis, including the increased use of participatory breeding and other participatory researches by effective involvement of grass root people.
- There is need to establish Genius Award for young scientists to attract talented youth to agricultural research, technology development and education.
- Emphasis on knowledge based precision farming intensification and diversification be given through appropriate research strategy.
- Attention be given to develop farming system approach according to the need of the agro-climatic zones.
- There is need to promote investment in agricultural research by private sector by strengthening regulatory and other enabling mechanisms and encouraging joint public private research.

#### **4.5.3 Extension**

- KVKs to give concurrent attention to develop link among researchers and farmers with reference to on farm and off farm livelihood and promote end to end approach and to link production with marketing and consumption.
- Entrepreneurship development programme should be included in the mandate of KVKs and other vocational training institutes.
- There is need to integrate the activities of KVKs, ATMAs, Lab to Land and Land to Lab programmes, Self Help Groups, agricultural cooperative and other grassroots institutions.
- There is need to increase the involvement of small land holders in public private partnership in high value agriculture by integrating the small holders with high value supply chain.
- There is need to develop our extension strategies to go beyond district boundaries and penetrate into village.
- There is need for a well developed dynamic infrastructure development and effective agriculture innovation system.

- Training should not end up with imparting knowledge and skill but appropriate followup monitoring and rendering assistance to the trained beneficiaries should be given equal importance. The extension machinery be geared accordingly. In this particular aspect “Varanasi Model” of agri-business and management could be followed.
- More concentrated efforts upon farmers participatory approach in research and extension education be made.

## 5. EPILOGUE

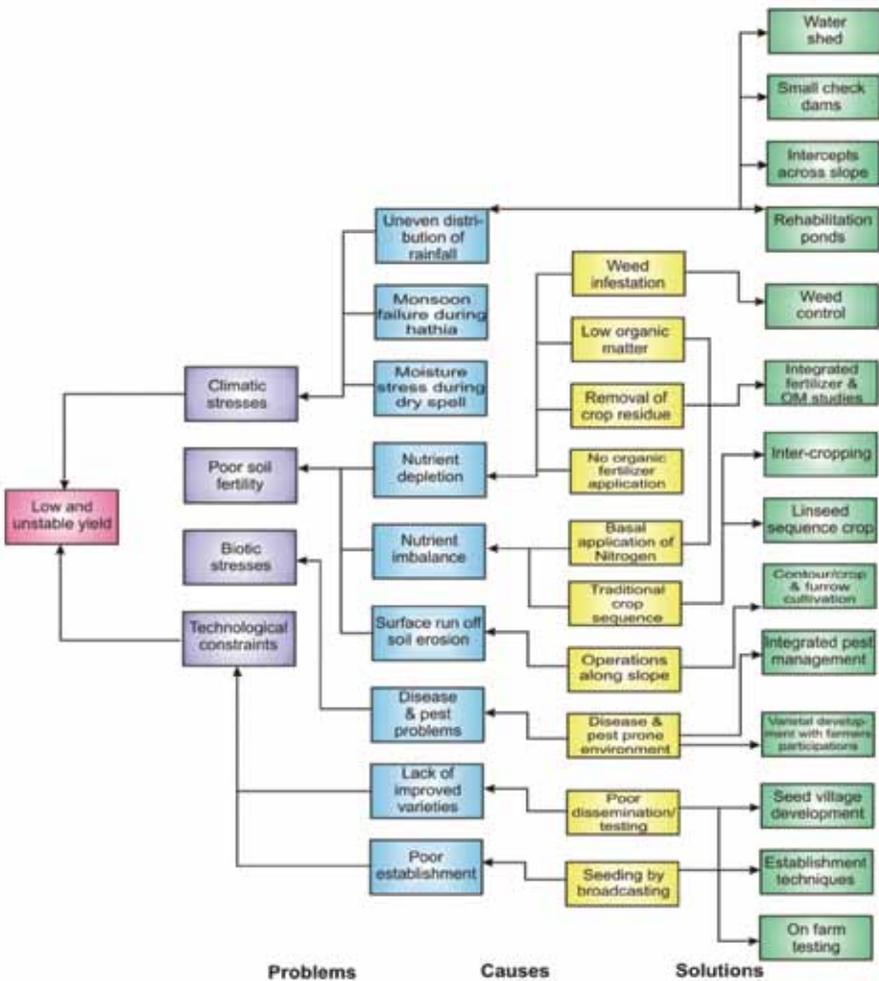
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It has been reported that each 1% increase in crop productivity reduces the number of poor people by 0.48% while in India, it is estimated that a 1% increase in agricultural value added per hectare leads to a 0.4% reduction in poverty in the short run and 1.9% reduction in the long run, the latter arising through the indirect effects of lower food prices and higher wages (Pingali, 2012). The farm productivity, diversification, farm mechanization, employment opportunities and income generation are significantly and positively correlated with the level of irrigation. The policy makers are fully aware of this fact and accordingly the area under assured irrigation would be doubled from the present level of 12.77 per cent to 25 per cent of NSA and raising cropping intensity to 150 per cent as per target set for the state by the Planning Commission (GOI) for the XII<sup>th</sup> Five Year Plan. The farming communities belonging to different farm size groups have good knowledge of traditional agriculture, animal husbandry, horticulture, medicinal and aromatic plants, forest product and their utilization and other related activities useful for households and family. But, they are helpless in the hands of nature and poverty mainly due to degraded ecosystem, inadequate natural resource management, decreasing total factor productivity, increasing cost of production, reducing farm size and ever increasing population pressure. Small and marginal farmers are trying their best for maximum production to meet the family requirements with available limited resources like land, water, animal and man power, with limited input supply and cash flow. They also experience the constraints in farming due to fragmented land holdings, land divided into small parcels and social systems with poor infrastructure, absence of market linkage, poor storage and post harvest management facilities. Moreover, as mentioned earlier 19 out of 24 districts of the state are under left wing extremism (LWE). The major constraints listed above are responsible for low farm productivity, low income and high migration. In the post-Green Revolution period, new investments in R&D for stress-tolerant crops and increased demand for food grains have changed the prospects for agricultural production in marginal areas. Drought- and pest resistant varieties, such as submergence tolerant rice and drought-tolerant maize, provide options that reduce farmers' risk

and improve incentives to invest in productivity-enhancing technologies (Pingali, 2012).

Nevertheless, Govt. of India has placed much emphasis to bring second green revolution (GR 2) in Eastern region including Jharkhand. Though, the growth rate in agriculture of 6.8 per cent has been achieved but, to sustain and maintain it, is the herculean task for the development of agriculture and allied sector and to get 'sustained' growth rate of 6.5 per cent set for the state by the Planning Commission-GOI for the XII<sup>th</sup> Five Year Plan, Emphasis will be given on multidisciplinary research in a program matrix involving land and water management, crop improvement, horticulture, agroforestry, livestock and poultry, fishery and aquaculture. Furthermore, there is need to integrate various rural development schemes operating under different departments (as in Bihar). The integration and convergence of different developmental and welfare schemes will be the key factors for overall progress with inclusive growth in order to convert coveted second green revolution into evergreen GR.

To summarize the problems, causes and possible solutions for Jharkhand agriculture have been presented in the form of flow diagram depicted below:



Flow diagram of problems, causes and possible solutions for overcoming low and unstable yields in rainfed of Jharkhand

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