Status of Centre-State Coordination in Agricultural Research, Education and Extension in Zone-III

(Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram
Nagaland, Sikkim & Tripura)

PROCEEDINGS
XX MEETING OF ICAR REGIONAL COMMITTEE NO. III
&
KVK INTERFACE MEETING

May 5-7, 2011
ICAR Research Complex for NEH Region, Umiam, Meghalaya

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
New Delhi - 110001

शरद पवार
SHARAD PAWAR

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MESSAGE

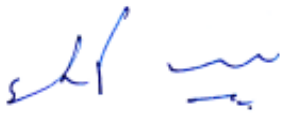
Indian Council of Agricultural Research along with the entire setup of National Agricultural Research System has played a major role in rapid stride in the agricultural growth over the past decades. The food grain production of India is expected to cross the 241 million mark during current year. However, we have some major challenges ahead to feed our future generations. The cultivable area is limited but the population is continuously growing, thereby increasing the requirements, of the agricultural commodities. Even after successfully achieving the green revolution, we still have disparities in production and productivity scenario in different parts of the country.

There has been appreciable growth in the agriculture sector in the North-Eastern states during the last few decades, however, the NE Region still has large food grain deficit. The decadal growth is only 0.49% while, the demand of the increasing population that has grown by 16.9% during 2001 to 2011 is much higher. This gap needs to be bridged. Most of the farmers of the hill states are tribal farmers living in poorly accessible areas. Agriculture is the mainstay of about 80 per cent of the population. *Jhum* is a dominant agricultural practice having many social and cultural dimensions. The research and development plan for the region is more challenging and is different than the other parts of the country. The region is characterized by rich biodiversity, mostly acidic soils, low cropping intensity, low input application, unique horticultural assets such as Khasi mandarin, orchids, pineapple, strawberry, etc., without much substantial value addition, lack of markets and transportation, shortage of water despite high rainfall, and lack of skilled and professional manpower and thus require adequate Research and Development efforts to meet the challenges.

Indian Council of Agricultural Research with its five research institutes and regional centers in addition to a Central Agricultural University at Manipur, Assam Agricultural University at Jorhat and Agriculture faculty of the Nagaland University, Medziphema, have been addressing various problems but active research and development support together with efficient management of resources is of utmost importance. Research at these institutes

resulted in development of rice varieties and technologies for the *Jhum* areas both in upland and lowland farming system models for different geographical situations, artificial insemination in pig, improvement of the local pig and poultry resource, conservation, evaluation and characterization of agri-biodiversity, etc. The ICAR realizes the importance of participatory development in agriculture to achieve food sufficiency in the region and work on need based research. It is in this direction that a new platform for the NE region, KIRAN (Knowledge Innovation Repository in Agriculture for North East) was launched during the Regional Committee Meeting. The regional committee is an ideal platform to bring all the stake holders such as farmers, policy makers, researchers, developmental organizations, state line departments and universities to exchange views and ideas, and bring forward the issues needed for the agricultural development of the region. It is a matter of satisfaction that State departments and Central Agencies are working in tandem to accelerate the pace of production and productivity of agriculture including agro-forestry, horticulture, animal husbandry and fisheries for the benefit of the farming community of the region.

I hope that, the recommendations of this XX Regional Committee Meeting and KVK interface meeting held at I C A R Research Complex for NEH Region, Umiam, Meghalaya, from 5-7 May, 2011, would help to strengthen the R&D policy of the ICAR for the NE region and shall contribute to the goal of achieving self-sufficiency in food grain production and agrarian prosperity of the north-east.



(SHARAD PAWAR)

डा. एस. अय्यपन
सचिव एवं महानिदेशक
Dr. S. AYYAPPAN
Secretary & Director General

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PREFACE

North East India is endowed with rich cultural and biological diversity. Although the region is deficient in food grain production, it has enormous potential to achieve self sufficiency in agricultural production. The bountiful of natural resources provide opportunities for multi-dimensional growth of agriculture. To achieve the goal of food sufficiency, knowledge driven agriculture is the need of the hour. Therefore, not only we need to develop situation-specific new technologies, but also readjust and refine the existing ones to fit into the changing social dimensions in terms of food habits, living standards, cultural diffusion etc., taking into account the agrarian interests of the tribal farmers of the North East region.

The ICAR Regional Committee-III has eight states including Assam, Arunachal Pradesh, Mizoram, Manipur, Meghalaya, Nagaland, Sikkim and Tripura. The five ICAR institutes including ICAR Research Complex with its six research stations in different states and four National Research Centers on Pig, Mithun, Yak and Orchid; seven Regional Centers of other institutes and several AICRP Centres in different disciplines/ commodities, a State Agricultural University at Jorhat, one Central Agricultural University at Imphal, both with their centres, and the agriculture faculty of the Nagaland University, Medziphema are engaged in addressing the problems of agriculture in the region, and have developed varieties of cereals, pulses, oilseeds, animal breeds, technologies for crops and animal production and management, fish seeds and fish production etc. Increasing cropping intensity, amelioration of acidic soils, value addition of horticultural produce, water management, integrated farming involving livestock, poultry and piggery with crops such as maize, rice, pulses, oilseeds, and fisheries altogether can bring about a spurt in agricultural development of the region and enhance the livelihood opportunities and farm prosperity. The scientists have produced piglets through artificial insemination, which is quite significant to this region.

Technology assessment, refinement and demonstration by the 71 KVKs in coordination with several other agencies is helping to resolve the problems and issues of agricultural

production and livestock management in the region. The KIRAN (Knowledge Innovation Repository in Agriculture for North East) launched during this regional committee meeting shall prove to be an efficient and effective mechanism to deliver agri-information to the stakeholders.

I am confident that, the recommendations of this XX meeting of the Regional Committee, Zone-III, held at ICAR Research Complex for NEH Region, Umiam, Meghalaya from 5th -7th May 2011 would help towards evolving road map and frame works for future research and development to make the region into an agricultural paradise of the country.

(S. Ayyappan)

Acknowledgements

The regional committee meeting is conducted every two years, where the state representatives, ICAR institutes, agriculture universities, central and state development agencies and NGOs discuss on the strategy for the growth of agricultural education, research and extension in the region/zone. This year's meeting, the 20th regional committee meeting of Zone III, was held at I C A R Research Complex for NEH Region, Umiam, Meghalaya from 5th to 7th May, 2011. The meeting was inaugurated by His Excellency, the Governor of Meghalaya, Shri R.S. Mooshahary *Jee*. We sincerely express our deep sense of gratitude for his kind presence and gracing the occasion. I am thankful to the Hon'ble Deputy Chief Minister of the Government of Meghalaya, Dr. B.M. Lannong, Hon'ble Minister of Agriculture, Horticulture, Fisheries, Govt. of Mizoram, Shri H.Liansailova, Hon'ble Minister for Agriculture & CADA, Govt. of Manipur, Shri Ph.Parijat Singh and Hon'ble Minister for Vety., & AH, Govt. of Nagaland, Shri T.R. Zeliang, for their kind presence and valuable inputs on the agricultural issues of the north east.

The interactive discussions on scientific and agricultural policy issues took place for three days and priorities were framed in the area of organic agriculture, animal health management, swine fever vaccine, agro-based entrepreneurship development, secondary agriculture, agroforestry and farming system research. KIRAN (Knowledge Innovation Repository of Agriculture in North-East) was launched for efficient and effective delivery of agri-information to the stake holders. The proactive and futuristic steps undertaken by Indian Council of Agricultural Research to meet the challenges of the future agricultural needs in the climatic change scenario through the new initiatives under NICRA (National Initiative on Climate Resilient Agriculture); livelihood security programmes under NAIP and extensive extension programme through a massive network of KVKs were well appreciated.

All these were possible because of the able guidance, critical suggestions and whole hearted support extended by Dr S. Ayyappan, Secretary DARE and DG ICAR. I sincerely express my gratitude to him. I thank Dr V.V. Sedamate, Advisor of agriculture, Planning Commission who could make it to the meeting in spite of his busy schedule and gave valuable inputs. The constructive and healthy suggestions made by Mr Sudhir Bhargava, Member of Governing body ICAR, New Delhi is duly acknowledged. I appreciate the valuable contributions made by Dr S.N Puri, Vice Chancellor, Central Agricultural University, Imphal especially in formulating the strategy for agricultural education for the region. I am also thankful to Dr K. M. Bujarbarua, Vice Chancellor, Assam Agricultural University who shared his vast experience on the north east and enriched us with his analytical inputs on critical issues of the region. Dr Arvind Kumar, DDG (Education), the nodal officer for this programme, was instrumental in the meticulous planning and management of the finer details of the

meeting. I am exteemly thankful to him for his able guidance and advice that helped us to successfully conduct the progamme. I am thankful to Dr A.K. Singh, DDG (NRM) for his constant support and guidance. I also express my gratitude to Dr H.P. Singh, DDG (Horticulture), Dr K.D. Kokate, DDG (Extension), Dr K.M.L. Pathak, DDG (Animal Sciences), Dr M.M. Pandey, DDG (Engg), Dr B. Meena Kumari, DDG (Fisheries) and Dr Bangali Babu, National Director, NAIP for their critical appraisal and thoughtful comments on the entire deliberation. The efforts of Dr Ravindra Kumar, ADG (Coordination) and Dr Venkatasubramanium, ADG (Agri. Extension) in providing valuable inputs and support is sincerely acknowledged. The contribution of all the regional directors of the ICAR institutes in the success of the meeting is highly appreciated. I thank the state government officials who shared their grass root level field experiences and concerns of their respective localities.

Finally, I extend my heartfelt thanks to all the joint directors, scientists, technical and administrative staff of ICAR and its constituent institutes who have helped us in making this thought provoking programme a success.

(S.V. Ngachan)
Director
ICAR RC NEH

CONTENTS

1. PROGRAMME

XX Regional Committee Meeting *(Region-III)*

Venue: ICAR Research Complex for NEH Region, Umiam, Meghalaya

Date: 5 - 7 May 2011

INAUGURAL PROGRAMME

Date 5.5. 2011

09:30 hrs	Arrival of Chief Guest & Dignitaries	
09:35 hrs	Felicitation of Chief Guest & Dignitaries on the dais	
09:45 hrs	Lighting of lamp	Chief Guest & Dignitaries on the dais
09:50 hrs	Welcome address	Dr. S.V. Ngachan, Director, I CAR Research complex for NEH Region, Umiam, Meghalaya.
09:55 hrs	Introductory remarks	Dr. Arvind Kumar Dy. Director General (Edn), ICAR, New Delhi
10:00 hrs	Address	Dr. S. Ayyappan, Secretary, DARE (GOI), & DG, ICAR, Krishi Bhawan, New Delhi
10:15 hrs	Address	Shri H. Liansailova, Hon'ble Minister of Agri., Horti. & Soil Conservation, Government of Mizoram
10:25 hrs	Address	Shri Ph Parijat Singh, Hon'ble Minister for Agriculture & CADA, Govt. of Manipur
10:55 hrs	Address	Shri T.R. Zeliang, Hon'ble Minister for Vety., & AH, Govt. of Nagaland
11:05 hrs	Address	Dr. B.M. Lannong, Dy.Chief Minister, Government of Meghalaya
11:15 hrs.	Inaugural address	His Excellency, The Governor of Meghalaya, Shri R.S. Mooshahary
11:30 hrs.	Vote of thanks.	Dr. Ravindra Kumar, ADG (Coordination), ICAR, Krishi Bhawan, New Delhi

TEA BREAK (11:35 - 12:30 hrs)

INTERACTIVE SESSIONS

12:30-13:00 hrs	Action Taken Report on the recommendations of 19th RCM held at ICAR RC for NEHR, Sikkim Centre on 23rd and 24th October, 2009
13:00-13:30 hrs	Discussion on Action Taken Report

LUNCH (13:30-14:30 hrs)

FRESH AGENDA ITEMS
Problems of respective states in terms of agricultural production, livestock and fisheries; Suggestions on researchable issues (14:30-18:00 hrs)

A-1 Government of Assam
A-2 Government of Arunachal Pradesh
A-3 Government of Manipur
A-4 Government of Meghalaya
A-5 Government of Mizoram

TEA BREAK (15:45-16:00 hrs)

A-6 Government of Nagaland
A-7 Government of Sikkim
A-8 Government of Tripura

RESPONSE TO THE ISSUES RAISED BY THE STATE GOVERNMENTS BY VICE CHANCELLORS

B-1 Vice Chancellor, Assam Agricultural University, Jorhat
B-2 Vice Chancellor, Central Agricultural University, Imphal

RESPONSE TO THE ISSUES RAISED BY STATE GOVERNMENTS BY HEADS OF ICAR INSTITUTES/CENTRES

B-3 Head, NBSS & LUP, Regional Research Station, Jorhat, Assam
B-4 Head, CRRI, Regional Lowland Rice Research Station, Gerua, Assam
B-5 Head, CPCRI, Regional Centre, Kahikuchi, Guwahati, Assam
B-6 Head, Ramie Research Station, CRIJ & AF, Barpeta, Assam
B-7 Head, CIFRI, Regional Centre, Guwahati, Assam
B-8 Head, NBPGR, Regional Station, Umroi Road, Umiam, Meghalaya
B-9 Head, CPRI, Regional Centre, Shillong, Meghalaya
B-10 Director, ICAR Research Complex for NEH Region, Umiam, Meghalaya
B-11 Jt. Director, ICAR Research Complex for NEH Region, Arunachal Centre
B-12 Jt. Director, ICAR Research Complex for NEH Region, Manipur Centre
B-13 Jt. Director, ICAR Research Complex for NEH Region, Mizoram Centre
B-14 Jt. Director, ICAR Research Complex for NEH Region, Nagaland Centre
B-15 Jt. Director, ICAR Research Complex for NEH Region, Sikkim Centre

B-16 Jt. Director, ICAR Research Complex for NEH Region, Tripura Centre
B-17 Director, National Research Centre on Pig, Rani, Guwahati, Assam
B-18 Director, National Research Centre on Yak, Dirang, Arunachal Pradesh
B-19 Director, National Research Centre on Mithun, Medziphema, Nagaland
B-20 Director, National Research Centre on Orchid, Pakyung, Gangtok, Sikkim

Date: 6.5.2011

RESPONSE OF DDGs of ICAR (09:30 – 13:00 hrs)

B-21 Dr. S. K. Dutta, Deputy Director General (Crop Science)
B-22 Dr. H. P. Singh, Deputy Director General (Horticulture)
B-23 Dr. A. K. Singh, Deputy Director General (NRM)
B-24 Dr. M. M. Pandey, Deputy Director General (Agril. Engg.)

TEA BREAK (11:10-11:30 hrs)

B-25 Dr. K.M.L. Pathak, Deputy Director General (Animal Science)
B-26 Dr. (Mrs.) B. Meenakumari, Deputy Director General (Fisheries)
B-27 Dr. Arvind Kumar, Deputy Director General (Education)
B-28 Dr. K. D. Kokate, Deputy Director General (Ag. Extension)

CONCLUDING SESSION

13:00-13:30 hrs Concluding Remarks by Dr. S. Ayyappan, DG, ICAR
13:30 hrs Vote of Thanks by Dr. Ravindra Kumar, ADG (Coordination)

LUNCH (13:30-14:30 hrs)

14:30-16:00 hrs Session on KVK, Presentation by ZPD, Zone –III and presentation by Programme Coordinators of NE Region

Date: 7.5.2011

09:30-11:30 hrs Session on KVK, to continue
11:30-13:00 hrs Plenary Session

Vote of Thanks by Dr. A.K. Gogoi, ZPD-Zone III

2. SPEECHES OF DIGNITARIES

Excerpts from the speech of His Excellency, the Governor of Meghalaya, Shri Ranjit S. Mooshahary, during inaugural session of 20th Regional Committee Meeting (Zone - III) on May 5, 2011

Dr. Ayyappan, Mr. Liansailova, Shri Parijat Singh, Shri Zeilang, Mr. Lanong, Dr. Arvind Kumar, Dr. Ravindra Kumar, Dr. Ngachan, ladies and gentleman and students.

I appreciate the efforts of ICAR in organizing the Regional Committee Meeting for deliberating on issues of agricultural productivity in the region and developing suitable technological interventions to augment output. Agriculture connotes to not only crop farming but all soil based ancillary activities for human physical sustenance. Therefore, livestock development and promotion is an important component of agriculture. It is particularly so in the northeast region where agriculture is the mainstay of livelihood and life continues to be pastoral and bucolic and livelihood a factor of soil.

Livestock has multiple uses for human sustenance in the form of meat, milk, urine, dung, hide, and in addition some of them are also used as draught animals and hunting aid. Since the dawn of civilization livestock has been man's asset and with time their usefulness for man has only increased. Healthy livestock is therefore the guarantee for healthy human life.

In the northeast it is even more important because of the people's food habit. Unlike in other region people are meat eaters in this region by tradition and upbringing and our demand for meat, eggs and fish far outweighs our production. At the moment we do not have concerted thrust for livestock development and it must be a part of our strategies to develop livestock along with agricultural crop production. Crop production and livestock care is mutually dependant and improvement in one helps the other immensely. The natural abundance of grasslands and water bodies, forest and grazing grounds in the region can really be used for revolutionizing the meat, fish and egg production. We need to feed our people not only with grains but also with other protein-rich items and it is not an impossible proposition.

Another important item of rural economy is horticulture and floriculture. Meghalaya has taken some strides in that direction. I am citing the example of strawberry cultivation. In fact before I came here I attended a ***Strawberry Festival*** in Shillong where the strawberry farmers came to tell the success story. One village in particular- Sohliya near Umsning- which is just a few miles away from here have constructed pucca houses and bought cars with the income from strawberry. They have learnt the techniques and made adaptations to the requirement for optimum production and the village is a model of self-reliance and economic security.

I term the strawberry as "Red Gold". The transformation of that village from poverty to prosperity through cultivation of strawberry is worth emulating by others. There in Sohliya village out of 68 household, 67 have taken to strawberry cultivation and within a period of eight years starting from 2003 they have experienced the sweet fruits of their labor. I am told that in some other parts of the country like Maharashtra also strawberry is being cultivated but they are not producing as much as the NE states. Meghalaya has also taken to growing anthurium on a commercial basis and it is now exported. Likewise in cash crops like cashew, rubber, pepper, tea the state has made much headway and they are bringing in good income to the farmers.

I stress upon improvement to the agricultural sector in the NE region. It is high time for agricultural researchers to think about adoption of specific technologies that is best suited across NE region. It is an indication of our poverty in research and technology that the northeast region still remains food deficient despite abundant natural resources. I want to point out that the laboratory success has no meaning unless the knowledge is implemented in field. The need is to have lab to land connectivity.

In relation to present food scarcity in the region I would like to mention the observation by Jean Baptiste Tavernie, a French Jeweler who undertook several voyages to the region during the 17th century when the whole region was known as Assam and other states like Nagaland, Meghalaya, Mizoram and Arunachal Pradesh were parts of it. According to him the kingdom of Assam was one of the best countries in Asia, for it produced all that was necessary to the life of the man without their being need to go for anything to the neighboring states. All peasants of Assam were at their ease and there was scarcely any one who had not a separate house in the middle of the land, a fountain surrounded by trees and even the majority kept elephant for their wives. So I raise the question- if it could be so in the 17th century, why not today in the 21st century with all the advancement in science and technology? NE region is deficient in food production not because of increased population but because of primitive agricultural practices. We still continue with our hand and hoe technique to grow food and in livestock management. Our food production is growing at 5.53% whereas population growth is 16.5%. So it is a great challenge to meet the gap.

NE region has rich flora and fauna as well as diverse cultures. We are proud of it but what is the most important culture right now is agriculture which can be termed as the basic culture. I urge the scientific community to help the farmer to grow more food. We have to keep in mind that ***no security is above food security*** which can be achieved through knowledge transfer to the farmers. We are all stakeholders in food security and let us try to replicate the conditions of the 17th century when everybody had enough to eat in our region.

The major threat to food security is land degradation by severe soil acidity, depletion of soil nutrients through leaching, ground water depletion, pollutions etc. Land holding is decreasing day by day due to population growth. Therefore, it is imperative to devise strategies involving the entire stake holder including students and farming communities under the banner of ICAR Research Module in order to conserve as well as efficiently use precious

resources, while maintaining/meeting the demands of food grain needs of the existing population. Crop intensification, diversified farming, value addition to agricultural products etc. are necessary factors for food security. We need to usher in **2nd Green Revolution. The motto should be to produce more from less land to feed growing population. Let us all work together to achieve this goal.**

JAI HIND

Address by Dr. B.M.Lanong, Hon'ble Deputy Chief Minister, Government of Meghalaya

I am very much happy to see you all in this auditorium. Thanks to ICAR for organizing this RCM for 3 days. In the North East there is a huge cultural and geographical diversity with each state differing from the others. There are 350 tribes in the north east with great cultural, language and livelihood variations. Due to population growth in NE, reduction in forest areas, orchards, agricultural lands etc. are going on rapidly. In Shillong City, previously almost in all households there was kitchen garden, orchard etc. But that situation has changed and now-a-days there is scarcity of land due to construction of buildings and new roads. Due to infrastructure developmental activities there is severe loss of agricultural land. Mining is another severe threat to agricultural production chain since most of the productive arable lands have been transformed into mined areas and therefore, restoration of soil health in mine spoilt soils through intervention of agroforestry approach, initiation of soil and water conservation measures should be taken on a large scale. Therefore, proper land use planning including road and transportation mechanism should be given due importance. In the north east there is a scope for agricultural development. The total geographical area of the north east is 2, 62,000 sq km and accounts for 7.98% of the total national area. The area under crop utilization in Arunachal is 3%, Assam is 51%, Manipur is 10%, Meghalaya is 12%, Mizoram is 4.3%, Nagaland is 22%, Sikkim is 18% and Tripura is 33%. In all of the states the average cropping area is 21% against the national average of 62% and in Punjab it is 73%. Hence, the North East is alarmingly low in agricultural utilization of land. NER states are mountainous and hilly terrains with difficult access to mainstreams hence ICAR should devise hill agricultural technology with due emphasis to horticultural sector by introducing new fruit cultivators from other parts of India having similar and comparable agro climatic conditions. If Apple can be grown in Himachal and Kashmir then why it cannot be grown here. In 1972, Kufri Jyoti was introduced from Himachal by the potato research station which became popular. When potato could be grown then why not apple? ICAR should look into the prospect of developing apple cultivation in Meghalaya. The technology relevant in other states with respect to heavy agricultural machinery may not be of relevance to the north east. Technology appropriate for the region should be identified and developed. Machinery for tillage at a subsidized rate is not reaching to the farmers hence ICAR should work at popularizing the access of farm machinery and implements. Improved varieties of vegetables are to be introduced. Proper use of maize is needed in terms of using maize as animal feed and converting the same to meat. ICAR should also look into the scope and development of introducing tea cultivation in Meghalaya. Suitable high yielding varieties of fruits and vegetables need to be introduced. Floriculture development with an emphasis of exporting anthurium should be initiated. Meghalaya has rare varieties of fruits *viz*., sohiong, soflang and parsimon which

could be explored for development and processing. We should set up facilities for intensive rearing of animals. ICAR should set up quick response teams to address issues of emergency and intervention in the agricultural sector. There is a good potential for development of dairy products and piggery in the region. There is no adequate supply of swine fever vaccine and ICAR has to ensure supply of the same. There is a need for farm mechanization, development of livestock sectors, emu and turkey farming etc. This would provide a useful platform for generating employment in the agricultural sector for the rural livelihood. There should be measures to ameliorate fodder shortages and trainings to farmers should be provided for health care and vaccination related issues. International community is concerned about climate change. Extensive cultivation by destruction of forest land is also another major threat that could lead to climatic changes. Congratulation to ICAR for organizing the 20th RCM. I hope that this type of interface meetings will be organized to discuss regarding the progress and problems affecting agriculture in the north east.

Address of Shri H. Liansailova, Hon'ble Minister of Agriculture, Horticulture, Fisheries Government of Mizoram

Respected His Excellency the Governor of Meghalaya, Shri R.S. Mooshahary, Dr. S. Ayyappan Secretary DARE, GOI and DG ICAR, Krishi Bhawan, New Delhi, Dr. B.M. Lanong Hon'ble Deputy Chief Minister, Meghalaya, Shri Parijat Singh, Hon'ble Minister for Agriculture, Govt. of Manipur, Shri T.R. Zeliang Hon'ble Minister of AH & Vety. Govt. of Nagaland, Dr. S.V. Ngachan, Director ICAR esearch Complex for NEH Region, Dr. Arvind Kumar Deputy Director General (Edn), ICAR, New Delhi, Dr. Ravindra Kumar, ADG (Coordination), ICAR, Krishi Bhawan, New Delhi and other dignitaries and officials from various North Eastern States; it is a great privilege and honour for me to take part in this august forum which takes care of the research and extension needs of the country particularly North Eastern Region.

Mizoram, formerly known as Lushai Hills, was a part of Assam state. It was accorded the status of union territory in 1972 and became a full-fledged state in 1987. The state stretches over 277 kms along the North-South while the East West width is 121 kms. Geographically, the land lies between $21^0$58' to $24^0$35' North latitude and $92^0$15' to $93^0$29' East longitude covering an area of 21,087 sq km having international border of 404 kms with Myanmar and 318 kms with Bangladesh. The annual rainfall ranges from 2000 mm to 2500 mm.

Livelihood security and food security are main concern in agriculture development. If we analyze we find that as far as livelihood is concerned agriculture is the main occupation and agriculture occupies a very important place in the economy of the state. About 60.60 percent of the total workers are engaged in agricultural activities mostly by practicing shifting cultivation. It is estimated that 97,223 nos. are operational holding and the area operated was estimated at 1,16,645 hectare; marginal and small holding together alone constituted about 83.50 percent of the total holdings.

As far as food security is concerned rice continues to remain the principal food crop and the staple food. The requirement of the state is estimated at 1,80,000 M.T./ year. Against the requirement, the state could produce only 46,000 M.T. per year which could meet only 25% of its rice requirement and the remaining 75% has to be imported from outside the state. The production of pulses and oil seeds are negligible and requirements are imported from outside the state. In the similar way, vegetable production meets only 30 percent requirement of the state.

In respect of milk, the state could meet per capita of 51 gms against the scale of 240 gms per day recommended by Indian Council of Medical Research. Similarly for eggs, only 20% of the requirement is met from the state and the remaining are imported from outside sources.

In fishery sector against the requirement of 11 kg per capita, the state could meet only 3.41 kg. Therefore, in fishery sector the state has to prioritize creation of new water bodies and augmenting unit area productivity to attain its per capita target of 11 kg.

Govt. of Mizoram has taken the following prgramme initiatives for food security and control of *jhum* cultivation and settlement of *jhumia* families to overcome the problem of livelihood of the state.

1. New Land Use Policy (NLUP)

- ➢ The Government of Mizoram with the approval of Planning Commission has launched a comprehensive project for inclusive development called New Land Use Policy termed as Flagship Project.
- ➢ The NLUP focused mainly amongst others, on a major overall of the economy through structural changes by weaning away farmers from destructive *jhum* practices to sustainable livelihood opportunities based on local resources, genius of the people and keeping in view regeneration of resources.
- ➢ The Government of India approved the comprehensive project under NLUP for sustained economic development and uplift of the poor of Mizoram amounting to Rs. 2873.13 crores to uplift 1,20,000 families for a span of five years in various agriculture and allied activities *viz*., Agriculture, Horticulture, Fisheries, AH & Vety, Soil Conservation and other sector *viz*., sericulture, Micro enterprise, Handloom and Forestry.

2. Other programmes

- ➢ To augment rice production from 4600 M.T. to 5200 M.T. in 2011-12 and for this purpose of rice cultivation will be adopted in 300 hectare and another 3000 hectare will be put under improved package of practices. The productivity is targeted to be increased to 2.5 M.T. per hectare from 1.70 M.T. per hectare.
- ➢ The present farm power availability is very meager being 0.47 KW/ha, therefore, the state aims at promotion of farm mechanization to bring it at par with the national average of 1.90 KW/ha.
- ➢ The state has further taken up expansion of areas under red oil palm cultivation with a target of 3000 hectare during 2011-2012.
- ➢ In fisheries sector the state is committed to create more water bodies to generate additional fish production to meet 11 kg per capita by the end of 2014-2015. At present the unit area productivity in the sector is very low being 1.25 M.T. per hectare. All efforts are being made to increase productivity to 2.50 M.T./ ha.
- ➢ The state has a vast scope of developing ornamental fisheries. Therefore, ornamental fisheries have to be developed to create entrepreneurship in the field.
- ➢ The state has further created new hydroelectricity impoundments which has been stocked under National Fisheries Development Board programme and capable of offering additional production of 600-700 M.T. annually.
- ➢ The state is passing through crisis of fish seed. Therefore, efforts are being made

to create more infrastructure for seed production by taping financial assistant from National Fisheries Development Board and Centrally Sponsored Scheme.

- ➢ In horticulture sector, the government takes up commercial cultivation of various fruits such as grape, passion fruit, pineapple, orange, banana etc. and cultivation of spices like ginger, turmeric etc.
- ➢ Under floriculture, cultivation of anthurium is being promoted besides cultivation of medicinal plants such as *Aloe vera* and *Stevia*.
- ➢ Government further plans to go for large scale production of vegetable under RKVY to meet the requirement of the state.
- ➢ Under soil and water conservation, more emphasize is given for production of coffee, rubber, broom and water harvesting structure on watershed basis as the whole watershed contributes towards availability of water for crop production. Priority is given for WRC area and other food crops area in cooperation with minor irrigation project to increase net irrigated area of 7.69 percent.
- ➢ Under RVP/FPR soil conservation department is taking 21 projects covering 19,772 hectares where all the activities of watershed management like bench terracing, contour trenching, series of check dams, silt retention dams, farm ponds, aforestation, horticulture plantation and drainage line treatment are being undertaken. During the 12th Plan, a much more intensive rain water harvesting scheme in all possible forms like terracing, bunding, series of check dams, farm ponds, percolation tanks, bank erosion control work etc. are required. Central sponsored scheme like RKVY, NREGS, IWMP etc. will be availed to implement such works.

ICAR plays an important role for development of different technologies in agriculture and allied sectors for which we need a big collaboration for technology development under Mizoram condition which could be utilized to overcome problems of livelihood and food security of the state through the speedy development of different initiatives taken by the state. It will be very much necessary to strengthen the present ICAR centre at Kolasib by posting more scientists in different agriculture and allied sectors as well as development of different infrastructure for all sector i.e. agriculture, horticulture, fisheries, AH&Vety etc. for development of different technology re-implemented in different sector of agriculture and allied sector. Moreover, the centre also needs to improve its financial status for smooth functioning.

By strengthening of ICAR at Kolasib, Mizoram government needs the following production technology and post harvest technology under Mizoram condition.

1. Improved production technology for rice production and recommendation of suitable varieties of rice, maize, pulses and oil seeds.
2. Water management technology for red oil palm.
3. To develop a farming system on hill slope under Mizoram condition.
4. Techniques of onion storage for practical uses of farmers.
5. Standardize package of practice of anthurium under Mizoram climate.
6. Trial on table grape varieties under Mizoram conditions.

7. Package of practices for Bird Eye chilly.
8. Suitable post harvest technologies on different crops including fisheries.
9. Technical assistance for *in situ* pen culture for raising advance fingerlings in open waters.
10. Technical assistance for introduction of pangasius cultivation in Mizoram condition.
11. Standardizing package of practices for fresh water prawn culture.
12. Technical assistance for introduction of culture and breeding of ornamental fish culture in Mizoram.
13. Development of suitable machinery and equipments, power driven as well as manual, for agriculture and horticulture sector.

I am happy to mention here that ICAR has setup 7 (seven) KVKs under Govt. of Mizoram for Kolasib, Mamit, Champhai, Lunglei, Serchhip, Lawngtlai and Saiha and 1 (one) KVK for Aizawl district under Central Agriculture University for on-farm testing of technologies released by different research organizations for recommendation to the farmers for adoption of the tested technologies for particular district by organizing front line demonstration, research based training to the farmers and with this each district of Mizoram is covered with 1 (one) KVK.

ICAR is bearing the total cost of establishment of the office and also provided necessary infrastructure like administrative building, staff quarters and farmers training hostel to each KVKs. The infrastructure were strengthened with allotting 20 hectare of land, construction of internal road in KVK complex, providing electricity and water connection to each KVK by the govt. of Mizoram. Some more staff quarters which are needed for the staff is also provided year by years to needy KVKs. Under RKVY, these are also assisted for production of quality seed and Hi-Tech green house for demonstration purposes. I would like to say that in north east Region only 7 (seven) KVKs of Mizoram is connected with I.T. instruments like V-SAT for proper intra KVK communication facilities. I am happy to inform that all KVKs are functioning well and government is satisfied with their works. During this regional conference all the KVKs of Mizoram are going to present their achievements. Therefore, I do not like to elaborate more on them.

I hope if ICAR Kolasib is strengthened with posting more scientists and financial assistance. ICAR centre and KVKs can work more efficiently for the development of agriculture and allied sectors in the state of Mizoram.

I am glad to state that in his recent visit, the Hon'ble Union Minister of Agriculture, Shri Sharad Pawar *ji*, was kind enough to commit to setup a college of Agriculture Science/ College of Horticulture and Post Harvest Technology in Mizoram under Central Agriculture University. I hope this would formally materialize soon and Mizoram government is ready to allot land near Mizoram University or at any other suitable place for the college.

With this I would like to conclude my interaction in the Regional Committee III of ICAR with thanks to the chair and all members present.

Ka Lawme & Jaihind

Speech of Shri Ph.Parijat Singh, Hon'ble Minister for Agriculture & CADA, Government of Manipur

His Excellency, the Governor of Meghalaya, Hon'ble Dy. Chief Minister, Meghalaya, Hon'ble Ministers of neighbouring states of Nagaland, Mizoram, and respected Secretary, DARE, Government of India, DDG (Edn.), ICAR, Director, ICAR Research Complex for NEH Region, Meghalaya and other dignitaries on the dais.

The ICAR Complex for NEH Region having its head qarter at Umiam, Barapani, Meghalaya has been catering the research needs of the NE states in the field of Agriculture and allied sectors. The local research requirement of the state are taken up at the Manipur center at Lamphelpat and the farmers of Manipur are being benefited with the development of high yielding varieties of various crops and also various improved package of practices including latest technologies for increasing agricultural production. The centre has so far released 6 (Six) high yiedling paddy varieties namely, RC-Maniphou 4 (RCM-7), RC-Maniphou 5 (RCM-8), RC- Maniphou 6 (RCM-5), RC-Maniphou 7 (RCM-9), RC- Maniphou 10 (Lungnilaphou) and RC Maniphou 11 which are suitable for the state. The Centre is continuously providing the nucleus (Breeder & Foundation) seeds of these varieties.

Paddy is the main crop in the state and at places where there is irrigation facilities two crops of paddy are taken. The cultivation of high yielding varieties (H.Y.V) are mainly confined to the valley areas and productivity are at the desired level. There are a number of varieties recommended for these areas. To meet the requirement of the increasing population we need to extend the area of cultivation of high yielding paddy varieties to the hill areas. The Rice Research Station (RRS), Wangbal, Thoubal district under the Department of Agriculture, Manipur is the only one of its kind for the state of Manipur. So far the RRS has released 7 (seven) varieties of rice that are well adapted and vary popularly grown by the farmers in the state. Though, research activities are under progress in the ICAR and the Rice Research Station, Wangbal, we need to develop sufficient number of HYVs of paddy suitable for the high altitudes and which are cold tolerant etc.

Therefore, we may require to have a research station in the hills. It is proposed to have a high altitude research station for the state to take care of the research requirements of these areas in Ukhrul district. The department is already having sufficient areas for establishment of the research centre. Similarly, high yielding semi-deep water/deep water paddy are also required to be developed for cultivation in the partially submerged areas /low lying areas of about 14,000 ha available in the state. It is proposed to have one research station for low-lying areas at Kharungpat. Sufficient low lying areas are available at the Regional Foundation Seed Farm for major field crops, Kharungpat in Thoubal district.

As regards the Agricultural Extension and Training requirement in the state, all the 9 districts are having one KVK each. Out of the 9 (nine) KVKs, 1 (one) KVK each is under the CAU and Department of Agriculture, 2 (two) KVKs are under NGO and remaining 5 (five) KVKs for all districts may be made.

In addition to this, it is also proposed to increase the intake of B. Sc. (Agri.) seats from 16 nos. to 25 nos. and B.Tech (Agri. Engg.) from 8 nos. to 12 nos. at the Central Agricultural University, Iriosemba, Imphal and College of Agriculture Engineering and Post Harvest Technology, Gangtok to meet the increasing demand for the students of this state. Some seats for studying of post graduate studies leading to Masters Degree and Doctorate degree may be reserved for in-service candidates of the state. Farmers exchange programme and exchange of extension personnel to other research institutes is giving good results by enhancement of their skill due to outside exposures. This programme should be continued and increased in number.

I would also like to urge upon the ICAR authority to come forward to help the farmers in the sector of Agri-business and Agro-based entrepreneurship development by providing training to the unemployed agricultural graduates and by opening small business prospects to increase their income in the field of horticulture, floriculture, poultry, fisheries etc.

On crops

Finally, the following agenda are placed for consideration,

1. Various improved package of practices including latest technologies for increasing agricultural production.
2. To develop sufficient number of HYVs of paddy suitable for the high altitudes and which are cold tolerant.
3. To have a high altitude research station for the state to take care of the research needs of the hilly region.
4. Suitable improved agriculture implements for hill agriculture.
5. Research work in finding proper/suitable seeds for growing in dry and upland areas be strengthened.

On Horticulture

1. **Formulation of packages of practices for indigenous crops:** There are few important indigenous horticulture crops which are preferred and consumed locally. These few crops are, Water Chestnut (*Trapa natana*), Swamp Taro (*Allocassia cucullata*), Gorgan nut (*Euryale ferox*), Water mimosa (*Mimosa hamata*) etc. The Deptt. would like to take up promotion of such indigenous crops as this would enhance the income as well as the water-logged area can be exploited for development of small & marginal farmers inhabiting in and around swampy areas and low lying water bodies. As such, establishment of package of practices for the above indigeous crops needs to be developed by ICAR so that through extension, State Horticulture & Soil Conservation Department can take up cultivation of the above indigenous crops.

2. **Formulation of High Density Plantation technology and management:** *Parkia roxburghii* commonly known as Tree Bean is one of the most important horticulture crop grown widely and highly consumed in the state. This is one crop which has really generated the farmers income as it fetches handsom income. In recent years, it has come to the light that this crop developed a sudden decline. This decline caused sudden death of the trees which results in huge reduction of its production in the local markets. ICAR is requested to formulate the management of declined Tree Bean orchard and high density plantation technology for rejuvenation of Tree Bean. Further, ICAR is also requested to develop a technique to shorten gestation period as this crop requires 7-8 years for bearing from seedlings.

On Fisheries

1. **Research on breeding and culture of important small indigenous fishes of the state:** The state has lots of small important indigenous fishes which are quite tasty and are almost on the verge of extinction. To name a few, Ngaroi, Sharengkhoibi, Nganap and Ngakkrijou etc. need to be mentioned. They are very much liked by the people of the state because of their taste and they fetch a price higher than those of the culture fishes like IMC. Steps for propagation and culture of these fishes need to be taken up. Therefore, it is proposed to take up experimental breeding and culture of the above mentioned species through the ICAR, Regional Unit, Imphal since the state department lacks infrastructure facilities.

2. **Establishment of Disease Diagnostic Laboratory:** The same was proposed in the 19th Meeting of the ICAR Regional Committee No. III held on 8-9 April, 2009 at Gangtok. However, no specific programme has been taken up regarding the establishment of the Disease Diagnostic Laboratory as yet. Since the state department does not have technical staff expertise in fish diseases, it used to face difficulties when severe cases of fish disease occur. It is therefore proposed to establish a Disease Diagnostic Laboratory at ICAR Regional Centre, Imphal in the interest of the fish farmers of the state.

3. **Research on application of EM/Probiotics on production of fish seed and table fish:** The department has tried on EM (Effective Micro organism)/Probiotics, by applying in the culture pond at the District Fishery Office, Imphal West but no successful result was obtained due to certain error in the methodology applied. Therefore, it is proposed to conduct research work on the significance of application of EM/Probiotics in production of fish seed and table fish which will in turn help in the development fo aquaculture in the state.

On Veterinary and Animal husbandry services

1. **Proposal for establishment of a Regional Project Directorate on Swamp Buffalo in Manipur.** The buffalo breed available in Manipur is Swamp type which is having different genetic makeup from common Indian buffalo breeds (Riverine type). In Manipur, the buffalo is considered as economically very important livestock as it is reared both for meat and draught propose. In some areas of the state, buffalo meat is preferred over the cattle meat. As per provisional report of Integrated Sample Survey for the year 2010-11, about 29 thousand buffaloes were slaughtered for consumption of 3708 tones of buffalo meat in the year. Whereas, according to the provisional report of Livestock Census 2007, during the last twenty years, population of buffalo in Manipur has decreased alarmingly from 1.41 lakhs in the year 1987 to a meager figure of 62 thousands in the year 2007. At present, about 89% of the total buffalo population is available in hills concentrating in Senapati (39%) and Ukhrul (18%) districts. Due to lack of research conclusions, improvement of local buffalo through upgradation by means of crossing local buffaloes with the recognized Indian buffalo breeds like Murrah is not yet taken up in Manipur so far, as these local buffalo have different chromosome numbers. In the year 2006-07, scientists from the NBAGR, Karnal (Haryana) have started genetical studies about the characterization of local buffalo in Manipur but they have not intimated either their findings or their recommendation for breed improvement till today. It is high time to do something for rejuvenation of buffalo popupation in Manipur. The problem can be solved only if research studies are taken up on how the performances on local buffalo can be improved. So, it is proposed for establishment of a Regional Project Directorate for Swamp buffalo in Manipur.

2. **Proposal for establishment of a piglet production centre at Andro village, Imphal East, Manipur under Regional Project Directorate on Pig, Khanapara, Assam:** The consumption of pig meat in Manipur is increasing day by day. Consequently, demand of quality piglets for rearing has also increased as the farmers know that quality piglets are essential for beneficial farming and for more pig meat production. At present, the state department is procuring parent piglets from the Meghalaya or Mizoram Government for multiplication and supplying to the needy farmers. But the quantum of demand of quality piglets cannot be met by the existing departmental farms. In order to supply the quality piglets to the farmers, it is now required to establish pig breeding centre for production of quality piglets in Manipur. The proposal has also been included in the recommendations of Development Seminar on Imphal East District held on 18th October, 2010 at Imphal. Accordingly, the department has selected suitable site for establishment of a pig breeding centre at Andro Village, Imphal East, Manipur. It is, therefore, proposed for setting up of a pig breeding centre at Andro Village, Imphal East, Manipur under the Regional Project Directorate on pig, Khanapara, Assam.

3. **Proposal for posting Animal Scientists and for taking up research on animal diseases at ICAR, Manipur Centre, Lamphelpat:** In spite of proposing for posting of an Animal Scientist at ICAR Manipur Centre, Lamphelpat in earlier Regional committee meetings after transferred of Dr. N. D. Burman, so far no Animal Scientist is posted at the centre for taking up research works on animal diseases. Whereas, due to lack of field research work, the local livestock farmers are facing problems like outbreak of diseased such as BQ & FMD in their cattle herds even after on time vaccination was done. It is, therefore, proposed to post Animal Scientists and for following research works on animal disease at ICAR Manipur Centre, Lamphelpat.

Thank you !

Address of Shri T.R. Zeliang, Hon'ble Minister for Planning and Coordination, Veterinary and A.H., Parliamentary Affairs and Evaluation, Govt. of Nagaland

His Excellency, the Governor of Meghalaya, and Chief Guest of today's programme, Shri. R.S. Mooshahary; Hon'ble Dr. B.M. Lanong, Dy. Chief Minister of Meghalaya; Shri H. Liansailova, Hon'ble Minister of Mizoram; Shri Ph Parijat Singh, Hon'ble Minister, Government of Manipur; Dr. S. Ayyappan, Secretary, DARE, GOI, & DG, ICAR, Krishi Bhavan, New Delhi; Dr. Arvind Kumar, Dy. Director General (Edn), ICAR, New Delhi; Dr. Ravindra Kumar, AGD (Coordination); ICAR, Krishi Bhavan, New Delhi; Dr. S.V. Ngachan, Director, ICAR Research Complex for NEH Region, Umiam; various dignitaries and scientists present here.

I am extremely glad and thankful to the ICAR organizing committee for giving me this opportunity to be in the midst of various luminaries and experts in the field agriculture and allied sector this morning. Attending the meeting of ICAR or any other agencies which involves so many resourceful, intellectual and expert people in various fields like you, have been my pleasure as it not only gives me knowledge but hope that one day such activities will come up with great vision and effected modalities for the upliftment of the economy of people of the region. I have a firm believe that this XX Regional Committee Meeting (Region-III) of ICAR will be an extraordinary one with brain storming session and will enable all of us to come out with renewed vision and resolution for the upliftment of NE Region, especially in the agriculture and allied sector.

At the outset, I would like to begin by re-collecting the 19th meeting of the ICAR Regional Committee No. III held at Gangtok, Sikkim on 23-24 October 2009, during which the Director General, ICAR, has assured me of establishing a new Veterinary College in Nagaland under Central Agricultural University (CAU). In this regard, the state govt. had identified Jalukie as the site and earmarked 277 acre of land and the work such as security fencing, internal approach road had been carried out. Presently, construction of rest house and security fencing of the remaining land is in progress. This land shall be handed over to the CAU, Imphal as and when required.

Further, the state is pursuing the matter earnestly for early implementation; however, it is still pending because of the reason that Nagaland has not been included in any of the existing CAU in North East Region. Therefore, the government of Nagaland had taken up issue with Shri Sharad Pawar *ji*, the Union Agriculture Minister, for amending the CAU Act in the Parliament for inclusion of Nagaland State under the ambit of CAU, Imphal at the earliest. The Hon'ble Union Minister assured us that necessary order will be issued within one month.

I would once again request the ICAR to extend full support and assist the Nagaland state in the process so as to enable the establishment of Veterinary College during this 11th Plan.

Today, I would like to stress upon some of the major issues facing the state.

Development of low cost and nutritious feeds

This high feed cost is a primary concern and is responsible for retarded growth of the most potential sub-sectors like, piggery, dairy and poultry including fishery in the state. Hence, research projects or centre for development of cassava, soya bean, groundnut etc, may be explored with a goal to utilize the cassava tuber and leaves as a cheap source of energy and by-product of soya bean and groundnut as protein source. These are abundantly and easily available in the region and if little efforts can be given by the govt. or centre like ICAR, it can be easily produced in large scale.

Secondly, recollecting the developmental strategies of the ICAR for "Co-development of pig and maize" during the year 2006, I would also like to emphasis for the introduction of the quality protein maize variety on large scale in the maize growing pockets of Nagaland for the benefit of the people and also for the animal husbandry sector. It is a well known fact that many of the local plants traditionally used for feeding livestock have been studied, analyzed and documented by various ICAR Centres of the NE Region. I personally feel that immense economic advantage can be derived out of the above exercise if appropriate and optimum utilization technique could be derived and passed on to the rural farmers of the region. This area needs to be viewed very seriously by ICAR for the benefit of the NER.

Besides, research for development of the other low cost feeds which is easily affordable by the rural population, who are the major stake holders in livestock and poultry rearing and employing of locally available and traditionally used ingredients requires serious consideration by this august house.

Development of Superior Germplasm: As I have been frequently stating in various meeting of the ICAR, there is an immediate need for superior germplasm of pigs and poultry to boost the development of this sub-sector in the NE region and Nagaland in particular. The pig research and development centre in the NER needs to be boosted in term of adaptability qualitatively and quantitatively for the benefit and upliftment of livestock sector of the region. While doing so, it is very important that indigenous species with quality production and having strong resistant to disease should be put into consideration.

Effective Disease Control: Another major factor affecting the veterinary and animal sector in the region is the unaccounted death of animal populations due to various diseases. I have experienced that quite a good number or sometimes almost all animals population like pigs, cows, buffaloes, and chicken perish due to various epidemics even in my own Peren district every year. However, this death of animal in large number are mostly not reported and unaccounted, thereby, it hugely degrade animal population and its products. This menace discouraged farmers from rearing animals in large scale and as a result directly affect the economy of the farmers.

Therefore, it is felt necessary that good animal health care centre or Vety. College should be established to study and come out with effective disease control measures if we really want the animal population and its products go up. Besides, the farmers should be imparted proper awareness on animal health care by the veterinarian of govt. agency like ICAR.

Agriculture continues to be main stay an occupation of the people of NER. The overall productivity of the agricultural sector in the state definitely do not indicate reasonable equilibrium in demand and supply; this is proven by the quantum of import of daily staple food like rice, potato, pulses, etc. It is felt that this situation could be alleviated to a considerable extent if a collective effort of the agriculture scientist present here could be channelized on the following issues:

1. Expedite the establishment of three KVKs in Nagaland, where site selection has already been done, but yet to take off.
2. Setting up of farm development demonstration unit in the existing KVKs so that activities like technology testing, refinement, dissemination etc. are actively carried out as mandate of the KVKs.
3. High altitude cold tolerant crops.
4. Seed storage facilities.
5. Studies on jhum on merits and demerits of jhum cultivation inclusive of its social implications. Suggestion on viable and adaptable alternative to large scale jhuming.
6. Research support for crops like small millets.
7. Research support for French bean (Cholar) varieties at Tuensang district.
8. Development of improved varieties of Colocasia at Mon district.
9. Research on location specific water harvesting structure and re-cycling.

Again in the fishery sector, we may dwell on the following major issues:

1. Large scale fishery in potential compact area need to be developed.
2. Production of high yielding breeds
3. Feeds
4. Storage
5. Technology (Success story in a state like Andhra should be addressed)

Finally, I once again thank each and every one present here for the privilege of allowing me to present before you the issues as mentioned and for the patient hearing.

I hope that my humble suggestion will be favorably looked into during your course of deliberation in the technical session.

Thank You.

Address of Dr. S. Ayyappan, Secretary, DARE, Govt. of India & Director General, Indian Council of Agricultural Research, New Delhi

Respected His Excellency, the Governor of Meghalaya, Shri R.S. Mooshahary *jee*. Dr. B.M. Lanong, Deputy Chief Minister, Government of Meghalaya; Shri T.R. Zeliang, Minister for Veterinary and Animal Husbandry, Government of Nagaland; Shri Ph Parijat Singh, Hon'ble Minister for Agriculture & CADA, Government of Manipur and Shri H. Liansailova, Minister of Agriculture, Horticulture and Soil Conservation, Government of Mizoram; Deputy Director General (Education), ICAR and nodal officer of this Regional Committee; Vice Chancellors of Agricultural Universities; Secretaries and senior officers of the State Governments; Members of ICAR Governing Body; Deputy Directors General and Assistant Directors General of ICAR; Dr. S.V. Ngachan, Director, ICAR Research Complex for NEH Region and Member Secretary for this Regional Committee; Joint Directors, other senior officers and scientists of ICAR; representatives of private organizations; guests, members of press and media, and ladies and gentlemen!

It is my privilege to extend a very warm welcome to all the distinguished guests, members and special invitees, who have spared their valuable time for attending the 20th meeting of ICAR Regional Committee-III, at the ICAR Research Complex for NRH Region, Umiam, Meghalaya. The NE Region has a special place in India, considering its rich bio-diversity and diversity in culture and food habits of key tribal communities.

We are greatly encouraged by the gracious presence of His Excellency, the governor of Meghalaya and Hon'ble Ministers from the different states and I am highly grateful to them. We are also thankful to the members of ICAR Governing Body for their presence today. The presence of Vice-Chancellors and faculty members from SAUs and the senior officials from the concerned state governments is indicative of their interest and commitment for sustainable growth of agriculture and allied sectors of the region. The ICAR Regional Committee-III has eight states *viz*., Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim, which are bestowed with bountiful of natural resources, both land and water, which offer tremendous scope and opportunities for multifaceted growth of agriculture sector, including horticulture and agro-forestry, animal husbandry, fisheries, and other allied sectors.

The Indian Council of Agricultural Research has divided the country into eight agro-climatic zones. The ICAR Regional Committees are tailored to provide an excellent platform to identify issues of contemporary importance in agricultural sector and deliberating over them, for setting priorities on regional basis, aiming at to foster partnership among various stakeholders to work in tandem for achieving tangible results in a time bound manner. Meeting of this nature, therefore, provides an effective mechanism to review and identify the R&D needs in agriculture and allied sectors. Sensitization of policy makers and development departments is another facet of such meetings, which provide an ideal venue of interface between the researchers and the concerned line departments. It also helps in bridging the

gaps of perception among various stakeholders through meaningful dialogues and in-depth discussions on various issues. Finding acceptable solution for various problems has been the focal point of regional committee meetings. Development of effective liaison and meaningful coordination among the ICAR institutes, SAUs and the line departments of a particular region is another important objective of such meetings. The Vice-chancellors and the faculty members of SAUs, Directors and Heads of various ICAR Institutes located in the region, the State Secretaries and Directors of concerned line departments, Members of ICAR Governing Body and Society are, therefore, invited to share their experiences on various issues of agriculture, horticulture, animal husbandry, fisheries, sericulture etc. for drawing an action plan for sustainable development of agricultural sector. Constraint analysis, for better implementation of projects and programmes, has been an inbuilt component of such meetings so as to develop mutually acceptable strategies and execution plans in a participatory mode. The recommendations arising out from the deliberations of such meetings are communicated to the concerned State Departments, SAUs, ICAR Institutes and other concerned agencies for appropriate action in a time bound manner. The status of implementation of action points by various agencies is also being reviewed by holding a midterm review meeting.

I am happy to share that during the last five decades, the agriculture sector including animal husbandry and fisheries, has delivered the desired results on a consistent manner towards the enhancement of production and productivity of various agricultural commodities as compared to all other economic sectors of the country. The food-grain production of India is expected to cross the 235 million tons mark during current year from a near famine condition in 1960s. The country today has a huge buffer-stock of food-grain for utilization in case of any exigency. This could be achieved because of the relentless efforts of agricultural scientists in developing effective technologies, their efficient application in fields by the dedicated farmers of the country and enabling government policies.

However, NE Region has a huge food grain deficit of 26.1% due to dismal decadal growth of 0.49% only, not matching with population increase of 16.9% during 2001 to 2011. This gap can be bridged by increasing the production of major crops like rice particularly in Assam valley, by utilizing two lakh hectares under marshy land and water logged areas like beels and lakes integrating fisheries. The adoption of SRI technology has also given boost to rice production in Tripura state.

At the present point of time, the country is passing through a phase of knowledge based agricultural revolution, which is much faster than the social transformation. The agricultural development in any part of the world today has to be viewed in the context of changing world order in the backdrop of WTO and IPR regimes. Therefore, we have to strive hard to keep ourselves in readiness not only to develop suitable technologies, but also to readjust them for the benefit of our society in the long run. I strongly feel that we cannot afford to compromise on efficiency and competitiveness, the cardinal principles for sustainable development. This would, however, need concerted efforts and adequate investment. In recent times, the Indian agriculture is at a cross-road in the face of increasing challenges from global markets, vagaries of uncertain monsoon, threshing change in climate and continued

encroachment of agricultural lands and water. The farmers of NE region are exposed to a unique agro-climatic sub-region that witnesses topographical constraints such as slope features, high rainfall and increased soil erosion.

Agriculture and allied activities are the main source of livelihood for the people of NE region and any endeavor to reduce poverty as well as to place the region in developmental paradigm shall have to have a base on system-wide and eco-regional planning of agriculture sector development. The region is characterized by rich biodiversity, mostly acidic soils, low cropping intensity, low input application, unique horticultural assents such as "Khasi mandarin", orchids, pineapple, strawberry etc. largely without any substantial value addition, lack of markets and transportation, shortage of water despite high rainfall, and lack of skilled and professional manpower. Farming is predominantly rice-based with exception in the state of Sikkim where maize is a dominating crop. Increasing cropping intensity, amelioration of acidic soils, value addition of horticultural produce, water management, integrated farming involving livestock, poultry and piggery with crops such as maize, rice, pulses, oilseeds and fisheries altogether can bring about a spurt in agricultural development of the region and enhance the livelihood opportunities and farm prosperity. For instance, piggery and Quality Protein Maize should together be the inseparable components of such integrated farming. The system, therefore, supports a large horticulture, crop and animal husbandry base partly due to benefiting from the complementarities and partly due to meeting the animal protein requirement of the people of the region as most of the population is non-vegetarian.

The region has immense challenges yet the region has immense potential opportunities. The key issues involved could be:

- About 70% of the soils in the region are acidic. Amelioration of these by addition of lime itself can result in tremendous increase in productivity and system efficiency.
- Rice is staple food of the region and intensification of its cultivation and popularization of recently released varieties like Chandrama, Chandan, CR Dhan 601, IET 18193 and CAU-RI could help in reducing the rice deficit in the region which presently is around 24.7%.
- The region is hot-spot of biodiversity including agro-biodiversity. Integrated farming, in a system-wide manner can bring in significant and positive socio-economic upliftment. Conserving natural resources and utilizing them using both molecular and conventional mechanisms will bring about lot of intellectual goods and products.
- The option of resorting to input intensive agriculture, however, remains open in certain areas such as valley land ecosystem where the productivity can be more than doubled. The fertilizer use in the state and in such valley area, in particular, is very low being about 11 kg/ha. This offers a tremendous scope to increase the productivity by judicious and balanced fertilization. There is also ample scope of resorting to double cropping in at least 25-30% of mid-altitude low land ecosystems.
- The region is agriculturally organic, mostly by default and also by choice in certain areas. Resorting to organic mode of food production in 70% of mid-altitude upland

ecosystem and the entire area under high altitude could enhance farm-prosperity as the organic produce and products are sold at premium. The Sikkim has already taken a big step in this direction. It appears difficult to eliminate the shifting cultivation or "jhum" cultivation in the North East. Improvement of "Jhum" system by utilizing it for organic cultivation and certification of "jhum" products will result in enhanced profitability of farmers.

- The emphasis may be centered around traditional agro-ecosystems, natural forest and freshwater ecosystems as they are linked with village ecosystem functions.
- Sikkim has predominance of maize and is the habitat of its landraces and other forms of diversity. This is unlike other states of the region where rice is the predominant crop. Maize has to be promoted not only in Sikkim but also in other states of the region. The non-vegetarian population depends on animal forms such as pigs, particularly quality protein maize (QPM) has to go hand-in-hand with piggery so as to provide for quality feed.
- In low-lying areas, promotion of fish based farming systems which need sustained efforts to meet deficit of 53.9%, fulfill the nutritional requirements and to increase the farm income of the indigenous communities.
- Agroforestry, poultry, piggery, etc. need to be strengthened for better income generation by protecting and managing forage, and the domestic animal health. To meet the deficit of meat (58.9%) and milk (99.4%), assured supply of quality fodder has to be ensured, and as such, greater thrust has to be given on the production of seed and fodder in the region.
- Jute and Remi are the two important fibre crops of the region which have great potential of generating substantial employment avenues in rural as well as urban sections.
- Improving the practice of homestead farming/mixed farming through intensive integrated farming system models is the need of the region so as to harness maximum benefit from the complementaries of the crop-livestock-fish system.
- Seed production and storage is a problem, in most of the region owing to high humidity. We have to encourage production of quality seed and planting materials using techniques like tissue culture for the latter. Farmers' participatory programmes of seed production also need to be encouraged.
- Human resource development is at low ebb in the region. A new Central Agricultural University is under process of establishment in the region and the existing universities and colleges are being strengthened particularly by the central government. Apart from imparting knowledge, there is a need to develop skill and attitude in the students.
- Horticulture including floriculture is the mainstay of the region. "Khasi Mandarin", strawberry, pineapple, passion fruit, unique orchids, anthurium etc. are the specialties of the region and there are several success stories of farmers in these. Sound technical backstopping, seed and planting material, storage and processing

are, however, needed. Upgrading the skill of the stakeholders is required to develop entrepreneurship particularly for value addition of the horticultural produce which is so abundant in the region. Post harvest handling, quality parameters, packaging are some of the areas which need to be addressed both by entrepreneurship development and also by public-private partnership.

- Despite the fact that the region receives high precipitation, there is shortage of water. The region also warrants location specific R & D efforts including rainwater harvesting, enhanced water use efficiency, efficient recycling of water and other such measures for sustainable agriculture. Also, the awareness on the climate change along with mitigation and adaptation strategy and preparedness for the change requires special attention as there could be significant changes in the cropping pattern and production. Given the natural outlay of the resources in the region and rich traditional knowledge base of the ethnic communities, it is also important to improve upon the traditional agro-forestry being practiced either in the form of "taungya" or home gardens. This will not only help in food production, but also ensure carbon sequestration to mitigate the climate change in the region over a long term.

The five ICAR institutes including ICAR Research Complex with six research research stations in different states and four National Research Centres on Pig, Mithun, Yak and Orchids; seven Regional Centre of other Institutes and several AICRP Centres in different disciplines/commodities), a State Agricultural University at Jorhat, one Central Agricultural University at Imphal, both with their centres, and the Agriculture Faculty of the Nagaland University, Medziphema are engaged in addressing the problems of agriculture in the region and, have developed varieties of cereals, pulses, oilseeds, animal breeds, technologies for crop and animal production and management, fish seed production, other fisheries technology, etc. The scientists have produced piglets through artificial insemination, which is of quite significance in this region. Technology assessment, refinement, and demonstration by the 71 KVKs in coordination with several other agencies is helping to resolve the problems and issues of agricultural production and livestock management in the region.

The meeting shall help towards evolving roadmap and frameworks for future research and development in the larger interest of the region. I am sure that the Central Government, ICAR, State Govt. and all other concerned agencies, through better coordination and interface, would function in unison to make the region usher into an agricultural paradise of the country.

Jai Hind

3. ACTION TAKEN REPORT

ACTION TAKEN REPORT ON THE MAJOR RECOMMENDATIONS OF THE 19TH MEETING OF THE ICAR REGIONAL COMMITTEE NO. III HELD AT GANGTOK, SIKKIM FROM OCTOBER 23- 24, 2009

Sl. No	Major Recommendations	Institutes/states/ agencies for taking action	Action Taken
1.	Establishment of Veterinary College in Nagaland under the new CAU.	DDG (Edu)/ V.C., CAU	The territorial jurisdiction of the existing CAU, Imphal will include State of Nagaland, after reorganization following creation of new CAU at Barapani.
2.	A Joint Research Co-ordination Committee for NEH Region to have unified and collaborative R & D endeavour in the region.	V.C., CAU/ Director, ICAR Research Complex	Action initiated and the first meeting was held on 13th April 2011.
3.	Promise to provide about 150 acres of land for establishment of a new CAU at Barapani. The Government of Meghalaya should transfer the identified land to ICAR expeditiously.	Government of Meghalaya	The land of about 200 acres for establishment of the CAU at Kyrdem Kulai, Meghalaya is at the final stage of allotment.
4.	Land for expansion of College of P G Studies at Barapani to be provided by the Government of Meghalaya.	Government of Meghalaya	The Department of Agriculture, Meghalaya is still in the process of negotiating with the Meghalaya Energy for additional land of 20 acres, the outcome of which will be intimated to ICAR in the near future.

Sl. No	Major Recommendations	Institutes/states/ agencies for taking action	Action Taken
5.	College of Agricultural Engineering and Post Harvest Technology, Ranipool to be provided additional land required for expansion and starting of PG and Ph.D programmes by the Government of Sikkim expeditiously.	Government of Sikkim	Action awaited
6.	Sustainable food security is a major issue for the region. The following areas need to be strengthened substantially: i. Research on *Indica* and *Japonica* rice for improvement of productivity and tolerance to abiotic and biotic stresses with special emphasis on soil acidity, cold tolerance, tolerance to blast disease and stem borer ii. Strengthening of maize research for improvement of quality and productivity iii. Strengthening of pulses research in general.	Director, ICAR Research Complex VC, CAU	i. Action initiated and is in good progress under NAIP ii. Initiated under NAIP iii. Initiated under AICRP-MULLARP A perspective plan will be developed and submitted to ICAR for further consideration.

Sl. No	Major Recommendations	Institutes/states/ agencies for taking action	Action Taken
7.	Chairman, ASRB be requested to explore possibilities of opening of an additional centre for ARS examination in the region.	Chairman, ASRB	The matter was considered by the Board. The Board has decided to conduct Prelim ARS/NET Examination online from this year at 23 designated centres across the country including one at ICAR Research Complex for NEH Region, Umiam, Meghalaya.
8.	In depth study on dieback disease of citrus is very important. Survey of the disease in the country needs to be taken up on priority basis.	Director, NRC-Citrus/Director, ICAR Research Complex.	Both the institutes have collaborative perspective plan and work is in progress under National Horticulture Mission.
9.	For induction of young talents in the agricultural education system a mechanism needs to be developed. High level discussions need be held to consider various options.	DDG (Edu)/V.C., CAU/V.C., AAU	Discussions were held in the Conference of Vice-Chancellors and, in the consultations organized for development of National Higher Agricultural Education Project document. Appropriate mechanisms are being planned.
10.	In the current plan period KVKs will be provided to all districts which were in existence up to 2007. Districts created after 2007 will be provided KVKs after receiving proposals from the State Governments and subsequent approval of the proposals.	DDG (Extn)	Presently there are 71 KVKs out of 85 districts under Zone-III. In the remaining 14 districts, 10 districts have completed the visits of the proposed sites by Site Selection Committee (SSC) and submitted their reports to the Council. Sanction orders are awaited. Visit to the proposed sites by SSDC will be made for establishment of KVK in Anjaw district of Arunachal Pradesh after receiving the land

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Sl. No	Major Recommendations	Institutes/states/ agencies for taking action	Action Taken
			related documents from the host institute. However, till date no proposal has been received from any host institute for KVK in NC Hills district of Assam. Letters of correspondence in this regard have been sent to different host organisations for submission of proposals. Two districts, namely Dibang Valley and Kurung Kumey of Arunachal Pradesh were not recommended in the EFC of the current 11th Plan.
11.	Acid soil is a major problem of NEH region. About 70% of NEH region has acid soil with low pH. To tackle the problem on a permanent basis, development of acid tolerant strains/varieties/ hybrids of field and horticultural crops should be taken up jointly by ICAR Research Complex, Umiam and CAU, Umiam.	Director, ICAR Research Complex, Dean, CAU, Umiam	Action is in progress and recommended varieties of paddy, maize, pulses, oilseeds, horticultural crops have been provided in Acid Soil Reclamation programme.
12.	Collective efforts to establish quarantine system for SAARC countries need to be taken.	DDG (Crops)/ ADG (Plant protection)	Action initiated by the Plant protection & Quarantine, GOI.
13.	Nagaland University may select a discipline where it would like to excel in the future. The matter then may	Dean, SASARD, Medziphema	Action not received.

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Sl. No	Major Recommendations	Institutes/states/ agencies for taking action	Action Taken
	be discussed with DDG (Edn) and proposal be prepared. However, the proposal should have HRD as its main component.		
14.	The KVKs may be empowered to utilise the money under Horticultural Mission to carry out demonstrations.	DDG (Extn.) / ZPD-III/ DDG (Hort)	Instructions in this regard have been communicated to the concerned host institutes of KVKs for necessary action.
15.	DDG (Engg) and DDG (NRM), ICAR to pay a visit to Arunachal Pradesh to have a first hand assessment of the situation in the State.	DDG (Engg) / DDG (NRM)	Interface meeting with the State Government has been conducted twice.
16.	The pig centre at Assam should take care of the seed requirement of Arunachal Pradesh also.	Director, NRC-Pig	Six numbers of improved pigs have already been supplied to the Regional Exotic Pig Breeding Farm and 31 breeding stock to private farms at Basar. Piglets have also been supplied to farmers nearby Arunachal Border.
17.	The good facilities already available in Tripura for diagnosis of disease in fish that could be extended to Manipur.	DDG (Fisheries) / College of Fisheries, C.A.U.	The institute discussed with all departmental representatives including Manipur to establish a network of disease diagnostic laboratories across all the states of NEH region in collaboration with NFDB and State Departments. The institute is preparing a network project to be submitted to NFDB in this regard. It is proposed to involve 30 researchers working in

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Sl. No	Major Recommendations	Institutes/states/ agencies for taking action	Action Taken
			the region along with two scientists from CIFA.
18.	As far as paddy-cum-fish culture is concerned the DDG (Fy) is to take up the issue of rice based fish culture in Manipur.	DDG (Fisheries)	In a workshop of network formation during 6-7 December, 2010, a discussion was made with State Departments of all NEH States including Manipur to assess the extent of resource availability and characterisation and potential of paddy-cum-fish culture. It was further discussed that based on available information, CIFA will undertake survey work to find out the researchable issues.
19.	Government of Manipur is to approach Horticultural Mission for the purpose of infrastructure development including potato seed production.	NEC / Director, CPRI	"Horticulture Mission for North-Eastern and Himalayan States" is looking after development of horticulture in the region. The nodal officer for NE region under the above Mission is the Director, NRC for Orchids, Pakyong, Sikkim. Government of Manipur to prepare a project on potato seed production and submit it to the Director, NRC for Orchids with a copy to the Director, CPRI, Shimla so that any help in this regard can be offered by CPRI.
20.	In Meghalaya, 2/3 specific areas needed to be monitored in respect of rainfall data, temperature variation, soil characteristics, pest and disease complex etc over a period of 10-15 years.	Director, ICAR Research Complex	Action is in progress under institute projects and in collaboration with NESAC (ISRO).

Sl. No	Major Recommendations	Institutes/states/ agencies for taking action	Action Taken
21.	The availability of water in the region in the next 20/30 years needs to be assessed and the future planning for the region has to be made based on the assessment of water availability. DDG (NRM) to make the assessment of water availability and its use for agricultural activities, identification of crops with changing scenario etc. within 2/3 years.	DDG (NRM) / Director, ICAR Research Complex	Action is in progress with data collection, capacity building with projects under SWAPL and NICRA. The AICRP (WM) centres at Jorhat, Assam and Shillong, Meghalaya are carrying out experiments on water requirement for different crops, availability of irrigation from different sources, and crop water requirement for dominant cropping system in the region. Jorhat centre has recommended water requirement for different oilseeds like seasamum, high value horticultural crop like banana (with drip), vegetables like capsicum, carrot, chilli etc. The Shillong centre has come out with recommendations for maize-mustard sequence, and zero tillage for water and soil conservation.
22.	A road map for post harvest operations is very essential for the region. A future horticultural scenario of the region including value addition is necessary in a printable format.	DDG (Engg)	A road map for post harvest technology and value addition in NE region has been prepared in a printable format. (Chapter - 10)
23.	The Vice-Chancellors and Director of the ICAR Institutes located in the region should sit 2/3 times in a year to decide the	V.C., CAU / Director, ICAR Research Complex	Action initiated for interface meeting and the recommendations of its first meeting held on 13th April have been put up in the RCM.

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Sl. No	Major Recommendations	Institutes/states/ agencies for taking action	Action Taken
	research agenda of the region and to avoid duplication in research. A NEH Consortium of all institutes located in the region and officials from the Council should be set up. The Director, ICAR Research Complex, Barapani should take the necessary initiative.		
24.	Swine fever and FMD vaccines not available	Director, IVRI / State Departments of NEH Region	IVRI has already supplied the vaccines against the requisitions made by two states of the region.
25.	Complete infrastructure development of KVKs in the region should get the top priority and as the index of construction is high in the region, whatever additional fund is required for completion of the infrastructures would be provided by the Council.	DDG (Agril. Extn.) / ZPD-III	Infrastructure items approved in the 11th Plan EFC will be provided to the KVKs. Keeping in view the higher cost index in the region necessary provision of additional funds has been made in the revised EFC on the basis of cost index. It is also to be mentioned that under the Zone, Administrative Building in 48 KVKs, staff quarters in 36 KVKs and farmers hostels in 26 KVKs are completed/ongoing up to 2010-11.
26.	Extension should be linked up with post harvest departments and processing and marketing should also be introduced in the KVKs. Each KVK should excel in a specified field.	DDG (Agril. Extn.)/DDG (Agril. Engg)/ ZPD-III	Instructions in this regard have been communicated to all KVKs for necessary action.

Sl. No	Major Recommendations	Institutes/states/ agencies for taking action	Action Taken
27.	There is a centrally sponsored scheme to reclaim acid soil areas. The problem of die-back in citrus would be taken up under this scheme if the problem is due to acid soil.	Director, ICAR Research Complex/ Director, NRC-Citrus, Nagpur	Recommendations already sent.
28.	ICAR Research Complex, Umiam has developed *Jalkund*, a water harvesting structure. For capacity building 100 officers and 1000 farmers from the region could be trained on water harvesting. The State Governments will have to bear only the travelling costs and the rest will be borne by ICAR.	Director, ICAR Research Complex	The DWM, Bhubaneswar is coordinating a centrally sponsored XI plan scheme on 'Scaling up of Water Productivity in Agriculture for improving livelihoods'(SWPAL) through demonstrations, training of trainers and farmers. The AICRP (WM) Jorhat and Shillong centres of DWM, Bhubaneswar are implementing the training under the scheme on different aspects of water management including water harvesting techniques. So far (up to March 2010) 1225 nos. of farmers and 50 nos. of trainers have been trained through Jorhat centre and 1966 nos. of farmers and 203 nos. of trainers have been trained through Shillong centre under the scheme 'SWPAL'.
29.	Modules on Integrated Farming Systems have been developed and these need to be tried in different locations before they could be taken up in a large scale.	Director, ICAR Research Complex/CAU	Action initiated under NAIP and institute programme.

Sl. No	Major Recommendations	Institutes/states/ agencies for taking action	Action Taken
30.	ICAR is to facilitate procurement of fingerlings from the Ganges and rearing into brood stock for Tripura and Assam	ADG (Fisheries)	Fisheries Institutes do not have the required facilities for rearing of fingerlings into brood stock. However, if the concerned state desires, CIFRI is ready to facilitate the collection of fingerlings of required fish species from river Ganga for rearing the brood stock in Tripura and Assam.
31.	The tools and implements developed by AAU, Jorhat can be tried by the different governments in the region and taken up in FLDs.	VC, AAU/ Directors, State Governments of NEH Region	1. PAU type (6- rows) paddy transplanter and AAU type (4-rows) paddy transplanter: both types of transplanters were put to test. The rate of coverage of area by the transplanter was between 0.03 to 0.42 ha/h depending on the size of the transplanter and land condition. 2. AAU modified bullock drawn helical blade puddler. This was tested and demonstrated at different villages. 3. Modified conoweeder: The testing and demonstration are in progress. 4. AAU improved yoke for bullocks/buffaloes. 5. AAU developed multipurpose tool frame. 6. AAU modified Dinabandhu biogas plant.

Sl. No	Major Recommendations	Institutes/states/ agencies for taking action	Action Taken
32.	The state governments should take the initiative to provide tools to the farmers. The simple tools may be locally manufactured and for other sophisticated tools dealers may be approached. The States should also have Agril. Engineering departments.	Directors, State Governments of NEH Region	Action initiated with the Government of Nagaland, Department of Agriculture.
33.	Indigenous material of plant origin from Assam and Arunachal Pradesh should be covered while formulating feed under the outreach programme on fish feed.	ADG (Fisheries) Govt. of Arunachal Pradesh Govt. of Assam	In Assam and Arunachal Pradesh, rice bran, mustard oil cake, sunflower oil cake and til oil cakes are available as indigenous plant ingredients for fish feeds. These ingredients are included in our fish feed formulations and the formulations are being tested in farmers' ponds in Orissa under Outreach activity on fish feeds (CIFA).
34.	A GIS-based inventory of water bodies in Assam is to be prepared and made available to the State.	ADG (Fisheries)/ Director of Fisheries, Assam	CIFRI has already completed the mapping of water bodies (>05 ha) on GIS platform in five districts of Assam (Barpeta, Bongaigoan, Kokrajhar, Karbi West and Nalbari) while mapping of water bodies in another nine districts is in progress and is likely to be completed during 2011. CIFRI will be in a position to provide GIS based inventory of water bodies, size of 75 ha toAssam Govt. by 2012.

Sl. No	Major Recommendations	Institutes/states/ agencies for taking action	Action Taken
35.	Prospecting for wild ornamental fishes from the North East is to be done in all possible areas. Breeding and production technology is to be developed for the selected species.	ADG (Fisheries) CAU, Imphal ICAR Research Complex	Under the Institute based project- "Study of fish bio-diversity, breeding and culture of carps and some selected ornamental fish species in North Eastern States of Meghalaya" fish diversity study has been undertaken in Simseng and Rongram river stretches through East, West Garo Hills covering Tura, Williamnagar and some lower parts of Meghalaya. About 14 species of ornamental value with export potential were identified. Breeding and production technology of some of the ornamental fishes of the NE region were done at CIFA ornamental breeding and culture unit. They were *Colisafaciata*, *Colisalalia*, *Esomusbarbatus*, *Puntiussophor*e and *Badisbadi*s. Further work in this line is going on.
36	Fisheries institutes of ICAR may organise need-based training programmes for the states of the region on request.	Directors of Fisheries of the concerned states	The institutes are regularly conducting training programmes and workshops on various aspects of freshwater aquaculture to disseminate scientific methods of fish farming to the farmers and other State Government officials of North Eastern Region. Besides, customised training programmes are also organised for the State Governments.

Sl. No	Major Recommendations	Institutes/states/ agencies for taking action	Action Taken
			CIFRI is organising training programmes on a regular basis, both in and on sites, for the States of the region like Assam, Mizoram, Arunachal Pradesh, Meghalaya, Tripura and Nagaland on various aspects of openwater fisheries, such as scientific management of wetlands and reservoirs; cage culture and pen culture in wetlands and reservoirs; methodology for collecting fish catch etc. The institute is ready to organise need-based training programmes for NE States on demand.
37.	Plant materials from Arunachal Pradesh and Tripura are to be screened f to substitute mahua oil cake (as pesticide).	ADG (Fisheries) CIFA, Bhubaneswar	There are two plans i.e. HINGON (Ritha) and DERRIS available in Arunachal Pradesh and Tripura which could also be used effectively in controlling unwanted fishes. However, other plant materials if any, available in these states would be screened in consultation with respective state agencies.
38.	Technology development for breeding, seed production and culture of small fish species for Tripura may be taken up.	CIFA, Bhubaneswar CAU, Imphal	Scientists of CIFA visited Tripura and collected brood fish of *Ompak pabda* from rivers of Tripura. The state officials were trained in Regional Research Centre of CIFA at Kalyani, West Bengal on breeding and seed production of pabda during 2010. The officials are in touch with CIFA on successful culture of *O. pabda*.

Sl. No	Major Recommendations	Institutes/states/ agencies for taking action	Action Taken
39.	Demonstration of cage culture of fish in Arunachal Pradesh is to be taken up.	DCFR, Bhimtal CIFRI, Barrackpore	CIFRI is ready to give demonstration of cage culture in Arunachal Pradesh for raising fingerlings for stocking in reservoirs to increase the production and productivity. However, the State of Arunachal Pradesh should identify the resource where cage culture demonstration can be given. A formal letter to this effect is being sent to the Director, Fisheries, Government of Arunachal Pradesh.
40.	Demonstration of magur and chocolate mahseer culture in Manipur is to be taken up.	CIFA, Bhubaneswar	Demonstration and training on Magur breeding and seed production to the farmers and State fisheries personnel of North-East region was undertaken on a regular basis by CIFA. The institute (CIFA) is operating a project entitled "Seed production and grow out culture of indigenous catfish, magur through training and demonstration in North East States (Assam and Manipur funded by NFDB). Under this project training and demonstra-tion on Magur farming is being undertaken at West Imphal District including KVK, Bishnupur.

Sl. No	Major Recommendations	Institutes/states/ agencies for taking action	Action Taken
41.	ICAR Fisheries Centre in Arunachal Pradesh will also work on development of indigenous fish feed.	ADG (Fisheries) Research Centre of Fishery in A.P.	In a workshop at Guwahati during 6-7 December, 2010 discussion was made with state departments of all NEH states including Arunachal Pradesh regarding availability of fish feed ingredients in these states and its utilisation in developing farm made feed at respective states.

4. MINUTES OF THE REGIONAL COMMITEE MEETING

The 20th meeting of the ICAR Regional Committee No. III was held at ICAR Research Complex for NEH Region, Umiam, Meghalaya from May 5-7, 2011. His Excellency, the Governor of Meghalaya, Shri R.S. Mooshahary, was the chief guest in the inaugural ceremony of the meeting.

Dr. S.V. Ngachan, Director, ICAR Research Complex for NEH Region, Umiam welcomed and expressed his gratefulness to His Excellency, for gracing the occasion. Dr. Ngachan also welcomed Dr. S. Ayyappan, Secretary DARE and DG, ICAR, New Delhi; Hon'ble Deputy Chief Minister of Meghalaya, Dr. B.M.Lannong; Hon'ble Minister of Agriculture, Horticulture and Soil Conservation, Govt. of Mizoram, Shri. H. Liansailova; Hon'ble Minister for Agriculture and CADA, Govt. of Manipur, Shri. Ph. Parijat Singh and Hon'ble Minister for Vety. and A.H., Govt. of Nagaland, Shri. T.R. Zeliang. He also welcomed the Vice-Chancellors, DDGs, ADGs, Directors and Joint Directors and Heads of different ICAR Institutes, officials of state department in NEH region, Govt. of India, Universities, scientists and other participants present in this meeting.

Dr. Arvind Kumar, DDG Education, ICAR, after welcoming the dignitaries, highlighted that in NEH region, conservation of bio-diversity and its multiple effective use, effective water management, amelioration of acid soils, crop diversification and improving the productivity under Jhum cultivation, improving the productivity of crop and livestock sector are the key issues which require utmost priority to improve the socio –economic status and livelihood security of the people. He contemplated the need for establishing close linkage between different institutions in this region.

Dr. S. Ayyappan, Secretary DARE and DG, ICAR, expressed great satisfaction and gratitude for the presence of His Excellency, the Governor of Meghalaya and Hon'ble Ministers representing various states. Since, the formulation of the 12th five year plan is in processes, he felt that the recommendations emerging out of this regional committee meeting shall be of immense value in developing research, education and extension strategies for the region. In terms of food grains, the country is expected to have record food grain production of about 235 million tonnes during current year and in future, Eastern and NE region shall have to play significant role in maintaining the pace of green revolution in the country. The NE region is vulnerable to the threats of abrupt climatic changes, and therefore the conservation and development of climate resilient agriculture needs to be stressed upon to meet the future challenges. He stated that the NE is very rich in biodiversity, both in plant and animal dimensions but the concern is how to use it effectively. The introduction of speciality agriculture with special reference to horticultural crops, value addition, agro eco-

His Excellency, The Governor of Meghalaya, Shri R.S. Mooshahary, deliverying the inaugural address

His Excellency, The Governor of Meghalaya, Shri R.S. Mooshahary, releasing a book

Dr S. Ayappan, Secretary, DARE & DG, ICAR, charing the technical session

Participants interacting in the RCM Meeting

tourism, diversification in farming and livelihood systems need immediate attention and the key issues like acid soils, water stress, low and imbalance fertiliser use, non-availability of quality seed and planting materials, difficult terrains, poor connectivity, language barrier and a dominance of resource poor and marginal farmers need to be adequately addressed. One of the potential areas of livelihood in this region is livestock sector particularly piggery, which needs substantial support. The organic farming has great scope in this region but fortification of site specific nutrients is essential to build up the fertility status of soils. Improving the productivity and development of superior cold tolerant rice varieties and cultivation of quality protein maize may be given due emphasis. Degraded *Jhum* lands should be reclaimed or fertility restored through agroforestry interventions in conjunction with crop diversification including pulse crops. To counter all these potentially inhibiting forces of NE agriculture, the project on climate resilient agriculture (NICRA) has been initiated. Due emphasis is also given on post harvest processing and value addition. He advocated for more international cooperation in NE region and stressed the need for harnessing potential of NE to become an agro-export processing zone and in that direction involvement of leading entrepreneurs was felt necessary. Regarding the veterinary college to be established in Nagaland, he mentioned that the ICAR is already taking necessary action in this direction.

Hon'ble Minister of Agriculture, Horticulture, Soil Conservation Govt. of Mizoram, Shri H. Liansailova, emphasized that the state is not having self-sufficiency in food production. He expressed his happiness at the establishment of 7 KVKs in the state by the ICAR. He gave an overview of the agricultural and socio-economic aspects of the state and desired that further ICAR help can play major role in improving the agricultural scenario of Mizoram. He pointed out that the Kolasib centre should have more scientists in various agricultural disciplines to strengthen the centre and help in effective technological guidance. He shared that the visit of Hon'ble Union Minister of Agriculture and Food Processing Industries, Sri Sharad Pawar, has been very fruitful and requested for setting up of colleges of agriculture, horticulture and post harvest technology in the state.

Hon'ble Minister for Agriculture & CADA, Manipur, Shri Parijat Singh, praised the ICAR Manipur centre for providing technologies which has helped the farming community. He desired that sufficient seeds of high yielding rice varieties suitable to the hilly ecosystem, cold tolerance, marshy areas need to be provided. He sought for the establishment of two rice research stations in high altitude area as well as in low lands. It was also desired that the unemployed youths be given opportunities for agri-based trainings to develop entrepreneurship. In horticulture sector, he stated that some of the neglected indigenous crops like Water chestnut, Taro, Water mimosa need improvement and should be popularised in wetlands that would result in enhancement of employment and productivity. The potentially rewarding tree bean that is a major source of income is on the verge of decline and research be formulated to reverse the trend. Indigenous fish species are on the verge of extinction

and need to be saved by experimental breeding and stock enhancement. Establishment of disease diagnostic lab, micropropogation, Project Directorate of swamp buffalo, pig production to bridge the gap between demand and supply, posting of a animal health scientist at the ICAR centres to work on the animal diseases were the other issues raised by him.

Hon'ble Minister of Vety. and Animal Husbandry, Nagaland, Shri T.R. Zeliang stressed that meat and fish production needs to be enhanced in the state and desired that there should be enough fish so as to prevent import of the same from other states Emphasis also be given on high altitude cold tolerant crops, improvement in French bean, water harvesting structures, large scale fisheries, poultry and piggery development. He indicated that Nagaland is a landlocked state and attention need to be given for building the road and communication network. The need for establishing a veterinary college in Nagaland on priority was highlighted by him since Nagaland does not have any national project as well as any central university.

Hon'ble Deputy Chief Minister of Meghalaya, Shri B.M. Lannong, indicated that due to population growth, land transformation like reduction in forest areas and orchards, agricultural lands is rapid. The concern is largely due to accelerated urbanisation. Therefore, proper land use planning including road and transportation mechanism should be given due importance. Mining is another severe threat to agricultural production chain since most of the productive arable lands have been transformed into mined areas, therefore restoration of soil health in mine spoiled soils, intervention of agro-forestry approach, initiation of soil and water conservation measures should be taken on a large scale. ICAR should devise hill agricultural technology with due emphasis to horticultural sector by introducing new fruit cultivars from other parts of India having similar and comparable agro-climatic conditions. He stressed the need for farm mechanisation, development of livestock sectors, emu and turkey farming, etc.

The programme KIRAN (Knowledge Innovation Repository of Agriculture in Northeast) an exclusive hub for knowledge transformation and dissemination to various stakeholders related to agriculture and allied sectors was inaugurated by His Excellency, the Governor of Meghalaya, Shri R.S. Mooshahary, on 5th May, 2011 at ICAR Research Complex for NEH Region, Umiam, Meghalaya. In his inaugural remarks, he stressed upon the need for proper utilisation of cattle population not only in N.E Region but also throughout India, since cattle is considered as one of the animals having multiple uses in the form of meat, milk, urine, dung, hide, hoofs, etc. which ultimately supports human food as well as other needs for sustenance. In his remarks, His Excellency also pointed out that since majority of the population of NE Regions are non-vegetarian (meat eaters), it is the need of the hour to look into the improvement of cattle population with respect to both quantity and quality through scientific breeding programmes.

His Excellency, the Governor of Meghalaya, also cited the example of ***Strawberry Festival*** where poverty changed to prosperity in a village of Ri-Bhoi district, Meghalaya due to the adoption of straw berry (Red Gold) cultivation. He emphasized that it is high time for agricultural researchers to think adoption of specific technology in best suited

conditions across NE region keeping in mind the improvement of livelihood of the most neglected sections of the society i.e. marginal and small farmers.

His Excellency the Governor of Meghalaya made a remark that *no security is above food security* which can be achieved through knowledge transfer from lab to land programmes. Therefore, he stressed all stakeholders for bringing food security first and then the other securities will subsequently follow on, in the present day context. He referred that the region NE India was self reliant in every aspects of life, particularly in food grains even during 17th Century, then why not now! At the same time, he also addressed that the major threats to natural resource sustainability in NE region, particularly land degradation by severe soil acidity, depletion of nutrients through leaching, ground water depletion, pollutions etc need adequate attention. Since the land holding is decreasing day by day due to burgeoning population growth in NE India, it is imperative to devise strategies involving all the stake holders including students and farming community under the banner of ICAR Research Complex for NEH Region in order to conserve as well as make efficient use of precious resources while maintaining / meeting the demands of food grain needs of the existing population. In this regard, he also emphasised several important approaches like crop intensification, diversified farming, value addition to agricultural products etc. for achieving *2nd Green Revolution* in NE region of India for prosperity and happiness through self reliance in food and nutritional security. The programme ended by vote of thanks by Dr. Ravinder Kumar, ADG, Co-ordination, ICAR.

The technical sessions started with presentation from the representatives of Govt. of Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim. The agenda items were taken and the responses were given by Dr. S.N. Puri, Vice-Chancellor, CAU, Imphal; Dr. K.M. Bujarbaruah, Vice-Chancellor, AAU, Jorhat; Directors of ICAR Institutes and Jt. Directors; Heads of various regional centres of ICAR institutes located in NE region; ADGs and DDGs.

Summary of the issues raised by the states

Some of the important issues raised by different state governments are summarized below:

Director of Agriculture, Government of Nagaland, Mr A.Y. Ovung, requested for assistance from ICAR in the establishment of KVKs in 3 new districts, research on high altitude cold tolerant crops, studies on alternate sustainable management approaches for *Jhum* cultivation, research emphasis on minor millets, colocassia and Kholar varieties of French bean. He also stressed upon research on location specific water harvesting structures and their recycling for multiple use. Request was also made for posting more number of scientists in the Nagaland centre. Director, AH & Vety, Government of Nagaland, Dr L.S.

Moses, requested for establishment of a research station for pig, poultry and fish. Dean, Nagaland University requested for more funds from ICAR for the university.

Director, AH & Vety, Dr Th Jeevan Singh, Manipur requested ICAR for establishment of a Regional Project Directorate on Swamp Buffalo in Manipur, a Piglet Production Centre at Andro village, Imphal East (Manipur) under Regional Project Directorate on Pig, Khanapara, Assam and posting of scientists and for taking up research on animal diseases at ICAR, Manipur Centre, Lamphel. Joint director of Agriculture, Dr O. Nobo Singh, Manipur raised issues such as development of good paddy varieties for high altitude areas, research in crops for dry land as well as wet land areas, development of cold crops (Cole) in hilly region and conservation of indigenous crops of the state.

Jt. Director Horticulture, Government of Meghalaya, Shri K.M. Brahma, put up the issue of creating facilities for post entry quarantine of planting materials that is being imported by the state, emphasis on post harvest management to bring in more practical preservation techniques especially at the primary/village level in the form of techniques for pre-processing for onward transmission to a few major central processing units, production of quality fish seed for the state, strengthening of CPRI center for supply of required breeder seeds of potato for the state and Production of quality fish seed for the state.

Director of Agriculture, Mr C. Lalzaeliana, Government of Mizoram requested for establishment of agriculture and horticulture college in Mizoram, research on cold tolerant rice varieties for high altitudes of Mizoram, research to optimise production technology on red oil palm, sugarcane and potato for increasing productivity and better management of the crop in Mizoram, research on rain water harvesting and its subsequent use for agricultural production during dry periods.

Director of Fisheries, Dr O.P. Singh, Government of Mizoram requested for supply of fingerlings for open water culture and to have more research on ornamental fish. Joint Director, AH & Vety, Dr Saingura Sailo, Government of Mizoram desired to have adequate supply of vaccines for swine fever and more studies on low cost feed with locally available materials. He also requested to have one AICRP on pig in Mizoram. Director, Horticulture, Mr Samuel Rosanglura, Government of Mizoram, wanted ICAR to develop package of practices for bird eye chilli and more supply of quality planting materials (virus free and disease free) of mandarin orange to check citrus decline.

DIO, AH & Vety, Arunachal Pradesh, Dr Karbom Basar requested for setting up of livestock check gates along its international boarders with China, Myanmar and Bhutan, extension of FMD control programme to Arunachal Pradesh, creation of sub-centres for Mithun and Pig. Representative from the Directorate of Agriculture, Government of Arunachal Pradesh raised the issue of increasing the seats of Arunachal quota at CAU and AAU. The issue of assessment and documentation of biodiversity of Arunachal Pradesh was also emphasized.

Addl. Chief Engineer, Irrigation, Mr R.D. Bhutia, Government of Sikkim raised the issues like identification and mapping of water bodies through remote sensing and GIS,

research on the diseases of large cardamom and technology for rejuvenating the large cardamom and technology on revival and rejuvenation of apple orchards.

Some major points raised by the Directorate of Agriculture, Dr S.N. Sen, Government of Tripura are identification/development of appropriate technlogy for SRI over different seasons, for Tripura conditions; Identification/development of specific rice varieties for Jhum system, glutinous and non glutinous both as sole crop and in a crop mixture, suitable Agro-forestry model for sustainable income including mixed farming and integrated system; development of early season regular bearing mango varieties for the state; Integrated nutrient management strategies for pineapple for slopy areas. The problem of broken rice in hybrid rice milling was also raised.

The summary of the responses

Issue	Response
	Natural Resource Management
Climate resilient agriculture in the NE hilly region	It was stressed that agroforestry as a component is very essential for improving the livelihood of the farmers, providing fodder and feed to the animals, and building resilience to climate change. This needs to be scaled up as several agro-forestry models have been developed by the institutions located in the North East. It was also mentioned that ICAR is involved in preparing district wise contingency plans for extreme climatic events. The ICAR-RC, Umiam, needs to increase the pace of these plans as they would be very useful to implement the National Initiative on Climate Resilient Agriculture (NICRA) for which ICAR-RC NEH is the nodal institution.
Training of state officials and farmers on water management	ICAR-RC NEH, Barapani and Assam Agriculture University (AAU) have been provided funds by ICAR to train 100 state officials and 1000 farmers each year on any issue related to water management. The sponsoring agencies have to only take care of the travel cost. The rest of the expenses involved are taken care by the ICAR. These trainings can also be conducted at the research stations or KVKs.
	Crop Science
Research on small millets	Research work on Rice + Finger Millet are going at Nagaland centre and collection and evaluation of native gerplasm is in progress at Sikkim centre. Works on other aspects shall be gradually taken up in due course of time.
Problem of broken rice in hybrid rice milling	The problem of broken rice in hybrid rice milling in Tripura can be reduced to affordable levels if hulling is delayed till the grains are dry. Three to four months of storage after harvest is good interval before milling is done.
SRI Technology for Tripura	SRI technology has been successfully introduced in Dhalai district of Tripura and Garo hills of Meghala. More than 200 ha are under SRI. The work on nutrient management is going on.

Issue	Response
	Horticulture
Exploitation of rare fruit species (Sohiong, soflang, parsimon) in Meghalaya	Sohiong has long gestation period and large canopy size. To address the issue, ICAR Rsearch Complex for NEH Region, Meghalaya has standardised grafting technique to produce quality planting material of desired idiotype. Post harvest protocol for preparation of Jam and RTS has also been developed at the institute. The states may use the technology to economically use this rare fruit.
Developing apple cultivation in Meghalaya	The climatic conditions required to fulfil the chilling hour requirement for Apple is not available in most of the areas of Meghalaya state. Apple was tried in early eighties in upper Shillong area but was not very much successful.
Development of improved variety of Colocasia for Nagaland	Evaluation of 25 local varieties/entries of colocasia are in progress at the Nagaland centre.
Availability of quality seeds and planting materials of fruits and vegetable	It was emphasized that seed production chain, including planting material need to be strengthened, which require diagnostic system and access to the nucleus material from ICAR. DDG (Horticulture) requested the Vice Chancellor, AAU, Jorhat, Assam to provide 10 acres of land at Kahikuchi so that the regional station serves the state for plantation crops, spices and floriculture. Meghalaya Govt. was also requested to provide 20 acres of land, since available land is not sufficient to produce required quantity of breeder/ foundation seed. If land is provided, work on core crop would also be strengthened.
Diagnosis of viruses in potato, banana and tuber crops	The Dipstick based diagnostic kit for potato virus has been developed which is effective in the diagnosis of potato viruses, and dip stick for other viruses in banana, tuber crops is also in the process of the development.
	Animal Science
Training on vaccination and health care of the animal resources.	National Research Centre on Pig is located at Rani, Guwahati. The Institute is also coordinating AICRP on Pig and Mega Seed Project on Pig. The Institute, thus, can provide training and piglets to the farmers / pig rearers for setting up both backyard (indigenous strains) and commercial piggeries (crossbreds) through the centres located

Issue	Response
	in different regions of NE. NRC on Pig has a well established slaughter house and core processing facility which can provide training to various levels of entrepreneurs in both pork processing and value addition. The artificial insemination technique in pigs has been standardized and the services are extended to pig breeders in the field area.
Adequate supply of swine fever vaccine in Meghalaya	It was suggested that NRC on Pig could be given indents for swine fever vacancies.
Training of fodder cultivation and its utilization	Need based trainings in Forage technologies can be provided at ICAR Research Complex for NEH region at Umium or any of its regional station. It was also added that AICRP centers on forage crops located at Imphal and Jorhat have similar agro-climatic conditions. VC, CAU was requested to locate stations at about 900-1000 m altitude within its various institutions.
Development of superior germplasm of poultry	The centre on AICRP on Poultry Breeding located at ICAR Research Centre at Agartala is involved in development and testing of suitable rural poultry strains and training of poultry rearers, and along with the centres of poultry seeds (new initiative in XI Plan) it is also making available chicks of strains suitable for rearing under backyard system.
Conservation of Animal genetic resources of the NE region	Characterization of Animal Genetic Resource of NER is being undertaken through the Core Lab (New initiative in XI Plan) established at AAU, Guwahati, Assam under the Network Project on Animal Genetic Resources. This would help in understanding the diversity and variability of genetic resources in the region and devise suitable strategies for their conservation and improvement.
Improvement and development of superior germplasm of animals such as cattle, pig and goats	Large and small ruminant production is being addressed through the centre of AICRP on Cattle (New initiative in XI Plan) at ICAR Research Complex for NEH Region, Gangtok, Sikkim for field progeny testing of Frieswal cattle (HF x Sahiwal crossbred). The semen of Frieswal is being used to produce improved crossbred progeny and testing of frieswal bulls in the state of Sikkim. Frieswal semen can be used for production of improved progenies from the existing population of crossbreds in NE states to improve milk production. The germplasm of Swamp Buffaloes in the state of

Issue	Response
	Assam are being improved and conserved through the centre of Network Project on Buffalo Improvement at AAU, Khanapara, Assam. Further, the riverine buffaloes in other states of NER, cryo-preserved semen of Murrah breed can be used for improving their productivity. The NER has a sizeable population and large variability of goats. This area at present is being addressed through the centre of AICRP on Goat Improvement (Field Unit of Assam Hill Goat) at AAU, Guwahati, Assam which is a new initiative in XI Plan. Similar approach can be followed by the other states of the region having sizeable goat population.
Development of low cost animal feed based on locally available resources	The centres of AICRP on Improvement of Feed Resources and Nutrient Utilization in Raising Animal Production at AAU, Khanapara, Assam and at NRC on Yak, Dirang, Arunachal Pradesh are working at farm-gate level for the development of requisite technologies for strategic supplementation of limiting nutrients (macro & micro) through locally available feed resources and have been instrumental in developing region specific resource based feeding schedules, mineral mapping, area-specific mineral mixture and assessing, Locally available feed resources. The information generated and facilities at the two centres can be effectively utilized to develop guidelines for the states in NER in developing suitable feeding modules based on available feed resources and requirements throughout the year.
	Fisheries
Conservation of the fish diversity of the region	Biodiversity conservation is being taken on priority basis for the protection of fish germplasm. It was suggested that if state require any help or guidance, this can be provided by fisheries research institutes.
Pungasius culture in pens	Fisheries officials of Mizoram wanted to know about *Pungasius* culture in pens. They desire to rear and breed ornamental fishes also. It was suggested that Mizoram may seek help from CIFRI for pen culture who has developed the technology.
Breeding and rearing of ornamental fishes	For breeding and rearing of ornamental fishes, officials can get know how from CIFRI Centre at Kolkata and CIFA, Bhubneswar.

Issue	Response
Assessment of water bodies through remote sensing	Sikkim Fisheries Department wanted to make assessment of water bodies through remote sensing. CIFRI, Barrackpore, DCFR Bhimtal and CIFE, Mumbai are working on these aspects from where information can be received.
Training of officials and farmer in fish rearing	It was informed that NFDB is providing funds for training to state officials and fish farmers to undergo training at central institutions. States may send their request to NFDB, Hyderabad and Fisheries Institutes may provide the training.
Processing and value addition of fish and fish products	DDG (Fisheries) informed that CIFT has established solar fish dryer in Arunachal Pradesh and technology can be extended to other states of NEH region. Different state-wise training programs on fish processing and value addition can be prepared as per the requirements of the states.
	Agricultural Education
Strengthening agricultural education for the students of north east	It was suggested that college of Agriculture at Medziphema (Nagaland University) need to pay more attention for strengthening the experiential learning units and upgrading the infrastructural facilities for quality assurance. The status of another central Agricultural University proposed to be established in Meghalaya was mentioned. On the issues raised regarding deemed to be University status for ICAR Research Complex for NEH region, located at Umiam, it was observed that the campus was having multidisciplinary faculty and the facilities can be effectively utilized. It was pointed out that the issue of the Central Agricultural University and its area of jurisdiction may be finalized in consultation with respective state Governments. The Niche Area of excellence on bio-fertilizer at AAU, Assam have given good results and need to be further expanded for the benefit of all stake holders. Giving the account of other ongoing schemes DDG (Education) highlighted the future strategies for improving the quality of higher agricultural education. It was pointed out that number of JRFs qualified in the entrance examination from CAU, Imphal during the last two years was quite encouraging.

Issue	Response
	Agriculture Engineering / Farm Machinery
Requirement of farm tools and equipments for mechanization of small farms, hill agriculture and horticultural crops	Good efforts have been made for development and introduction of need based farm tools and equipments suitable for different crops in NEH region through cooperating centres of AICRPs at ICAR Research Complex for NEH Region, Barapani; AAU, Jorhat; NERIST, NIRJULI and College of Agricultural Engineering and Post Harvest Technology, Ranipool. The designs of suitable farm tools and equipment are available; however, the availability of the equipment in north-eastern region is very poor for want of local manufacturing facility, lack of dealership network and difficulty in transportation of tools and equipments from manufacturing hubs in different parts of the country.
	Agriculture Extension
Strengthening extension mechanism for technologies dissemination	Presently in the region 71 KVKs have been established and establishment of 12 more KVKs in the region are in process. In Nagaland, the establishment of 3 new KVKs viz. Paren, Kiphire and Longlegs are in process and after obtaining the proper land and other essential documents from the host Institution, the KVKs will be considered. In KVK Papumpare, Arunachal Pradesh, the proposal for construction of administration building and demonstration units are in progress. Boundary fencing has already been approved. In regard of filling up of KVK staff in Meghalaya, due consideration will be given in future, so that local eligible candidates get opportunities for better convergence with farming community of the region. In case of the staff positions in two KVKs of North Tripura and Dhalai, presently, only programme Coordinators were appointed for which mandated activities are suffering to a great extent. It is suggested to the Director of Agriculture, Tripura to fill up the vacant positions immediately. Director of Agriculture, Tripura ensured that post has been advertised and process will be completed soon. With respect to higher costs of construction of infrastructure facilities in the region, it was suggested that proper cost standards of concerned organization need to be considered and accordingly funding will be provided. It was also suggested that ZPD should scrutinize all the land related documents for finalization of sites of new KVKs in the region. Presently, five KVKs in the region are have e-connectivity facilities and during XII plan more KVKs be included in this programme.

Recommendations

The recommendations emerged based on the deliberations are given below:

Issues	Recommendation	Action
	Natural Resource Management	
North East Regional Forum on Climate Change	In view of the importance of climate monitoring in the region, ICAR, through VC, AAU, shall facilitate establishment of a NE Regional Climate Forum involving all the stakeholders as the region is more fragile and vulnerable to effects of climate change.	VC AAU, Jorhat/ DDG (NRM)
Research centre for wetland areas	Establishment of a research centre for wetland areas of the region be explored by ICAR in XII Plan. Programme for effective utilization of marshy land in Assam be undertaken.	DDG (NRM); DDG (CS); VC AAU, Jorhat
Acid soil amelioration	Acid soil amelioration measures should be taken up in an integrated manner by proper combination of locally available organic and inorganic amendments. The problem regarding acid soil amelioration needs to be addressed, with feasible technological options that are to be immediately disseminated to the farmer's field.	VC AAU, Jorhat; VC CAU, Imphal; Director ICAR Research Complex for NEH, Umiam; DDG (NRM)
High altitude research	In order to address the issue of high altitude research, ICAR may consider strengthening the research base at Sikkim or in any other suitable area. Research on high altitude cold tolerant rice needs to be strengthened.	DDG (CS; DDG (NRM); VC CAU, Imphal; Director ICAR Research Complex for NEH, Umiam.
Addressing Jhum cultivation	Stakeholder workshop on "*Jhum* Cultivation" be arranged with focus on addressing the issues related to enhancing the productivity and alleviating farm income and suggesting alternatives	Director ICAR Research Complex for NEH, Umiam

Issues	Recommendation	Action
	Crop Science	
N.E. forum of Agricultural Biodiversity	Formation of regional bio-diversity boards is be pursued through National Bio-diversity Authority, as many states do not have bio-diversity boards to take care of documentation and conservation of bio-diversity.	Director NBPGR/ NBA
Introduce peri-urban agriculture	Considering the need to introduce peri-urban agriculture concept in the region, ICAR may consider funding such project for Guwahati and the proposal for the same may be submitted by AAU, Jorhat	VC AAU, Jorhat; DDG (NRM)
Development of organic package of practices for crops	Package of practices for different crops to be grown organically be developed by the research institutes and universities of the region. Production of quality seed and planting material is also to be given emphasis.	VC, AAU, Jorhat; VC CAU, Imphal; Director ICAR Research Complex for NEH, Umiam
	Horticulture	
Research on Bird Eye Chilli for Mizoram	ICAR Research Complex together with other universities shall take up research on Bird Eye Chilli, evaluate good varieties of grape for wine making and diseases of Anthurium for Mizoram State.	Director ICAR Research Complex for NEH, Umiam; DDG (NRM); DDG (Hort.); VC CAU, Imphal
Strengthening R&D effort on mango, pine apple at Tripura centre	ICAR Research Complex, Tripura centre may strengthen research to evaluate early season mango varieties, high yielding rice varieties and also develop suitable INM Packages for pineapple.	Director ICAR Research Complex for NEH, Umiam; DDG (NRM); DDG (Hort.).
Seed availability of Kufri Megha Potato	Central Potato Research Station at Shillong may take up the issue of generating sufficient quantities of Kufri Megha Potato seeds required for the region.	DDG (Hort.); Head CPRI Research Station, Shillong

Issues	Recommendation	Action
	Animal Science	
NER preparedness to track Trans-boundary pests and diseases in crops/ animals.	The possibilities of establishing a cell be explored with post-quarantine facilities in one of the regional universities or research institutes, to monitor trans-boundary crop and animal diseases, considering exposed border of NE region to many other countries.	DDG (AS)
Availability of swine fever vaccine	In order to address the issue of non-availability of swine fever vaccine, ICAR together with DAHD&F, shall make necessary attempt to establish one swine fever vaccine production centre at AAU, Khanapara. Meanwhile, NRC-Pig, Guwahati shall make arrangements to store the swine fever vaccine after collecting from IVRI to meet the large scale demand and for timely availability. The need for FMD vaccine in Arunanchal Pradesh was also projected. It was mentioned that respective State Govt. should submit their demand to IVRI, immediately.	VC AAU, Jorhat; DDG (AS); DDG (NRM); Director NRC (Pig); Director IVRI
Expansion of R&D facilities for Pig, Mithun and QPM	Establishment of AICRP units on Pig, in Manipur and Arunachal Pradesh may also be explored in XII Plan by ICAR. Similarly NRC Mithun may be expanded during XII plan. The cultivation of QPM Maize in NEH region be promoted to enhance availability of nutritional feed to Pigs.	Director NRG Pig; Director NRC Mithun; DDG (CS); Director DMR, New Delhi
Production of quality semen	For production of quality semen, facilities at AAU should be strengthened by State Govt./ ICAR. Import of superior bulls may be undertaken.	DDG (AS)
Opening of a research centre on Duck	Opening of a research centre on Duck in the region be considered during XII plan under CARI, Izatnagar. Three major missions on Pig (NE region), Duck (Eastern region) and Goats (in central region) should be given emphasis during XII plan.	Director CARI; DDG (AS); Director NRC (Pig); Director CIRG

Issues	Recommendation	Action
	Fisheries	
Research on indigenous small and endangered fish species	Fisheries Division of ICAR Research Complex, at Umiam, Meghalaya be strengthened further to take up research on indigenous small and endangered fish species, fish processing and packaging studies	Director ICAR Research Complex for NEH, Umiam/ DDG (Fy.).
Research on paddy-cum-fish culture	Research on paddy-cum-fish culture may be taken up by CIFRI/CIFA centers located in the region and field demonstrations be also undertaken. These institutes along with DCFR Bhimtal may take necessary measures to address various issues related to Fisheries in NE region.	Director CIFRI/ CIFA / DCFR / DDG (Fy.)
	Agricultural Education	
Skill development among students	Some final year students of the universities be also exposed to leading institutions abroad and budget provision for this purpose be made during XII plan. The HRD programme during XII plan be strengthened.	DDG (Edn.)
Establishment of veterinary college at Nagaland	One Veterinary college at Nagaland may be established by ICAR as soon as the necessary formalities are completed.	DDG (Edn.)
Improving scientific manpower in the North-East	The scientific man power in NE region be filled on priority basis by the universities and ICAR. The SMS from animal science sector should be increased in view of the known potential of livestock sector in NE region.	VC AAU, Jorhat; VC CAU, Imphal; Dean Medziphema; DDG (AS); DDG (AE)
University status to ICAR Research Complex, Umiam, Meghalaya	On the issue of establishing Central University in NE region, it was felt to have various options including deemed to be university/ university status to ICAR Research Complex located at Umiam, Meghalaya. A policy decision involving all state Governments be taken in this regard. The Meghalaya Govt. shall take necessary action for providing land for expansion of P. G. College, as requested earlier.	VC CAU, Imphal; Govt. Of Meghalaya; Director ICAR Research Complex for NEH, Umiam; DDG (Edn.)

Issues	Recommendation	Action
Strengthening infrastructure of CAU	The hostel facilities at CAU be enhanced to accommodate more number of students, in view of growing demand. The CAU may also have its central instrumentation facility .	VC CAU, Imphal/ DARE
	Agricultural Engineering	
Building competitiveness in Agro-Food Processing and value addition	In view of the opening up of East-West corridor through NE Region, a need to build competitiveness in Agro-Food Processing and value addition was felt and accordingly, strengthening of this sector in existing universities and ICAR Institutes was needed.	Director CIPHET; DDG (Engg.); VC AAU, Jorhat; VC CAU, Imphal
Popularization of farm tools	Extensive utilization and popularization of farm tools and implements should be initiated among the farmers in various states of the North East region. Storage facilities also need adequate attention	Director ICAR Research Complex for NEH, Umiam; DDG (Engg.)
	Agricultural Extension	
Agro-entrepreneur-ship and Agri-incubators	Concept of Agri-incubators be gradually introduced by the universities and ICAR Research Institutes in the region. The agro-entrepreneurship be encouraged in the Research institutes and universities of the region.	ADG (IP& TM); VC AAU, Jorhat; VC CAU, Imphal; Director ICAR Research Complex for NEH, Umiam.
Operational-izing KIRAN	The programme KIRAN (Knowledge Innovation Repository in Agriculture for Northeast) an exclusive hub for knowledge transformation and dissemination to various stakeholders related to agriculture and allied sectors programme launched during the RCM be nurtured and supported by all concerned.	Director ICAR Research Complex for NEH, Umiam.
ZPD relocation	ZPD office should preferably have a station at CIFRI, premises Guwahati for easy access and co-ordination.	Director CIFRI; ZPD Zone III; DDG (Fy.)

Issues	Recommendation	Action
	Policy	
Trans boundary adaptation and application of agricultural research	Agriculture is not boundary specific but climate specific. Therefore, institutes/ centers located at similar altitude need to find out appropriate technologies instead of establishing new research centers in each state.	Director ICAR Research Complex for NEH, Umiam; VC AAU, Jorhat; CAU, Imphal.
Requirement of Joint Director at the head quarters of ICAR RC,Umiam	In view of the need to have Jt. Director at ICAR Research Complex, Umiam, Meghalaya, the placement of the Jt. Directors in Centers be reviewed and a policy decision taken. The centres where the number of scientist is inadequate, the need for having Jt. Director be reviewed. The extent of original and adaptive research which needs to be carried out by ICAR research Complex and its Centres in NEH region be defined.	Director ICAR Research Complex for NEH, Umiam/ Director (P)
Periodic review of the implementation of the RCM recommendations	VCs and ICAR Institutes Directors/Regional Heads are required to undertake six monthly reviews to assess implementation process of the decisions taken in the regional committee and feedback given in this meeting. The above committee shall also deliberate on complimentary agriculture, speciality agriculture and Secondary agriculture for the region. The Director ICAR Complex for NEH region at Umiam shall take necessary actions, accordingly. The scientists should also visit various sub-centres and build up net work to address regional problems. Location specific and viable research options should be exercised after mutual discussion.	Director ICAR Research Complex for NEH, Umiam/ VC AAU, Jorhat/ VC CAU, Imphal/All Regional Heads/ DDG (Edn.)/ DDG (NRM)

5. Minutes of KVK Interface Meeting

Proceedings of KVK Interface Meeting held at ICAR Research Complex for NEH Region, Umiam, Meghalaya from May 5-7, 2011

During the 20th ICAR Regional Committee Meeting of Region III, the Regional KVK Interface Meeting was held on 5-7 May 2011 at ICAR Research Complex for NEH Region, Umiam, Meghalaya under the chairmanship of Dr. S. Ayyappan, Secretary DARE and Director General, ICAR, New Delhi. The meeting was attended by all the Deputy Director Generals of ICAR, New Delhi, Shri. S. Bharghava, Member of ICAR Governing Body, Vice-Chancellors from Central Agricultural University and Assam Agricultural University, Assistant Directors General, Director DKMA, Directors and Project Coordinator from ICAR Institutes, Deans and Directors of Research and Extension from State/Central Agricultural Universities, Programme Coordinators of KVKs under region III and special invitees of Regional Committee. (List of participants attached in Annexure –II)

Dr. K.D. Kokate, DDG (Agril.Extn.), ICAR, New Delhi, welcomed the dignitaries and participants of the meeting. In his welcome address DDG (Agril.Extn) briefed about various activities performed and salient achievements made by KVKs in the region and indicated the linkages developed between commodity-based ICAR institutes and KVKs. He indicated that joint DAC and DARE policy document on Convergence between Agricultural Research and Extension need to be referred by all KVKs to further strengthening of convergence. Further, he also informed the house that keeping in view of the challenges related to climate change, 100 KVKs in the country have been identified on pilot basis under National Initiatives on Climate Resilient Agriculture (NICRA) project for addressing the needs of the farmers. Also, he emphasized that KVK resources and infrastructure have to be fully utilized for welfare of farming community. He asked the Programme Coordinators as well as host institutes of KVKs for ensuring maintenance of proper land records, data base related to district, state and on KVK activities. He further expressed the need for filling up of all the vacant post of the KVKs within three months. He conveyed his appreciations for their contribution in implementing the Pulses demonstration and Kisan Mobile Advisory programs in the region.

Dr. S. Ayyappan, Secretary DARE and DG ICAR in his opening remark stated that main motto behind conducting KVK interface during Regional Committee Meeting is for building confidence and learning by sharing experiences by Programme Coordinators. He thanked all the Programme Coordinators and Zonal Project Director for identification of district level farm innovators in the region and for their successful participation in the *Farm*

Innovators meet- 2010 at Mysore, which was appreciated by the Hon'ble Prime Minister. The DG, ICAR expressed that the ZPD has to examine the feasibility of starting an all 'Women KVK' in the region and also urged various host institutes in the zone to explore the possibility. He suggested the eligible KVKs in the region to submit their application for KVK Award (Zonal) within 15 days for which the Zonal Project Director has to take the initiative.

He further desired to see the KVKs to function effectively as knowledge management centre having convergence and partnership with different stakeholders of agricultural development in the region. He opined that effective monitoring and evaluation of the KVKs are to be done by ZPD so as to ensure that KVKs are working on the mandated activities. KVKs need to develop various extension models suitable to their districts and function as Agricultural Intelligence Centre.

While presenting the achievements of the Zone-III, Dr A.K.Gogoi, Zonal Project Director said that emphasis was given to enhance productivity of rice, Quality Protein Maize, promotion of pulses and oilseeds, fishery, SRI, backyard poultry, bee-keeping and mushroom cultivation. In view of climate change, initiative has been taken up for climate change adaptation/mitigation strategies through 17 selected KVKs in the region. Kisan

Dr S. Ayappan, Secretary, DARE & DG, ICAR, responding to the querries in the KVK interface meeting

Dr. K.D. Kokate, DDG (Agril.Extension) addressing the gathering

Mobile Advisory (KMA) is being implemented by the KVKs for timely dissemination of information to the farmers. He suggested that e- connectivity, Soil Water Testing Labs, Rain Water Harvesting Structures are to be provided to all the KVKs under the zone during the XIIth plan. Also he raised the issue of filling-up of the vacant posts of the KVKs by the host institutes.

The Programme Coordinators of various KVKs expressed their views on the various issues related to KVKs as given below:

1. There is a need for KVK foundation course for PCs as well as for SMSs.
2. Regular refresher training and in-service training course for SMSs of KVKs.
3. PC, KVK Cachar, Assam requested for one additional technical staff for assisting in soil testing.
4. Director of Agriculture, Tripura informed that they are in the process of recruiting the staff for the KVKs Dhalai and North Tripura.

This was followed by views from various dignitaries from National Agricultural Research System present during the interface meeting and the details are placed below.

Dr. K. M. Bujarbaruah, Vice Chancellor, AAU, Jorhat expressed that all the KVKs under AAU were involved in technology showcasing program, and as a result there is increase

in production of rice in the state of Assam. He requested the ICAR for administrative approval of three KVKs viz., Dhubri, Darang and Morigaon for the new sites. Also, he expressed his views that acid soil management using micro- organism is important in the region and AAU can provide the technology to farmers within a year.

Dr. S. N. Puri, Vice Chancellor, CAU, Imphal opined that timely reach of recently developed technologies to farmers are to be strengthened through better extension linkages, trainings, FLDs and orientation programmes through the College of Horticulture, Pasighat, and College of Veterinary Sciences, Aizawl.

Mr. Sudhir Bhargava, Member, ICAR Governing Body suggested that the KVKs have to provide a well demarcated picture of district map with the area covered under FLDs and other KVK activities so that third party monitoring can be done for the impact assessment. He also requested the ICAR for training of KVK personnel either at CAU, SAUs or ICAR institutes for scaling up of the latest technology available.

Dr. H.P Singh, DDG (Horticulture) indicated that KVKs may prepare the database of changing cropping patterns in the respective districts that can be analyzed for planning research and extension programs. He also expressed that KVKs need to have 'targeted plan' for different crops including horticulture. KVKs under Horticulture Technology Mission can strengthen the linkage with the host institutes for enhancing productivity in horticulture and each KVK can focus on any specific horticultural crop depending on the priority of the concerned district. KVKs can play an important role in germplasm preservation and IPR issues.

Dr. M.M Pandey, DDG (Agril. Engineering) informed that 50 KVKs has been identified on pilot basis for demonstration of product processing, value addition and fabrication of the equipments. He highlighted the need of custom hiring and entrepreneurship training so as to promote farm mechanization. Users of farm machinery along with SMSs of KVKs may attend safety training at CIAE, Bhopal. He stressed importance on primary processing by having information on the surplus produce and the price in the district.

Dr. K.D. Kokate, DDG (Agril.Extn.) suggested for orientation of newly recruited SMSs of KVKs. He emphasized that KVKs have to send Kisan Mobile Advisory regularly to the farming community as well as conduct the impact assessment of different interventions made in the district during the last ten years. Further he added that KVKs have to promote entrepreneurship, farm mechanization, ground water recharge, rain water harvesting and diversification towards horticulture crops.

Dr. A.K Singh, DDG (NRM) indicated that the KVKs need to prepare the district-wise contingency plan for agriculture and allied activities to face climate change in agriculture. He also suggested the recommendation of crop management practices based on testing of technologies in extreme climatic conditions. Resource conservation technologies have to be given priority and conservation of locally available germplasm of major crops need to be done by KVKs.

Dr. (Mrs.) B. Meenakumari, DDG (Fisheries) stressed on Integrated Fish Farming that could increase the socio-economic status of the farmers of the region and suggested the KVKs of the region to promote fisheries by organizing need-based training to fish farmers as North Eastern region is having enough potential for fish farming.

Dr. T. P. Rajendran, ADG (Plant Protection) advised the KVKs to make use of maximum resources available for exploration of agricultural technologies. E.g. *Trigona carbonaria* (Stingless bee) for honey production in North East region. He added that in case of any outbreak of pest or diseases in the district, KVKs should send SMS alerts to the farmers and ZPDs.

Dr. V. Venkatsubramanian, ADG (Agril.Extn.) suggested the KVKs to analyze the output, outcome and impact for their activities. He emphasized to concentrate on mandated activities and thrust areas of the district. KVKs are provided with e-connectivity facilities to develop both static and dynamic content according to the need of the farmers.

Dr. Bangali Babu, Director, NAIP highlighted that KVKs to have documentation of resource profile of the district and their utilization for overall productivity in the district. He also emphasized that KVKs to have contingent measures in case of outbreak of diseases, pests in agriculture and allied sectors.

Dr. S.V. Ngachan, Director, ICAR RC for NEH Region briefed about the achievements of KVKs under the institute at different districts of the region in terms of increase in production and productivity of major crops like rice, maize, sesamum and groundnut including poultry and livestock. He also emphasized on the infrastructure development for better performance by the KVKs in the region.

Dr. K. C. Bansal, Director, NBPGR, New Delhi made a presentation on the role of KVKs in germplasm collection in the North East region.

The following are the recommendations and action points emerged during the interface meeting:

1. Foundation course need to be organized in NAARM for newly joined Programme Coordinators and Subject Matter Specialists to provide orientation about mandates and activities of KVKs. **(Agricultural Extension Division,ZPD-III and Host Institutes, NAARM).**
2. Filling up of vacant positions in all the KVKs. The State Government of Meghalaya and Tripura have to fill up all the posts within 3 months. **(VCs of CAU/AAU, Directors of ICAR Complex Barapani, Director Agriculture/Veterinary, Government of Meghalaya/ Tripura/ Arunachal/ Nagaland/ Manipur).**
3. Construction of approved infrastructures of KVKs have to be completed during 11th Five year plan. **(VCs of CAU/AAU, Directors of ICAR Complex Barapani, Director Agri/Veterinary, Government of Meghalaya/ Tripura/ Arunachal/ Nagaland/ Manipur and ZPD).**
4. Director of ICAR Institute, Zonal Project Director, Directors of Extension Education of SAU and CAU have to visit KVKs frequently for proper monitoring

and feedback collection. **(DEEs of AAU and CAU/ZPD/Director, ICAR and ICAR Research Institutes in the region).**

5. Feed back about technologies generated by ICAR institutes, SAUs and other Research Institutes should be provided for modification/ refinement required in the technologies. **(DEEs of AAU and CAU /ZPD/Director, ICAR and ICAR Research Institutes in the region).**
6. Technological backstopping is to provided to NGOs, KVKs by ICAR institute and Director of Extension Education of CAU/ AAU**(Director, ICAR/ DEEs and ZPD).**
7. KVKs have to consult nearby institute, SAU/CAU/ICAR organizations for technology backstopping. **(PCs of all KVKs).**
8. Administrative approval for changing site for 3 KVKs of Assam i.e. Dhubri, Darrang, Morigaon has to be approved from Site Selection Committee. **(VC, AAU, DEE and ZPD).**
9. Staff of KVK Wokha should shift to KVK Site (Lonsachung) within a month i.e. June 2011 *(***KVK Wokha, Director, ICAR Research Institute and ZPD**)
10. SAC meeting has be conducted regularly in addition to interface meeting with SAU/CAU/ICAR and other agriculture and allied organizations. **(ZPD and PCs of all KVKs).**
11. Studies on impact assessment of KVK activities during last 10 years should be conducted. **(KVKs/ZPD).**
12. KVKs may take-up programmes on Acid soil Management, Resource conservation Technology and Agri-Intelligence. **(PCs of all KVKs).**
13. Due importance has to be given on livestock, fodder production and fisheries while assessing and demonstrating technologies. **(PCs of all KVKs and ZPD)**.
14. The host institutes have to ensure the placement of SMS in Animal Science and need to release funds in time. **(All the Host Institutes in the Zone/ZPD).**
15. Exploring the possibility for establishment of Women KVK in the region. **(ZPD).**
16. Submission of application for the Best KVK Award (Zonal Level) within 15 days. **(ZPD, PCs of all KVKs).**
17. Ensuring for proper maintenance of land records of KVKs.**(PCs of all KVKs/ host institutes/ZPD).**
18. Establishment of Crop cafeteria and Technology Park for bringing more visibility of technologies. **(PCs of all KVKs/DEEs and ZPD).**

The meeting concluded with the vote of thanks to the Chair, all the dignitaries from the Council, Agricultural Universities/ICAR institutes of the region, State Govt. officials and other participants from Zone-III.

6. PRODUCTION AND REQUIREMENT OF FOOD GRAINS AND OTHER COMMODITIES

The Region III of ICAR is rich in agri-biodiversity that feeds to almost 100 tribes and more than 250 sub tribes in the northeast region of the country. However, major staple food is rice, pulses, fishes and meat that is being harnessed by the indigenous people of the region through natural resources management. However, research and education in agriculture sector has started only 4 decades ago and since then several innovations and interventions have been popularised that has helped the farmers to manifold their production and productivity. However, with growing population and development scenario, the pressure on agricultural land is more and therefore causing challenges to food security in the NE region. The trends in production, productivity and requirements based on the current population status given in Table 1.

The decadal increase in rice production has been recorded for Arunachal Pradesh, Meghalaya, Nagaland and Tripura. Other states have shown a decline in production such as by 5-6% in Assam and Manipur and a maximum of 63% in Mizoram. However, production of total food grains (cereals+pulses) also showed a decrease by about 59% in Mizoram as opposed to other north-eastern states. Pulse production showed a considerable increase by about 7-40% across in the north-eastern states except Mizoram. However, there is a steady growth of increased fish production in all the north-eastern states that varied in between 17-24%. From meat production view point, all the states except Manipur have shown considerable increase in the last decade.

Despite decadal increase in production, almost all the food commodities have registered deficit in all the states thus posing a challenge to sustainable food security in the region.

Table 1. Production, Productivity and Requirement Statistics of Component States of Region III

States/ Human Population	Commodity	Production (Triennial period from 2001 to 2003) in '000 tons	Production (Triennial period from 2008 to 2010) in '000 tons	% increase in production during 2001-2010	Requirement in '000 tons as per 2011 population	Deficit/ Surplus in '000 tons	Deficit/ Surplus in %
Arunachal Pradesh	Rice	134.0	170.7	27.3	217.1	-46.4	-21.4
1382611	Total Cereals	227.2	242.8	6.9	218.5	24.4	11.2
	Pulses	7.4	10.4	41.0	25.2	-14.8	-58.7
	Total Foodgrains	234.7	250.4	7.1	268.1	-17.7	-6.6
	Fish*	2.4	2.9	20.0	18.0	-15.1	-83.9
	Milk	49.0	25.0	-49.0	100.9	-76.0	-75.2
	Eggs	86.0	361.0	319.8	2073.9	-1712.9	-82.6
	Meat**	9.2	21.0	129.0	15.2	5.8	38.1
Assam	Rice	3905.0	3640.3	-6.8	4893.6	-1253.2	-25.6
31169272	Total Cereals	3921.0	3721.4	-5.1	4924.8	-1203.4	-24.4
	Pulses	63.2	67.8	7.3	568.8	-501.0	-88.1
	Total Foodgrains	3984.0	3714.2	-3.3	6043.1	-2328.9	-38.5
	Fish	159.8	199.4	24.8	405.1	-205.8	-50.8
	Milk	751.0	840.0	11.9	2275.4	-1435.4	-98.4
	Eggs	5067.0	4659.0	-8.1	46753.9	-42094.9	-90.0
	Meat	22.4	31.0	38.6	342.9	-311.9	-91.0
Manipur	Rice	378.0	356.1	-5.8	427.3	-71.2	-16.7
2721756	Total Cereals	375.7	390.1	3.8	430.1	-39.9	-9.3
	Pulses	3.0	6.0	102.5	49.7	-43.7	-87.9
	Total Foodgrains	378.7	401.3	8.0	527.7	-126.4	-23.9
	Fish	15.5	18.8	21.2	35.4	-16.6	-46.9
	Milk	77.0	87.0	13.0	198.7	-111.7	-83.1
	Eggs	902.0	995.0	10.3	4446.0	-3451.0	-77.6
	Meat	22.0	22.0	0.0	30.0	-7.9	-26.5
Meghalaya	Rice	184.0	201.8	9.6	465.3	-263.6	-56.6
2964007	Total Cereals	225.2	230.2	2.3	468.3	-238.1	-50.8
	Pulses	3.4	3.7	7.8	54.1	-50.4	-93.1
	Total Foodgrains	228.5	233.7	2.3	574.7	-341.0	-59.3
	Fish	4.7	5.5	17.5	38.5	-33.0	-85.7
	Milk	75.0	78.0	4.0	216.4	-138.4	-94.7
	Eggs	902.0	995.0	10.3	4446.0	-3451.0	-77.6
	Meat	35.6	37.0	3.8	32.6	4.4	13.5

contd....

Mizoram	Rice	99.3	36.0	-63.7	171.3	-135.2	-79.0
1091014	Total Cereals	127.1	49.6	-60.9	172.4	-122.7	-71.2
	Pulses	4.5	3.1	-30.7	19.9	-16.8	-84.5
	Total Foodgrains	131.6	65.2	-59.9	211.5	-146.4	-69.2
	Fish	2.9	3.8	30.1	14.2	-10.4	-73.5
	Milk	16.0	13.0	-18.8	79.6	-66.6	-217.2
	Eggs	289.0	411.0	42.2	1636.5	-1225.5	-74.9
	Meat	8.7	13.0	49.6	12.0	1.0	8.3
Nagaland	Rice	199.9	326.9	63.5	310.9	16.0	5.1
1980602	Total Cereals	354.0	460.2	30.0	312.9	147.3	47.0
	Pulses	30.4	41.1	35.3	36.1	5.0	13.8
	Total Foodgrains	384.4	491.5	31.1	384.0	107.5	28.0
	Fish	5.0	6.2	23.6	25.7	-19.6	-76.0
	Milk	67.0	55.0	-17.9	144.6	-89.6	-126.7
	Eggs	540.0	832.0	54.1	2970.9	-2138.9	-72.0
	Meat	26.2	63.0	140.6	21.8	41.2	189.2
Sikkim	Rice	22.4	22.0	-1.6	95.4	-73.4	-76.9
607688	Total Cereals	92.1	99.8	8.4	96.0	3.8	3.9
	Pulses	6.3	9.6	51.8	11.1	-1.5	-13.3
	Total Foodgrains	98.4	105.6	11.2	117.8	-12.2	-10.3
	Fish	0.1	0.2	21.4	7.9	-7.7	-97.8
	Milk	49.0	49.0	0.0	44.4	4.6	-100.0
	Eggs	97.0	143.0	47.4	911.5	-768.5	-84.3
	Meat	4.0	19.0	375	40.4	-21.4	-52.9
Tripura	Rice	535.5	630.9	17.8	576.4	54.5	9.4
3671032	Total Cereals	574.1	634.4	10.5	580.0	54.3	9.4
	Pulses	5.4	5.4	-0.2	67.0	-61.6	-92.0
	Total Foodgrains	579.5	637.6	10.2	711.7	-74.2	-10.4
	Fish	29.3	36.0	22.7	47.7	-11.7	-24.6
	Milk	89.0	97.0	9.0	268.0	-177.0	-89.9
	Eggs	607.0	1388.0	128.7	5506.5	-4118.6	-74.9
	Meat	128.0	206.0	60.9	501.5	-295.5	-58.9
Total NE	Rice	5396.2	5384.7	-0.2	7157.3	-1772.6	-24.8
45587982	Total Cereals	5896.1	5828.6	-1.1	7202.9	-1374.3	-19.1
	Pulses	123.7	147.2	19.1	832.0	-684.8	-82.3
	Total Foodgrains	6019.8	5899.4	0.5	8838.6	-2939.2	-33.2
	Fish	219.7	272.7	24.1	592.6	-320.0	-54.0
	Milk	1173.0	1244.0	6.1	3327.9	-2083.9	-99.5
	Eggs	8305.0	9894.0	19.1	68382.0	-58488.0	-85.5
	Meat	128.0	206.0	60.9	501.5	-295.5	-58.9

* Total Fish production is of 1999-2000, 2008-09 and percentage increase in fish production during 1999 – 2009, respectively in different colomn; fish requirement has been worked out @13 kg/ person/ year.

** Meet required has been worked out @ 11kg/person /year.

7. Status of Agricultural Research, Education and Extension

A. Assam Agricultural University, Jorhat, Assam

Assam Agricultural University, Jorhat, established in 1969, has grown to a premier institute in Northeast India over the years with significant contribution to its mandated activities like imparting education, prosecution of research and undertaking extension in agriculture and allied sciences like animal husbandry, fishery and home science. It has four faculties with 5 constituent colleges i.e. two in Agriculture and one each in Veterinary, Fishery and Home Science for imparting education; 6 Regional Agricultural Research Stations and 4 commodity research stations for conducting location specific research and 19 Krishi Vigyan Kendras (KVK), 1 Farm Women Training Centre and 1 Extension Education Institute (EEI) to undertake extension activities of the university**.** The University has been granted accreditation by the ICAR for five years during the year. A brief information on some salient activities of the University under its mandates during 2009-10 is given below.

1. Education

1.1 Student's Admission & Output: The University offers courses for Bachelor Degree, Master Degree and Ph.D Degree in the fields of Agriculture, Veterinary and Home Science education but in Fishery Science, it offers courses only for Bachelor Degree. During 2009-10, 488 students were newly admitted in the University of which 333 in Bachelor's, 146 in Master's and 9 in Ph. D Degee level. During the year, 330 students obtained degrees of which 256 Bachelors Degree, 65 Masters Degree and 9 Ph.D. degree. The faculty-wise students enrollment (fresh) & output under different degree programme is shown Table below

Table : Students enrolled and passed out in different degree programmes of the faculties of the university during 2009-10

Faculty	Bachelor's Degree		Masters' Degree		Ph.D Degree		Total	
	Enrolled	Passed out	Enrolled	Passed out	Enrolled	Passed out	Enrolled	Passed out
Agriculture	**180**	**123**	84	41	4	4	268	168
Veterinary	93	93	51	17	4	5	148	115
Home Science	40	23	11	7	1	-	52	30
Fishery	20	17	**-**	**-**	**-**	**-**	20	17
Total	333	256	146	65	9	9	488	330

1.2 Revision of Course Curriculum: The new course curriculum as per 4th Deans' Committee of ICAR has been introduced in all the Faculties of the University except Faculty of Veterinary Science where courses as per Veterinary Council of India are being carried out.

1.3 Human Resource Development: Altogether 166 faculty staff of the university were sent for attending training, workshop, conference, seminar and summer and winter school organized both inside and outside the country during 2009 -10. Of these 93 faculties were from Faculty of Agriculture, 49 from Faculty of Veterinary Science, 20 from Faculty of Home Science and 4 from Faculty of Fisheries. Some of the teachers also attended more than one seminar/ training during the year. Besides, during this period, few teachers/ scientists were deputed for higher studies leading to Ph.D degree.

1.4 Publication: The faculty staff had published 177 full length research papers in regional, national and international journals, 136 popular articles in addition to a sizeable number of abstracts, book chapters, review papers, bulletins, practical manuals etc. Faculty of agriculture had the highest contribution followed by Veterinary, Fishery and Home science.

1.5 Seminars/ Symposium/Workshops/ Training organized: During the year, different faculties organized 119 Seminars/ Symposium/Workshops/ Training of which Faculty of Agriculture organized 70, Home Science 23, Veterinary 21 and Fishery 5.

1.6 Achievement under ICAR Development Grant: The university received a substantial amount of grant from the ICAR under "Strengthening and Development of Agricultural Education in SAUs" in different heads during 2009-10.The fund was mostly utilized for creation of infrastructure facilities and development of undergraduate and post graduate education. Some of the development works undertaken & completed are given below.

- Construction of girls hostel at College of Agriculture.
- Construction of examination hall.
- Repair, refurnishing/renovation, modernization of educational structure/ infrastructure and other works related to teaching and learning including model class rooms and PG lab.
- Purchase of equipments, computers, implements for education.
- Repair and maintenance of equipments.
- Preparation of quality instructional material, practical manuals and resourses, contingency grants for practical for UG/PG/ERNET.
- Faculty Development- participation in symposia, seminars and training.
- Students study/educational tour.
- Students' amenities, students counseling and placement, health facilities, faculty amenities.

1.7 Experiential Learning: ICAR has sanctioned and released fund to the university during 2007 & 2008 for execution of the scheme of experimental learning. Facilities for

hands on training on 8 specific areas covering all the faculties have been set up. The facilities are already created in all the faculties and they are ready for use by the students as part of their UG course curriculum.

1.8 Niche Area of Excellence: Production Potential of Biofertilizer Enriched Organics for Sustainable Agriculture: The niche area of excellence on 'Biofertilizer enriched organics for sustainable agriculture" was implemented in the Department of Soil Science, Assam Agricultural University, Jorhat to achieve educational excellence in teaching, research, consultancy and other services in the area. Infrastructure facilities like renovation of laboratories, glass house, net house and seminar cum training hall have been developed besides construction of 33 nos of Azolla tanks, 90 nos of compost pits, 10 vermicompost tanks and 10 nos of BGA tanks till to date. In the academic achievement, 11 numbers of M.Sc. (Agri) and one Ph.D. students are at present working in various aspects of research under Niche area of Excellence. An optional course on "Production of Biofertilizer" was introduced in under graduate programme to develop skill for self employment. Research works have been initiated to screen and evaluate efficient soil microbes for enriching organics, development of hybrid azolla; results are encouraging. Production of Biofertilizer enriched organics and Azolla compost are continuing with a total production capacity of 75 t compost and 1 tonne of biofertilizer per annum

2 Research

The research activities in the university are carried out mainly through 6 Regional Agricultural Research Stations, four commodity research stations, All India Coordinated research projects and Adhoc and Net work projects funded by different external agencies besides PG research done in different faculties. There are 43 AICRP and 60 ongoing ad-hoc research projects in Agriculture Science as against 8 AICRP and 14 other research projects including NAIP in Veterinary Science. Some of the salient findings of research in both fields of science during the period under report (2009-10) are given below.

2.1 Agriculture Research (including home science & fisheries)

- Rice varieties for shallow water (Kmj 14s-1-2-17), semi deep water (IET 18193 & IET 19189), aromatic short grain (IET 18673) and hybrid type (PA 6444, NK 5251, DRRH 2 & CRHR 5) have been found satisfactory and are on the verge of recommendation for use of farmers.
- Screening of rice genotypes for acid soils and related nutritional constraints, the variety IET 20556 was found to be the most promising in terms of higher productivity, nutrient uptake, tolerance to iron toxicity and response to lime management followed by genotypes MTU 1010 and IET 20997.
- Neem based products viz., Neem Azal @ 2.5ml/kg protected the stored grain from infestation up to three months of storing. Neem oil @ 5ml/kg and econeem plus @ 2.5ml/kg recorded 1.33 per cent infestation of 7.67 per cent by the weevil and the germination percentage is also below the IMSCS. As a whole the neem product at lower doses provided good protection up to three months.

- Emamectin benzoate @ 2mg a.i. /kg seed and Spinosad @2mg a.i./kg seed as seed protectants provided effective management of storage insects infesting paddy and green gram seed without impairing seed viability up to 9 months.
- Seed treatment with Neemazal TS (10000 ppm @ 1.5 ml/kg of seed and Econeem (3000 ppm) @5 ml/kg seed were found to be successful in management of storage insects infesting maize seed up to 6 months.
- Suitability of super grain bags for commercial seed storage has been identified. Grain super bags and HDPE interwoven unlaminated bags were recommended for commercial storage of moongbean, paddy and hybrid maize for one planting season.
- Performance of two pulse varieties, one each from green gram and black gram under moisture stress condition have been found satisfactory. Thus, the green gram var. SGC-16 and black gram variety SBC-40 for summer season have been proposed for recommendation in lower Brahmaputra valley zone of Assam.
- A combination of 10 kg seed rate of yellow sarson (Var. Binoy) with 125 % recommended fertilizer dose (75:37.5:37.5 kg $N:P_2O_5:K_2O$ kg/ha) as basal application and also broadcasting of seed within mid Oct. to end of Nov is recommended for central Brahmaputra valley zone of Assam.
- Preparation of Plant Variety Protection DUS Testing through ICAR-SAUs system is in process. Forty five reference collections of rice varieties received from DRR, Hyderabad were evaluated in two replications. So far observation on 57 characters was recorded as per DUS guidelines.
- The organic nutrient package comprising Green manure @ 40 kg/ha + FYM @ 2t/ha + Paddy straw @ 10 q/ha (ashing) + Biofertilizer Azospirillum @ 3.5 kg/ha + Biofertilizer PSB @ 3.5 kg/ha + Rock phosphate @ 100 kg/ha has been developed for recommendation for lowland kharif rice(*sali*) in the hill zone of Assam.
- Studies on tree-crop interaction in Agri-Silvi cultural system integrating *Acacia mangium* with oil seed crops under rainfed condition revealed that the growth of *Acacia mangiun* in terms of height and dbh recorded a maximum plant height (11.89 m) and dbh (19.85 cm) in spacing 5 m X 5 m. A gradual increase in organic C, available N and available P_2O_5 was observed in all the tree crop combinations.
- In Brut Jalakia (*Capsicum chinense*), use of planting geometry of 75cm × 60cm in the month of September was found to produce the highest total fruit yield per unit area.
- Among seventy varieties (Source- DRR, Hyderabad) screened for resistance against *Hirschmanniella oryzae,* Nineteen varieties were found moderately resistant and the rest were found susceptible.
- Soil application of carbofuran 3G @ 1 kg a.i./ha at 10 DAS was found to be the best in increasing the plant growth parameters (plant height at max tillering and at harvest: 48.9 cm and 79.5 cm, respectively) and yield of rice (15.34 q/ha) and reducing nematode population (soil population at harvest 151/200 c.c.)

- The performance of the improved spreading tool 'Lakhimi' for sundrying of paddy grains scored highest i.e., 5 in terms of human power used. Weeding done with improved khurpi was more (25 sqm/hr) than traditional khurpi (15 sqm/hr). Labour employed was reduced to 40% and overall economic benefit was Rs 910 in terms of labour wages. Intervention of improved technologies reduced the drudgery experiences of sowing, weeding, harvesting and threshing.
- Performance evaluation of conventional tool (Dhenki) showed that farm women takes approximately 25 hrs to pound one quintal of rice (4kg/hr). The physiological workload of farm women in terms of working heart rate and energy expenditure were 118.8 beats/min and 10.04 $Kjmin^{-1}$ which can be considered as moderately heavy work.
- Assessment of resource management practices among farm women revealed that rural women were not aware of fuel efficient devices, water management technologies, alternative energy devices, time and labor saving devices. After intervention, the knowledge level regarding these aspects was considerably enhanced.
- For diversification of rice-based cropping system under rainfed condition, out of four cropping sequences, *winter rice-Chili* followed by Winter rice-Rajmah produced better economic return in comparison to Winter rice-Potato and Winter rice-Capsicum.
- For utilization of homestead ponds for culture of small fish species, availability of the three species in 123 natural water bodies of Assam showed a drastic decline in the population of these species in *beels* where management operations are frequently practiced. Out of these species, availability was recorded to be highest in case of Singora followed by Kanduli and Mowa.
- Under seed production of cat fish (Magur), 8500 hatchlings were produced from 25 breeding operations during May-Aug. Hatching percentage was in the range of 40 to 90% and incubation period was found to be 20-40 hrs depending on the environmental temperature.
- During 2009-10, a proposal for establishment of model integrated farm in KVK and infrastructure development in seed farms of AAU under RKVY was submitted and accordingly an amount of Rs. 500 lakhs was sanctioned & received for the said purpose . Three KVKs and three farms located at different districts of the state were taken up for development of model integrated farms and infrastructure development of seed farms.

During 2010-2011, the university also received an amount of Rs.1300 lakh for various components of Agriculture, Veterinary and Fisheries, of which Rs. 960 lakh is for Agriculture components. The major components include large scale planting material production, strengthening soil and water testing laboratory, production of organic inputs, rain water harvesting, participatory seed production, macro and micro monitoring of weather and information kiosks and development of e-villages.

2.2 Veterinary research

(a) National Agricultural Innovation Project: Value Chain on Novelty Pork Products under Organized Pig Farming system

- Pig with a floor area of about 27,000 sq.ft and feed mill unit have been constructed.
- A total of 113 Hampshire and Hampshire crossbred gilts are maintained as breeding stock.
- 133 farm born piglets are being reared for slaughter purposes.
- A booklet on Nutritional Profile of Locally Available Feed Ingredients of Assam has been published.
- Technology for production of value added cooked pork sausage with bamboo shot has been standardized and a multimedia presentation prepared.

(b) ICAR National Fellow Project on "Development of ELISA based diagnostics for Classical Swine Fever"

- Classical swine fever (CSF) virus antigen was detected in 18.48% of the tissue samples of slaughtered pigs collected from 11 districts of Assam.
- A repository of more than 50 CSF virus isolates including the cell culture adapted lapinized vaccine virus strain and a virulent virus strain has been maintained.
- Liquid phase blocking ELISA was performed to evaluate the protective/neutralizing antibody in 52 serum samples of pigs vaccinated with CSF virus vaccine (Lapinized) and having 1:64 (Log titre 1.505) titre or more in indirect ELISA. Out of the 52 samples 27 (51.92%) samples showed 1:64.
- Production of monoclonal antibodies against CSF virus antigen was performed and seven hybridoma clones secreting antibodies against CSF virus antigen were obtained.

(c) AICRP on Pig

- A total of 27(14+13) sows of 75% H genetic group were bred and 81 piglets of 75 %H and 78 piglets of 87.50% H were obtained from 22 (11+11) sows.
- AI was done for the first time to produce 87.50 % H piglets.
- The average (2^{nd} crop) litter size at birth, litter weight at birth, litter size at weaning and litter weight at weaning were found to be 7.37 ± 0.51, 6.96 ± 0.85, 6.45 ± 2.01 and 44.33 ± 8.81 kg, respectively in 75 % H genetic group and the corresponding values for 87.50% H genetic group were 7.09 ± 1.23, 6.47 ± 0.94, 4.67 ± 1.40 and 23.17 ± 7.66 kg.
- The average body weight at birth and at 6 weeks (weaning) of ages were found to be 0.94 ± 0.00 kg and 6.92 ± 0.09 kg, respectively in 75% H and 0.91 ± 0.00 kg and 5.11 ± 0.33 kg, respectively in 87.50% H genetic groups of pig.
- A total of 24 sows of 75% H were placed for breeding (June- July'2009) and 71 piglet of 75% H and 48 piglets of 87.50% H genetic groups (total 119) were obtained

- The average (3rd crop) litter size at birth and litter weight at birth were found to be 7.10 ± 0.52 and 7.23 ± 0.50 kg, respectively in 75 % H and the corresponding values for 87.50% H genetic group of pig were 9.60± 0.58 and 9.76 ±.0.40 kg.
- Ten numbers of awareness programme and demonstration conducted.
- Award: ICAR Jawaharlal Nehru award was awarded to Dr. Mohan Narayana Harihara for his PhD thesis entitled "Molecular synthesis of fatty acid and desaturation in Pig". This work was conducted in the AICRP on Pig, AAU, Khanapara.

(d) Mega Seed Project on Pig under AICRP on Pig

- Under Mega Seed project on Pig, 219 piglets were produced of which 50% Hampshire were 156, Ghungroo 31 and T&D 32.

(e) Network Project on Swamp Buffalo

- The present herd strength is 66 heads.
- The total milk produced during 2009-10 was 10,079.65 kg with the average peak yield of 3.73 kg. The individual daily milk yield of the swamp buffalo was 5.75 kg. The herd average is recorded as 1.06 kg and wet average 2.15 kg .
- Milk fat percentage ranged from 4.16 to 13.52 (average 8.52%), SNF % 7.87 to 12.02 (average 9.30 %), total solids average 17.82% and protein 2.75 to 5.31% (average 3.42).
- The female and bull conception rate was 50%.
- There is a stock of 12195 doses of frozen semen straw in the project. The average age at initiating training for semen collection was 24 months and average age at first collection of semen was 34 months.
- Karyotyping of swamp buffalo: 26 blood samples were sent for karyotyping to the NBAGR, and all the samples were reported to exhibit 48 nos. of chromosomes which is characteristic of swamp buffalo.

(f) All India Co-ordinated Research Project on Poultry Breeding

- Preliminary survey work to know about the choice of the farmers for the type of birds (i.e. Meat, egg or dual type) in six districts representing six agro-climatic zones of Assam is completed. In each district hundred farmers were selected. Thus a total of six hundred farmers were considered for the preliminary survey work.
- A total of 190 numbers of indigenous birds (Male-28 & Female-162) in the age group of 3-4 months had been procured on 17.12.09.
- A flock of Vanaraja Parent stock was procured from PDP, Hyderabad and reared to know their performance.
- Eggs collected from indigenous birds were hatched out. A total of 50 (fifty) numbers of indigenous day-old-chicks have been produced so far.

(g) Network Project on Animal Genetic Resources, Core Laboratory, AAU, Khanapara

- DNA isolation work for molecular characterization of Assam hill goats has been completed.
- Characterization and diversity analysis work on local pigs of NER, which included Meghalaya local pigs and Ghungroo has been initiated.

(h) AICRP on Improvement of Feed Resources and Nutrient Utilization in Raising Animal Production

- Supplementation of colacasia with azola and colacasia with earthworm as source of protein improved growth rate but it was lower than soyabean supplemented group .
- The serum progesterone concentration varied from 3.58 - 4.2 ng/ml in supplemented group. In control group progesterone level was 1.89 ng/ml.
- Zinc supplementation study revealed that piglets receiving 500 ppm Zn supplement were heavier (43.38 kg) than 100 ppm zinc supplement. (38.77 kg).
- Dietary zinc bioavailability could be prevented when 1.5% calcium carbonate was fed to growing piglets producing clinical symptoms of parakeratosis.

(i) All India Coordinated Research Project on Post Harvest Technology

- The Khanapara Centre has been adjudged as one of the six best performing centers of the AICRP on PHT during X Plan period.
- As per mandate of the project *i.e.* "Documentation of traditional meat products of the NER" *1. Toongpak Ngam 2. Ñoau-Soum 3.Ñoau-Hang 4. Ashi Kipki* which are traditional meat products of Assam and Arunachal Pradesh were collected and analyzed for physico- chemical and microbiological qualities. A book on "Traditional Meat Products of NE India" has been published.
- Meat biopreservative culture has been isolated and characterized for preservation and improvement in hygienic quality of meat and meat products.

(j) Application of Multihurdle Technology for Value Addition and Preservation of Spent Chicken Meat at Room Temperature

- Technologies for production of Honey Treated Deep Fried Chicken, Nuggets, Intermediate Spent Chicken Meat, Spent Chicken Meat Pickle and Pickle from gizzard of spent chicken were developed.

(k) Pharmacological studies on *Plantago ovata* and *Drymaria cordata* with reference to their analgesic and anti inflammatory activity

- Two plants of ethno-medicinal importance viz. *Drymaria cordata* and *Plantago ovata* were undertaken for studying their analgesic and antinflammatory activity in standardized models using various extracts. The hydroethanol extracts showed promising analgesic, anti inflammatory, anxiolytic, sedative and antioxidant property.

(l) Pharmacological studies on *Alternanthera brasiliana* and *Achyranthes aspera* with reference to their wound healing and immunomodulatory activity

- Under this project two plants *Alternanthera brasiliana* and *Achranthes aspera* were used to study their wound healing and immunomodulatory activity in various animal models. The plants showed significant wound healing property in diabetic, burn wound and in immuno compromised & aged animals, which was not reported earlier.
- The methanol extract showed analgesic, anti inflammatory, immunosuppressant, antidepressant, anxiolytic, mild anticonvulsant property and devoid of muscle relaxant property in addition to wound healing activity

(m) Ethno Veterinary Medicine under A.P. Cess Fund, ICAR, GOI

- Ecto-parasiticidal activities of AAU-EVM-NW-1 and AAU-EVM-NW-2 were studied in this project. Topical treatment (5% ointment) using AAU-EVM-NW-1, and AAU-EVM-NW-2 and their combination in naturally infested goats with *Sarcoptes* showed efficacy. Treatment with 7.5% ointment of AAU-EVM-NW-2 in rabbits infested with *Psoroptes* showed that the infection was cured in 28 days and their body coat returned to normal.

(n) All India Coordinated Research Project on Animal Disease Monitoring and Surveillance (Date of implementation; 27.01.10)

- For the first time occurrence of *Pestes the Petits* in goats were recorded and confirmed in Assam.
- Occurrence of severe form of *Contagious Ecthyma* in goats was recorded.

(o) AICRP ON GOAT IMPROVEMENT

- Survey of Assam Hill Goat in different districts of Assam has been completed.
- Two field centers at Darrang and Kamrup district of Assam have been established.
- Procurement of Assam Hill goat to raise in the farm at G RS, Burnihat is going on.

(p) Goat Research Station, Burnihat

- The present heard strength is: 26 Beetal, 69 Assam local and 45 crossbred goats.
- Reproductive Performance: The kidding percentage was 89.28% from April, 2009 to March 2010.
- Fodder cultivation**:** Fodder grown during Kharif season were Maize, Teosinte, Guinea, Setaria, Para etc and in Rabi season Oat, Winter Maize, Para, Napier. In addition, trees like Dimaru, Subabul, Kanchan, Jackfruit, Neem, Banana etc. were also planted for feeding the goat.

(q) Livestock Research Station, Mandira

- Mega Seed Project for production of certified seed of Boro (Joymati) paddy: Certified seed amounting 12.93 tons have been produced.
- Approximately 35 tons of grains of above mentioned variety have been produced.

(r) New Initiatives

- Under RKVY cattle semen production centre, performance study of improved goat in field condition, development of integrated farming system at LRS, Mandira and fish and chick seed production at different centers will be taken up.
- A proposal to establish a centre for production of Swine Fever Vaccine with funding from GOI/ICAR have been submitted.
- To establish a centre of AICRP on Zoonotic diseases of livestock at FVSc, AAU, Khanapara proposals have been submitted to ICAR.

3. Extensions

The Directorate of Extension Education of Assam Agricultural University, Jorhat works through five organized services for an effective and result oriented extension programmes. They are Farm Advisory Service, Training and Skill Development,Transfer of technology, Farm Information and Publication and Agripreneurship through Agri-Clinic and Agri-business Centre Scheme. Some of the activities under these broad based services are discussed below:

3.1 Farm Advisory Service: Extension Specialist/ Scientist and other field staff of the Directorate provide technical guidance to the farmers through individual, farm and home visit, personal contact and correspondence. Similarly, farmers including farm women regularly visit the university for seeking guidance in agricultural technology, animal production, livestock management, sericulture, pisciculture, home science and other farm problems and they were well attended by the university scientist. The farm advisory service has received its momentum after establishment of Agricultural Technology Information Centre (ATIC) in the university in January, 2002. The extension specialist/ scientist make themselves available in the centre for providing advisory service to the farmers whenever needed.

3.2 Training and Skill Development: The Directorate of Extension Education undertakes the training programmes through Extension Education Institute (EEI) located in Jorhat, Krishi Vigyan Kendras (KVKs), collaborative programmes with other institutes and organizations and Farm Women Training Centre. The number of trainings organized under all these during the period under report is given in Table below

Number of trainings organized by different working units/ Programme of the Directorate of Extension Education/, AAU, Jorhat during 2009 and 2010

Training Units/ Programme	Number of Trainings Organized	Number of Participants
Extension Education Institute (providing training to middle level extension functionaries of NE states)	22	570 from all NE states
Krishi Vigyan Kendras (traing to farmers)	1056	28597
Farm Women Training Centre (providing training to Anganwadi Workers)	4	140

3.3 Seed Production Programme under Technology Showcasing: Seed Production Programme in six Agro-climatic zones of Assam under PPP mode was under taken by Assam Agricultural University with the involvement of 11 KVKs & Regional Agricultural Research Stations and 1890 farm families in 11 districts of Assam. The programme was initiated from the *Kharif* season of 2010-11 with *Sali* paddy (var. Ranjit) as the first crop followed by toria (var. TS-36) and summer rice (var. Joymoti/ kanaklata) in respective zones. The programme has enhanced visibility of the AAU technology and helped the farmers to utilize the fallow land after rice by adopting AAU technology. The average productivity of rice varied from 5.8 to 6.5 tonnes/ha across the districts against the existing yield of 1.5 to 3 tonnes/ha.

3.4 Farm Information and Publication: The publication unit of the university during 2009-2010 published 64 extension bulletins, 5 issues of A.A.U. News Letter, 12 issues of Ghare Pathare (Assamese farm Newsletter) and 20 other publications.

3.5 Agricultural technology Information Centre (ATIC): The Agricultural Technology Information Centre (ATIC) was established to provide information and technology to farmers through a single window delivery system. The services include both providing solution to location specific problems and make available all the technological information along with technology inputs and products to the needy farmers. During 2009 and 2010 6033 farmers had visited ATIC for different purposes. In addition, under chief minister's Gyan Jyoti programme, school children of Kamrup, Nagaon, Jorhat, Golaghat and Dibrugarh district also visited the ATIC. The unit earned an amount of Rs. 7, 31,375.00 by selling paddy seed, pea, black pepper, honey and seeds of horticultural crops during the period under report.

3.6 Kishan Call Centre (KCC) Programme: Directorate of Extension Education, AAU has been offered the responsibility of nodal agency to monitor and evaluate the activities of KCC for the state like Assam, Nagaland and Manipur since 2004. From 21 January 2004 to 31 January 2011, a total of 35698 farmers' queries on various topics on Agriculture, Veterinary and Fishery were replied.

3.7 Farmers Friendly Website "Briddhi" on Vernacular Language on Agricultural Technologies: Technologies developed so far at Assam Agricultural University have been depicted in local language i.e. Assamese and disseminated through a newly constructed website "Briddhi" which was launched on 10th may, 2008 for the benefit of the farming community as well as other stake holders of the state. The contents included in the website are: bulletin on various topics of agriculture, veterinary, fisheries and home science; package of practices of kharif, rabi, horticulture, tea cultivation, and fisheries; photo package of important agricultural technologies; photo galleries of diseases, insect and weeds; information and activities of KVKs; video films on agricultural and allied subjects; question and answer sessions on KCC programmes along with a search engine etc. The project has been sponsored by the World Bank under AACP. The URL of the website is *http://briddhi.aau.ac.in/*

3.8 Farmers Training through Video Conferencing: All together 12 training programmes were conducted during 2009 and 2010 through video conferencing facility available in the Directorate. This is a collaborative programme of ISRO ABITA - AAU covering 10 villages of six districts of Assam.

3.8 Web- portal: ASHA: Assam Small Farmers Agribusiness Consortium (ASFAC), a State Govt. Organization has developed recently a web portal "ASHA", *www.assamagribusiness.nic.in* for the benefit of the farmers as well as stakeholders of Assam, wherein Assam Agricultural University is a major partner in developing the web portal. Till date more than 50 farmers' queries from different parts of Assam have been replied in the field of agriculture and fisheries.

3.10 Implementation of RKVY Programme: Under RKVY programme, six KVKs *viz.* KVK Kokrajhar, KVK Jorhat, KVK Kamrup, KVK Karbianglong, KVK Nagaon and KVK Barpeta are included in the first phase for establishment of Integrated Farming System Model. For infrastructure development, all necessary process had already been completed and farm implements had already been procured for said KVKs.

3.11 Phone in Programme: Altogether 25 questions on various aspects relating to Agriculture, Veterinary, Horticulture, Animal Husbandry and Fisheries received from 24 farmers were replied by the scientists of the university.

3.12 Radio Talk: During the period from April, 09 to March 10, altogether 120 programmes were broadcasted through AIR, Jorhat and 45 programmes were broadcasted through AIR, Dibrugarh.

3.13 Exhibitions: The scientists of the Directorate participated in 6 exhibitions during 2009-10 as given below:

Date	Subject	Place
August 18-20, 2009	Rajiv Gandhi Alcshya Urja Divas	Jorhat District Library, Assam
December 18-21, 2009	State Level Exhibition	Sarusajai, Guwahati, Assam
December 25-27, 2009	Golden Jubilee Celebration of Moheswar Borkotoky High School	Teok, Jorhat, Assam
January 4-6, 2010	Kishan Mela	B. B. Hall, Jorhat, Assam
February 25-27, 2010	State Level Horticultural Show	Golaghat, Assam
March 19-20, 2010	Agricultural Technology Show Case	ICAR Research Complex for NEH Region, Barapani, Meghalaya

3.14 Workshop: The Directorate organized 5 workshops during 2009-10, the details of which are given below:

Date	Subject	Place
May 15 - 16, 2009	Interaction of DDG (AE) with PCs of KVKs/Heads of Institutes of North East India	AAU, Jorhat
Sep 3, 2009	Package of Practices Workshop for Horticultural Crops, Home Science and Fisheries	Dr. M.C. Das Memorial Auditorium, AAU, Jorhat
Sep 5-7, 2009	KVK Workshop of Zone III	AAU, Jorhat
Feb 23-25, 2010	Training Programme on Commodity Future Market	Extension Education Institute, AAU, Jorhat.
March 17-18, 2010	Review Workshop of KVKs of AAU	Extension Education Institute, AAU, Jorhat

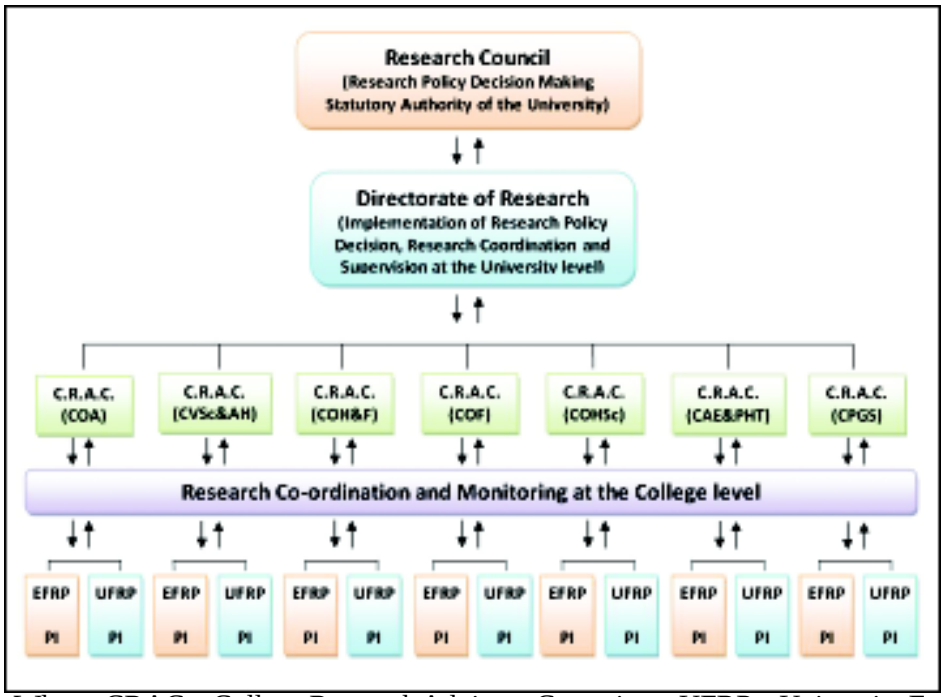
B. Central Agricultural University, Imphal, Manipur

The research activities under the Directorate of Research, Central Agricultural University (CAU) aim at developing technologies which can bring about a far reaching impact on productivity and production of crops, animals and fishes through sustainable and eco-friendly technological approaches for socio-economic development in the region. With these objectives in view, a number of need based, local specific internally and externally funded research projects are being taken up in all constituent colleges of the university.

Research Administration and Management in CAU

The downward and upward research administration and management linkages, at present, are followed as : Hon'ble Vice-Chancellor and Chairman, Research Council → Director of Research and Member Secretary, Research Council → Dean and Chairman, CRAC → Research Co-ordinator and Member Secretary, CRAC → Concerned PI.

The flow diagram of research administration and management linkages in the university is depicted below:



Where, CRAC = College Research Advisory Committee, UFRP = University Funded Research Project, EFRP = Externally Funded Research Project, PI = Principal Investigator.

As a research policy decision of the university, research administration, management, co-ordination, monitoring and evaluation of externally funded research projects undertaken by faculty members of the College of Agriculture, C.A.U., Imphal and scientists of AICRPs under the university headquarters, Imphal are operated directly under the supervision of the Directorate of Research, C.A.U., Imphal while the externally funded research projects undertaken in different constituent colleges of the university other than the College of Agriculture, C.A.U., Imphal are operated under the supervision of the Directorate of Research, C.A.U., Imphal indirectly through the Dean and Chairman, College Research Advisory Committee (CRAC) of the respective colleges. All the university funded research projects are operated indirectly by the Directorate of Research, C.A.U., Imphal through the College Research Advisory Committee (CRAC) of the concerned college.

Present Research Status of C.A.U., 2010-11

Different categories of research presently conducted under C.A.U. are as under:

I. University Funded Research Projects (UFRP)

a. Intramural Research Projects (IRP)

b. University-funded Innovative Research Projects (UIRP)

II. Externally Funded Research Projects (EFRP)

A. ICAR funded Research Projects

a. All India Co-ordinated Research Projects (AICRP)

b. All India Network Research Project (AINRP)

c. National Agricultural Innovation Projects (NAIP)

d. National Horticulture Technology Mission (MM-1)

e. ICAR Seed Project on field crops (Mega Seed Project)

B. Precision Farming Development Centre (PFDC) funded by DAC

C. Individual Scientist's Research Project (ISRP) funded by DBT, DST, ICMR, MoFPI, NABARD, etc.

D. Biotech Hub funded by Department of Biotechnology, Govt. of India

The number of research projects undertaken as University-funded Research Projects (UFRP) are presented as Table 1.

Table 1. University-funded Research Projects under different colleges

Sl. No.	Name of College	No. of IRP Completed	No. of IRP on- going	Total no. of IRPs	University-funded Innovative Research Projects (UIRP)		Revolving Fund Scheme	Total no. of projects
					Completed	On - going		
1.	College of Agriculture, Imphal, Manipur	6	9	15	1	2	1	**19**
2.	College of Veterinary Sciences & A.H., Selesih, Mizoram	22	13	35	-	-	-	**35**
3.	College of Fisheries, Lembucherra, Tripura	13	9	22	-	-	-	**22**
4.	College of Horticulture & Forestry, Pasighat, Arunachal Pradesh	18	9	27	-	-	-	**27**
5.	College of Home Science, Tura, Meghalaya	12	6	18	-	-	-	**18**
6.	College of Agricultural Engg. & PHT, Gangtok, Sikkim	4	10	14	-	-	-	**14**
7.	College of Post Graduate Studies, Umiam, Meghalaya	-	7	7	-	-	-	**7**
	Total	**75**	**63**	**138**	**1**	**2**	**1**	**142**

The number of externally funded research projects (EFRP) undertaken in the University are presented in Table 2.

Table 2. Externally Funded Research Projects under different colleges

Sl. No.	Name of Institutions	ICAR funded Research Projects					PFDC	Bio-tech Hub (DBT)	ISRP	Total
		AICRP	AINRP	NAIP	MM-I	Mega Seed Project				
1.	Directorate of Research & College of Agriculture, CAU, Imphal.	8	2	1	1	1	1	1	4	**19**
2.	College of Horti. & Forestry, Pashighat, Arunachal Pradesh	7	3	—	1	—	—	1	14	**26**
3.	College of Veterinary Sciences and Animal Husbandry, Selesih, Mizoram	1	3	1	—	—	—	1	1	**7**
4.	College of Fisheries, Lembucherra, Tripura	—	—	1	—	1	—	—	8	**10**
5.	College of Home Science, Tura, Meghalaya	—	—	—	—	—	—	—	1	**1**
6.	College of Agricultural Engg. & PHT, Gangtok, Sikkim	6	—	1	—	—	—	—	—	**7**
7.	College of Post Graduate Studies, Umiam, Meghalaya	—	—	1	—	—	—	1	1	**3**
	Grand Total	**22**	**8**	**5**	**2**	**2**	**1**	**4**	**29**	**73**

Major Research Achievements, 2010-11

During the year 2010-11, University carried out 63 Intramural Research Projects (IRPs), 22 All India Co-ordinated Research Projects (AICRPs), 8 All India Network Research Projects (AINRPs) and 38 Externally Funded Research Projects (EFRPs) from different funding agencies namely DBT, ICAR, ICMR, etc. university also took part in the National Agricultural and Horticultural Research Projects namely National Horticulture Technology Mission (MM-I), National Agricultural Innovation Projects (NAIPs), ICAR Seed Projects,

Precision Farming Development Centre (PFDC), etc. The university also took up, from time to time, the contingency research projects which are of great concern and need immediate attention, related to crops, animals and fishes in the region. The salient achievements of these research endeavours are highlighted as follows:

I. Agriculture

A. Plant Genetic Resources and Crop improvement

Cereals

Rice

- In order to increase the rice productivity and production in Manipur valley and similar situations in the North Eastern Hill Region, CAU-R1 was released by the State Variety Release Committee and subsequently notified by the Central Seed Committee during the year 2008. The variety has very high performance under low applied fertilizer level of 60:40:30 NPK kgs per ha with an average brown rice recovery of 72%. The variety is tolerant to biotic stress namely rice blast, bacterial leaf blight, rice gold midge and abiotic stress like submergence upto 7 days, late sowing upto the end of July in Manipur valley. However, the variety is susceptible to high level of nitrogen top dressing at reproductive stage, rice sheath rot and false smut leading to chaffy grains. CAU-R1 recorded the highest grain yield of 10,210.14 kg/ha in farmers' field by Shri Nongthonbam Brojen Singh of Awang Potsangbam, Imphal West District, Manipur who stood first position in the HYV rice crop competition of Manipur state during 2009-10.
- The HYV rice genotypes CAU-S1 for rainfed lowland, CAU-R3 with extra early duration of 100-105 days as contingency crop, CAU-R4 with 145-150 days duration for low lying areas and CAU-R6 with 115-120 days duration suitable for multiple cropping in Manipur valley are in the pipeline for release to meet different rice growing situations of Manipur valley.

Maize

- In a screening trial of 28 corn genotypes under different levels of aluminium and manganese in acid soils of Arunachal Pradesh, local corn genotypes AP-2 and AP-3 were found to be the most tolerant to Al and Mn toxicity, respectively under the acid soils of Arunachal Pradesh. These genotypes may be used as parents in development of Al and Mn toxicity tolerant maize variety for growing in acid soils of Arunachal Pradesh.

Pulses

- With a view to increase the productivity and production of pulses in Manipur, a number of *kharif* and *rabi* pulse varietal trials were conducted during the last 5

years under the university. As a result of these pulses trials, *Uttara* (IPU94-1), an urdbean variety and PDM54, a moongbean variety, *Rachna*, a fieldpea variety, BIOL-212 (*Rattan*), a lathyrus variety and PL4, a small seeded lentil variety, were identified as promising varieties under Manipur valley conditions.

- Among the pea genotypes studied for screening tolerance to aluminium and manganese, pea genotypes PC-55-11-1-2 and PC-493-5 were found to be tolerant to Al and Mn toxicity, respectively when studied in hydroponic and sand assays for adaptation to acid soils. These two genotypes may be utilized as parents in pea breeding for Al and Mn toxicity tolerance in acid soils of Arunachal Pradesh.

Oilseeds

- Oilseed variety trials conducted consecutively for the last three years under AICRP, at CAU, Imphal revealed that soybean variety JS 335 developed by J.N.K.V, Sehore, rapeseed variety M-27 developed by A.A.U., Shillongani and groundnut variety ICGS-76 developed by ICRISAT, Patancheru, Hyderabad were the highest yielder with an average yield of 1248 kg/ha, 1262 kg/ha and 1360 kg/ha, respectively under Manipur conditions with recommended package of practices. These varieties may be recommended for general cultivation.

B. Natural Resource Management and Crop Production

Cereals

Rice

- Crop stand establishment studies with similar nutrient management practices among System of Rice Intensification (SRI), Integrated Crop Management (ICM) and Conventional Rice Culture (CRC) revealed that the maximum grain yield of 54.48 q/ha and straw yield 71.38 q/ha was achieved in a spacing of 20 cm row to row and 20 cm plant to plant with two seedlings per hill with Integrated Crop Management (ICM) followed by System of Rice Intensification (SRI) with the grain yield of 52.93 q/ha and straw yield of 69.68 q/ha at a spacing of 25 cm row to row and 25 cm plant to plant with single plant per hill. Integrated Crop Management (ICM) has greater potential for adoption in high rainfall mid altitude areas of Northeast region as it withstands heavy rainfall and also it is easier to handle 20 days old seedling in ICM than 10 days old seedling in SRI by the farmers.
- Nutrient management studies on the productivity of low land rice under SRI, ICM and CRC revealed that 80:60:40 NPK kg/ha + FYM 5 t/ha resulted in significantly higher grain yield of 56.48 q/ha which remained at par with 40:30:20 NPK kg/ha + FYM 10 t/ha. Therefore, the integrated use of 80:60:40 NPK kg/ha + 5 t/ha FYM or 40:30:20 NPK kg/ha + FYM 10 t/ha can be adopted depending upon the availability of resources as both were found better for higher productivity in the state of Meghalaya.

Maize

- Weed management studies on hybrid maize under Manipur conditions suggested that application of Atrazine @ 1 kg a.i./ha + one hand weeding at 40 DAS with an average grain yield of 60.95 q/ha or mulching with rice husk with an average grain yield of 60.31 q/ha may be adopted for efficient weed control and higher grain yield of hybrid maize depending upon the availability of resources.

Pulses

- Utilization of rice fallow during *rabi* season through utilization of adequate water harvesting system is a challenge to the university for socio-economic upliftment of the state. Studies on the development of production technologies of pulses in the rice fallow during *rabi* season, 2009-10 revealed that without life saving irrigation growing of *rabi* pulses was a futile exercise but by giving a minimum of two life saving irrigations at early vegetative stage and pre-flowering stage of pea variety *Rachna*, lentil variety L4076 and lathyrus variety BIOL-212 were able to produce grain yields of 435 kg/ha, 500 kg/ha and 500 kg/ha, respectively which were economically viable.

Oilseeds

Soybean

- Nutrient management studies under AICRP on soybean with soybean varieties RKS-18 and JS97-52 under Manipur conditions revealed that the maximum grain yield of soybean was obtainable upto 1627 kg/ha in RKS-18 with nutritional level of 20:60:40 kg NPK/ha + FYM @ 5 t/ha.

Mustard

- In order to study the best time of sowing of mustard under Manipur conditions, three mustard varieties namely Sej-2, JD-6 and Urvashi were sown in four different dates of sowing *viz*., 25th September, 10th October and 9th November during *rabi*, 2008-09 and 2009-10. The optimum date of sowing for maximum grain yield was 10th October with an average grain yield of 701 kg/ha in mustard variety JD-6. Therefore, the best time of sowing of mustard under foot hills and valley conditions of Manipur may be recommended as the second week of October for maximum productivity.

Vermicomposting

- Compost preparation initiative from the vegetable waste of Vegetable Market, Imphal suggested that vermicomposting was found to be more adaptive, easy and economical for such raw material. The earthworm species used for composting were Red Wigglers (*Eisenia foetida*) and Kinberg (*Eudrilus eugenia*). Mature compost weighing 700 kg could be obtained from 1000 kg of vegetable market

waste in 90 days with a gross income of Rs. 4,500/- @ Rs. 6.5/kg vermicompost. The average N, P and K contents (%) of vermicompost obtained from such market vegetable waste under three seasons are presented in Table 3.

Table 3. N, P and K contents of seasonwise vermicompost

Season	N (%)	P (%)	K (%)
Rainy	1.89	0.63	0.87
Winter	1.70	0.58	0.85
Summer	1.42	0.53	0.83

C. Plant Health Management and Crop Protection

Pulses

- In the studies on growth and development of pulse beetle (*Callosobruchus chinensis* L.) with different pulses, the most suitable hosts for *C. chinensis* were found to be pigeon pea, cowpea, greengram and kabuli channa where the adult emergence was higher than that of other pulses. In the management of *C. chinensis* with different leaf powders, neem leaf powder was found to be the most effective in reducing egg laying, adult emergence and per cent weight loss when treated @ 50 g/kg greengram seed. Among oils, neem, mustard, sunflower and safflower oils @ 5 ml/kg seed was found to be effective in the management of *C. chinensis* on green gram. Neem oil was found to be effective even at the lower doses of 2.5 ml/kg. Therefore, for the management of *Callosobruchus chinensis*, oils were more effective than botanical powders.

Oilseeds

- Seed treatment with garlic bulb extract followed by spraying of the extract @ 20 ml/litre of water at 50 DAS was found to be effective for management of white rust in rapeseed and mustard under Manipur valley conditions. The yield increase was found to be 20% over the mancozeb treated rapeseed and mustard seed @ 2 g/kg and sprayed at 50 DAS @ 2 g/litre of water with a cost:benefit ratio of 1:1.95 as compare to 1:1.72 in mancozeb treatment.

II. Horticulture

Pomology

Banana

- As Manipur is prone to cold and frost during winter season, the introduced dwarf banana varieties, so far, are not suitable for commercial fruit production. Hence, three popular local semi-dwarf banana varieties namely *Meitei Hei*, *Maring Hei* and *Meitei Heijao* were evaluated for cultivation under cold and frost conditions of Manipur. Out of three varieties, *Meitei Hei* was identified as the best local banana cultivar in terms of productivity, quality and tolerance to cold and frost during winter season in Manipur.

Citrus

- Post harvest management of *Khasi* mandarin (*Citrus reticulata* Blanco) in Meghalaya revealed that Holy basil treated fruit pack in corrugated fibre board (CFB) boxes recorded the minimum physiological loss in weight (20.01 %). The losses in peeled weight, pulp weight and juice content of fruit were also minimum i.e. 20.80 %, 67.98 % and 39.26 %, respectively in Holy basil treated fruits. The maximum increase in TSS (13.46%) and total sugar (8.39%) was recorded in fruits treated with Holy basil. Minimum decrease in acidity (0.69%) and ascorbic acid (29.69 mg/100ml.) was also recorded in fruits treated with Holy basil. The sensory analysis of *Khasi* mandarin during storage revealed that fruits treated with Holy basil and packed in CFB boxes recorded maximum sensory scores in terms of taste (7.33), texture (7.27), appearance (7.47), flavour (7.60), colour (7.60) and overall acceptability (7.33) as compared with other treatments. As the Holy basil can be available easily in NEH Region, Holy basil treatment in packing *Khasi mandarin* orange with corrugated fibre board may be economical for long distance marketing.
- The management of citrus leaf miner, *Phyllocnistis citrella* (Stainton), in Meghalaya with different pesticides and botanicals revealed that among the synthetic insecticides, imidacloprid (0.075 %) was found to be the most effective in reducing larval population and per cent infestation of citrus leaf miner whereas among the botanicals, karanjin (2 %) was found to be the most effective botanical followed by azadirachtin 300 ppm.

Indigenous fruits

- In a study to utilize the potential indigenous fruit crops of Manipur viz. *Heimang* (*Rhus simialata*), *Heiyai* (*Elaegnus latifolia*) and *Heining* (*Spondius* sp.) for product development and commercialization, the conventional plant propagation methods were attempted for large scale vegetative propagation. In the study,

softwood, semi-hardwood and hardwood cuttings with different levels of IBA and NAA were attempted. Semi-hardwood cutting responded better to the applied IBA @ 2000 ppm amongst the three different methods of cuttings. Of the three types of indigenous fruit crops, *Heimang* (*Rhus simialata*) recorded the highest rooting rate. Hence, semi-hardwood cutting with 2000 ppm IBA treatment is considered to be the best for large scale vegetative propagation of these indigenous fruit crops.

Olericulture

Snapmelon

- A total of 53 Snapmelon [*Cucumis melo* L. var. momordica (Roxb.) Duthie et Fuller] landraces were collected from Arunachal Pradesh and evaluated for twelve morphological characters, four biochemical parameters as well as reaction to three major diseases of the crop. Out of them, collection no. SM26 was found to be the highest fruit yielder with 13.23 kg/plant followed by SM33 with 13.17 kg/plant. Among the biochemical traits, the highest carotenoids content was found in the collection no. SM48 (58.45µ/g fw) followed by SM47 (42.06 µ/g fw) while ascorbic acid content was found to be the highest in collection no. SM13 (100.56 mg/100 ml) followed by SM19 and SM24 with 84.34 mg/100 ml. Two collections (SM51 and SM53) were found to be resistant to powdery mildew, two collections (SM17 and SM40) were resistant to downy mildew while three collections SM44, SM46 and SM53 were resistant to cucumber mosaic virus. The above collections may be utilized in the improvement of snapmelon which is an important indigenous fruit of Arunachal Pradesh.

Sweet potato

- From the studies on integrated nutrient management of sweet potato (*Ipomea batatas* L. Lam.) cv. Sree Bhadra, it was suggested that application of 33 kg N + 25 kg P_2O_5 + 50 kg K_2O per hectare with 2 kg Azospirillum/ha as Vine dipping + 10 kg Azospirillum/ha as soil application could give a tuber yield of 26.67 t/ha under Manipur conditions.

Tomato

- From the studies on eco-friendly management of late blight (*Phytophthora infestans*, Mont.de Bary) of tomato in mild hill conditions of Meghalaya consecutively for two years (2007-08 and 2008-09), it was concluded that genotype Co-3 was found to be promising for cultivation in mid-hill conditions of Meghalaya and botanical MATW-2 is beneficial in reducing the disease as well as enhancing the yield of tomato.

Onion

- In a study to standardize the planting time, spacing and nutrient level of common onion under Manipur valley conditions, the highest average bulb yield of 16.72 t/ha

was recorded when transplanted with 30 days old onion seedlings by 25th November in 10 cm x 10 cm spacing with 125:60:40 NPK kg/ha.

Okra

- The management of insect pest complex in okra revealed that among the synthetic insecticides, imidacloprid (0.004 %) was found to be the most effective in reducing the population of all pests followed by thiamethoxam whereas, among the botanicals, karanjin (2 %) was found to be the most effective against aphid, neem oil (5 %) against jassid and NSKE (5 %) against blister beetle and red cotton bug. Among the microbials, *Verticillium lecanii* (0.16 g/l) was found to be the most effective against aphid, whereas *Beauveria bassiana* (1 ml/l) was the most effective against jassid, blister beetle and red cotton bug.

III. Veterinary Sciences & Animal Husbandry

Animal production and management

- Among the domesticated animals, piggery is considered to be one of the most profitable enterprises among the people of NEH Region. Pregnancy diagnosis in swine, which is important in piggery for obtaining timely litters is not commonly practiced in field conditions. Therefore, a simple method of pregnancy diagnosis in swine using Cuboni test was studied in the university. The accuracy of Cuboni test for pregnancy diagnosis from urine samples of pregnant sows at less than 38 days (1st stage), 38-76 days (2nd stage) and 76 days to term (3rd stage) was 74%, 16% and 80%, respectively. The effectiveness to identify the non-pregnant sows at 1st stage, 2nd stage and 3rd stage of gestation is 76%, 80% and 88%, respectively. Hence, this simple test may be utilised for pregnancy diagnosis of swine under field conditions.
- Mizo pig locally known as *Zovawk* is an indigenous breed of Mizoram known for its meat quality and better adaptability under local environmental conditions. Considering the importance of this local Mizo pig, selective breeding of the local Mizo pigs and upgradation with exotic breed particularly Large White Yorkshire were initiated. The result appears to be encouraging in terms of quality and quantity meat production as well as adaptability from such a program in upgrading the low yielding local Mizo pigs.

Animal health management

- The effect of povidone iodine, placentrex and human amniotic membrane on prevention of experimentally induced intra peritoneal adhesion in rabbits after surgical manipulation was evaluated. Intra-peritoneal administrations of povidone iodine to serosal cuts at uterus and stomach in rabbits were much more effective in preventing the intra-abdominal adhesion formation after surgical manipulation than the placentrex and human amniotic membrane.

- In a study on causes of mortality of birds in poultry farms of Aizawl District, Mizoram, the main disease for bird mortality causing great losses in the economy of the poultry farmers of Aizawl District was identified as "Colibacillosis". The disease when occurred in combination with Ascites syndrome caused heavy mortality ranging from 75-80% in broiler birds.
- In the case studies on the mineral deficiency diseases of livestock in Aizawl District, Mizoram, it could be concluded that milk fever, post parturient haemoglobinurea, magnesium tetany, repeat breeding, anestrous, piglet anaemia are the major mineral deficiency related problems in Aizawl District and mineral contents of Ca, P, Mg, Cu, Fe and Zn in the soil of forest fodder and bollod serum of cattle of the district were below the normal value.

IV. Fisheries

Fish production and management

- To inventorize the fish diversity and conservation of fish species in relation to the important water quality parameters of habitats was undertaken. A total of 103 fish species were listed systematically under 28 families. Out of the total species, 98 fish species were recorded from wild habitats and five fish species were observed in captive condition. A total of 63 fish species were identified as ornamental fish which included beautiful loaches like *Botia dario*, *Acanthocobitis botia*, etc. and hill stream trout like *Barilius barna*, *Barilius bendelsis*, *Barilius gatensis*, etc. These beautiful fresh water ornamental fishes may be utilized in breeding ornamental fishes for commercialization.
- Indigenous fermented fish of North East India locally known as *shidal* in Tripura and *ngari* in Manipur is a very popular dietary component particularly in Manipur. Accelerated fermentation process of *shidal/ngari* with reduced total maturation period and increase production per year without any additional infrastructural inputs for production of *shidal*/*ngari* was standardised by the scientists of the College of Fisheries, Lembucherra, Tripura. Isolation of micro-organisms responsible for fermentation, packaging and storage are being studied to upgrade the technology improvement and product quality.

Fish health management

- *Androgrphis paniculata* which is known as wonder drug in traditional ayurvedic system of medicine, was systematically administered by incorporating dried powder in feed and evaluated the health status of Indian Major Carp (*Labeo rohita*). The herb was nonlethal to fish but feeding intensity reduced when the incorporation level was 10% or more. The feeding trial for 60 days with different level of herb powdered showed enhancement in nonspecific immune parameters, haematological

parameters and biochemical parameters. The 3% incorporation level of herb powder was found to be the most effective to enhance nonspecific immune parameters whereas 1% level was effective for haematological and biochemical parameters. The challenge test conducted with bacteria *Aeromonas hydrophila* and *Edwardsiella tarda* after 60 days of feeding trial offered better relative percentage survival with 3% dose of herb powder.

V. Agriculture Engineering & Post Harvest Technology

Farm mechanization and renewable energy

- In order to overcome the hindrances faced by the rural farmers and households in open sun drying of agricultural crops in North Eastern Hills States, a "portable forced convection multi-rack solar dryer" using solar energy suitable for Northeastern hilly climatic conditions was developed. Hot air developed inside the chamber due to solar energy was circulated with 2 DC fans (10 watts capacity each) fitted on opposite wall of drying chamber thereby helping faster removal of moisture from the produced. The dryer could give solar insulation ranging from 75 mW/cm^2 to a maximum of 106 mW/cm^2.

Post harvest technology and value addition

- Osmo-air dehydrated pineapple slices offer advantages of longer shelf life, economical processing, bulk weight reduction by a factor of 1:10 and good quality value added products. The major cost of processing is the cost of sugar which is needed for osmotic dehydration. The quality of sugar syrup after single use is greatly reduced in terms of high acid content, lower TSS and increased cloudiness. In this process, focus is being made to clarify and recycle the used sugar syrup with the help of bio-cleansers and edible additives to regain the quality of the used syrup to its original fresh quality in terms of physical and chemical properties viz. colour, TSS, pH, etc.
- The North Eastern hill region is proud of its orchid bio-resources. Due to poor communication facilities in the remote areas of the region, these naturally beautiful orchids are still not known much outside the region. The College of Agriculture Engineering & Post Harvest Technology has studied effect of packaging methods on the shelf-life and quality of selected orchid cut flowers. They are successful in developing packaging system of orchid cut flowers which can be kept for about a month without affecting the flower quality.

VI. Home Science

- In a study for identification of training needs of Garo women in West Garo Hills, Meghalaya in agricultural and animal husbandry, the highest training needs in the

settled agriculture is plant protection measures followed by seed selection and treatment whereas in animal husbandry, the highest training need is in the care of pregnant pigs followed by care of piglets and management against diseases.

- In a study on the role of *Nokma* (Village Headman) in the development of agriculture in West Garo Hills, Meghalaya, it was concluded that the *Nokmas* were trying their best to help the villagers in different aspects of agricultural activities. But, their lack of knowledge about the modern scientific agricultural technologies and practices hindered to help their people to help themselves. Hence, proper training of *Nokmas* about the scientific aspects of agricultural production could improve agriculture production in West Garo Hills, Meghalaya.

Major research thrust areas of the colleges under C.A.U. as per recommendation of the 2nd C.A.U. Research Council meeting held on 16th December, 2010

A. College of Agriculture

1. Agro bio-resource management and utilization for sustainable production under location specific agro-ecosystems.
2. Crop improvement for productivity, quality, biotic and abiotic stress for different agro- ecosystems with particular reference to Manipur through conventional, cellular and molecular breeding approaches.
3. Agro-ecosystem based crop production technology development for sustainable agriculture.
4. Natural resource management – integrated farming system in watershed approach and soil health management through the principles of conservation agriculture, organic farming, integrated nutrient management, etc. with particular reference to Manipur.
5. Development of eco-friendly plant health management and crop protection technology.
6. Training need analysis for extension services and village adoption programme for transfer of technology with socio-economic impact studies.

B. College of Horticulture & Forestry

1. Exploration, evaluation, conservation and utilization of regional horticultural and forest bio- resources.
2. Introduction and evaluation of promising varieties of horticultural and forest crops.
3. Production of quality planting material of horticultural crops and forest trees.
4. Development of cultivation techniques to increase productivity of the common horticultural and forest crops of North East hill region.
5. Integrated nutrient and water management and development of organic farming technology for sustainable production of horticultural crops.

6. Development of bio-control based integrated pest management of horticultural and forest crops.
7. Use of biotechnological approaches in horticulture and forestry.
8. Post harvest management of horticultural produce with emphasis on handling and processing.
9. Bench marking and training need assessment.
10. Assessment of production and marketing of horticultural and forest crops.

C. College of Veterinary & Animal Sciences

1. To improve the production and productivity and conservation of indigenous breeds of livestock and birds of the region.
2. To improve animal disease diagnostic, therapeutic and prophylactic techniques.

D. College of Fisheries

1. Fish biology and fisheries resource management of North East (NE) hill region of India.
2. Enhancement of fish production through locally available inputs and efficient management strategies.
3. Development of location specific intensified aquaculture production system for NE hill region.
4. Aquarium fish culture management for indigenous potential ornamental species of NE hill region.
5. Environmental and biological contaminants/extremes affecting aquatic animal health and ecosystem.
6. Characterization of disease causing pathogens of aquatic animals and development of prophylactic measures.
7. Genetic diversity and breeding of important indigenous fishes of NE hill region.
8. Livelihood improvement, food and nutritional security through fish farming, fish processing and technological intervention in fisheries.
9. Waste management in fisheries.

E. College of Home Science

1. Explore the indigenous (tribal) designs for fashion garments.
2. Study on natural dyeing and natural fibre and its processing.
3. Assessment on the reproductive health status of women.
4. Development of play material for children and their acceptability.
5. Processing of regional fruits and vegetables.
6. Effect of dietary pattern on the anthropometric measurement of the Garos.
7. Assessment on the introduction of soy flour in bakery products.
8. Drudgery reduction in different livelihood options.

9. Study on Agricultural Information Systems in Garo Hills.
10. Collective strength and productive resources.
11. Marketing management and value chain analysis of agricultural/horticultural commodities.
12. Nutritional evaluation of pineapple grown under organic and conventional farming system.
13. Development of Functional Drinks by combining the fermented food products of the region and some medicinal plants.

F. College of Agricultural Engineering & Post Harvest Technology

1. Mechanization of hill agriculture for increased production and productivity with reduced drudgery.
2. *In-situ* soil and water management including water harvesting and protected cultivation.
3. Post harvest management and value addition of crops produced in NEH region.
4. Enhanced utilization of renewable sources of energy.

G. College of Post-Graduate Studies

1. Assessment, exploration, conservation and utilization of regional agro-bioresources.
2. Understanding genetic and molecular mechanisms underlying important traits like yield, biotic and abiotic stress tolerance, fertilizer use efficiency, etc. for crop improvement.
3. Production of quality planting materials for location specific agro-ecosystem.
4. Characterization and management of natural resources for improving soil and water productivity.
5. Improving nutrient use efficiency and organic carbon dynamics in acid soils.
6. Improvement of existing cropping systems through crop diversification and development of integrated farming system in NEH region.
7. Documentation of major pest and diseases including post harvest problems of important crops of the NEH region.
8. Integrated Management of pests and diseases under different cropping systems.
9. Economic analysis of natural resources in agriculture & allied enterprises.
10. Village adoption programme for technology transfer.

University quality seed production activities

University is actively participating ICAR Mega Seed Project since 2007-08. During the year 2010-11, the following quantity of quality seeds were produced by the university:

Field crops

A) Cereals:

a) Rice variety: CAU-R1
   I. Breeder Seed - 40 Qntls.
   II. T.L. Seed - 147 Qntls.

B) Pulses:

a) *Kharif* pulses- Urd variety: Uttara
   I. T.L. Seed - 1 Qntl

b) Rabi pulses
   I. Lentil variety: L-4076 - T.L. seeds 25 Qntls
   II. Lathyrus variety: BIOL-212 - T.L. seeds 20 Qntls

C) Oilseeds

a) *Kharif* oilseed
   I. Groundnut variety: ICGS-76 - T.L. seeds 5 Qntls
   II. Soybean variety: JS 335 - T.L. seeds 0.5 Qntl

b) *Rabi* oilseed
   I. Rapeseed variety : M-27 - T.L. seeds 20 Qntls

Horticulture crops

A) Spices

a. Ginger
   i) var. Bhaisey– 70.80 kg (Rhizome)
   ii) var. Nadia – 80.60 kg (Rhizome)
   iii) var. Gourbathan – 62.80 kg (Rhizome)

b. Turmeric
   var. Lakadong – 50.10 kg (Rhizome)

c. Chilli
   var. Giant chilli – Seedlings 5,000 Nos.

B) Fruits

a) Banana var. Meitei Hei - 22,500 Nos. (suckers)
b) Orange var. Tamenglong (Polyembryonic) - Nucellar seedlings 23,000 Nos.
c) Lime var. Kachai – Seedlings 10,000 Nos.
d) Passion Fruit var. Purple - Seedlings 40,000 Nos.

Research publications of the University, 2010-11

In order to disseminate the location specific university research achievements and findings pertaining to N.E.H. Region to the researchers, policy makers, extension specialists,

research students, needy farmers, etc., the following research publications were made by the Directorate of Research during the year 2010-11:

I. CAU Annual Research Report, 2009-10
II. CAU Research Newsletter, January to June, 2010. Vol. 1, No.1
III. CAU Research Newsletter, July to December, 2010. Vol. 1, No.2.

Conclusion

In order to develop technologies which can bring about a far reaching impact on productivity and production of crops, animals and fishes through sustainable and eco-friendly technological approaches for socio-economic development of the NEH Region, faculty members and scientists of the university undertook a number of research projects under various research thrust areas as recommended by the Research Council of the University which will help for socio-economic upliftment of the NEH Region under the changing environments of climate change.

8. RESPONSE OF DIFFERENT SUBJECT MATTER DIVISIONS

A. STATUS OF RESEARCH ON CROP SCIENCE

FOOD & FODDER CROPS

Important Crops of the Region

This region comprises the states of Assam, Sikkim, Mizoram, Arunachal Pradesh, Nagaland, Tripura, Meghalaya and Manipur. Rice is the main crop of this region. Other food crops grown are maize and wheat. Rice is grown as rainfed upland, lowland and irrigated crop. The main seasons for growing rice in Assam are Ahu (March-June); Sali (June-October); and Boro (Nov-May).

Area, Production and Productivity of Crops in the Region

During the last 5 years, the area under rice has increased marginally in states of Assam and Arunachal Pradesh, whereas in Nagaland, it has increased substantially from 153000 ha to 173000 ha. The productivity has increased in states of Arunachal Pradesh, Nagaland, Tripura and Meghalaya. The area under maize has increased in states of Arunachal Pradesh, Nagaland and Mizoram. The details of area, production and productivity of the important crops in this region are given below:

Area, Production and Productivity (State -wise) of important crops during 2004-2009

A – Area (000' ha) : P – Production (000' tones) : Y- Productivity (Yield : Kg/ha)

State/crop		2004 – 05	2005 – 06	2006 – 07	2007 – 08	2008 - 09
Assam						
Rice	A	2376.8	2420.3	2189.0	2324.0	2484.2
	P	3470.7	3552.5	2916.0	3319.0	4008.5
	Y	1460.0	1468.0	1332.0	1428.0	1614.0
Wheat	A	63.9	50.0	60.0	56.0	50.1
	P	68.1	53.7	67.0	71.0	54.6
	Y	1066.0	1074.0	1117.0	1268.0	1090.0

contd..

State/crop		2004 – 05	2005 – 06	2006 – 07	2007 – 08	2008 – 09
Maize	A	19.2	19.0	18.0	18.0	17.4
	P	13.9	13.7	14.0	13.0	12.6
	Y	724.0	721.0	778.0	722.0	724.0
Sikkim						
Rice	A	14.7	15.0	15.0	14.0	14.7
	P	21.6	21.5	21.5	22.9	21.7
	Y	1469.0	1433.0	1433.0	1630.0	1476.0
Wheat	A	5.7	6.5	6.5	4.5	5.8
	P	8.3	9.0	9.0	4.5	7.8
	Y	1456.0	1385.0	1385.0	1000.0	1345.0
Maize	A	37.7	37.9	6.5	39.1	37.7
	P	58.2	56.5	9.0	62.6	58.2
	Y	1586.0	1491.0	1385.0	1601.0	1736.0
Arunachal Pradesh						
Rice	A	121.6	122.3	122.3	124.0	126.0
	P	135.0	146.2	146.2	158.1	163.9
	Y	1110.0	1195.0	1195.0	1275.0	1293.0
Wheat	A	4.3	4.0	4.0	3.6	3.3
	P	8.7	6.1	5.3	5.3	5.2
	Y	1525.0	1472.0	1472.0	1576.0	
Maize	A	37.8	41.9	46.3	42.7	42.9
	P	55.0	57.9	63.5	57.4	58.8
	Y	1455.0	1382.0	1371.0	1344.0	1371.0
Nagaland						
Rice	A	153.0	156.4	164.7	172.5	173.1
	P	259.8	263.1	263.5	290.6	345.1
	Y	1698.0	1682.0	1600.0	1685.0	1994.0
Wheat	A	8.2	1.2	1.5	1.5	1.4
	P	13.0	1.9	1.3	1.6	2.1
	Y	1585.0	1583.0	867.0	1067.0	1500.0

contd..

State/crop		2004 – 05	2005 – 06	2006 – 07	2007 – 08	2008 - 09
Maize	A	46.6	51.6	64.7	67.0	64.4
	P	83.5	52.9	108.3	119.8	115.9
	Y	1800.0	1800.0	1674.0	1788.0	1800.0
Tripura						
Rice	A	242.6	244.7	251.6	237.2	242.5
	P	545.1	552.9	620.5	624.6	627.1
	Y	2247.0	2260.0	2472.0	2633.0	2586.0
Wheat	A	1.1	1.1	1.0	1.0	0.6
	P	2.8	2.9	1.8	1.9	1.2
	Y	2545.0	2636.0	1800.0	1900.0	2000.0
Maize	A	2.8	2.2	2.5	2.1	2.1
	P	3.0	2.2	2.4	2.1	2.0
	Y	1539.0	1284.0	1326.0	1437.0	1495.0
Meghalaya						
Rice	A	111.5	100.7	104.5	106.4	108.1
	P	193.7	151.9	200.2	200.0	203.9
	Y	1737.0	1508.0	1916.0	1880.0	1886.0
Wheat	A	0.9	0.7	0.6	0.6	0.4
	P	1.6	1.2	1.2	1.1	0.7
	Y	1178.0	1714.0	2000.0	1833.0	1750.0
Maize	A	16.9	16.9	17.0	17.1	17.1
	P	24.0	24.1	25.0	25.1	25.7
	Y	1420.0	1426.0	1471.0	1468.0	1503.0
Mizoram						
Rice	A	54.8	55.8	52.8	54.6	52.0
	P	104.1	99.2	29.5	15.7	46.0
	Y	1900.0	1778.0	539.0	288.0	885.0
Maize	A	7.5	11.7	10.7	7.4	9.6
	P	15.7	22.7	21.0	0.7	9.3
	Y	2093.0	1940.0	1963.0	95.0	969.0

contd..

State/crop		2004 – 05	2005 – 06	2006 – 07	2007 – 08	2008 - 09
Manipur						
Rice	A	176.3	166.3	166.3	166.1	168.4
	P	435.9	386.1	386.1	406.2	397.0
	Y	2472.0	2322.0	2322.0	2446.0	2357.0
Maize	A	3.2	2.9	2.9	3.0	4.3
	P	8.9	7.9	7.9	8.4	11.5
	Y	2781.0	2724.0	2724.0	2800.0	2674.0

Research Support in the Region

a) ICAR Institutes/ Directorates/ Regional Stations/ Centres

- CRRI Rainfed lowland Research station, Gerua, Distt Kamrup, Assam.
- NBPGR Regional Station, Umiam, Shillong, Meghalaya

b) All India Coordinated Research Centres

- The list of research centres under All India Coordinated Research Projects of the crops are given below:

Crop	AICRP Centres
Rice	(i) Imphal, Manipur (ii) Kohima, Nagaland, (iii) Agartala , Tripura, (iv) Upper Shillong, Meghalaya, (v) AAU Jorhat & Karimganj, Assam
Wheat	(i) Imphal, Manipur (ii)Shillongani, Assam
Maize	(i) Imphal Manipur (ii) AAU Jorhat
Forages	(i) Imphal , Manipur (ii) AAU Jorhat

Major Achievements

- Suitable recommended varieties have enhanced the production and productivity of the food crops in the region.
- Development of single cross hybrids in maize are gaining popularity and have helped in increasing area and productivity of the region..
- System of Rice Intensification (SRI) method has shown yield advantage over the traditional method of rice cultivation in Tripura.
- Three rice hybrids have been recommended for cultivation in Tripura.

Major Recommendations

Rice

State	Varieties
Assam	: Chandrama, Aghoni, Ketkijoha, Lachit, Manoharsali, Padmanath, Ranjeet, Satyaranjan Boro Rice: Bishnu Prasad, Chandrama and Jyothi Prasad
Sikkim	: Addey, DR 92, RCPL 3-2, RCPL 3-6
Mizoram	: Ngoba
Nagaland	: Khonorollu, Ruluo
Tripura	: Kali Khasa, Swati, TRC Borodhan, Naveen, Vandana, Mahsuri, Swarna Hybrids: KRH-2, PA-6201, PA-6444
Meghalaya	: NEH Mega rice 1, NEH Mega rice 2, Bha Lum 1, Bha Lum2, Lam Pnah1, Shah Sarang1
Manipur	: Akutphou, Eriemaphou, Ginphou, Lunglinaphou, Pariphou, RC Maniphou 6, RC Maniphou 7, Sanaphou, Tamphaphou

Other Recommendations

- To ensure optimum plant population, transplant 25-30 days old seedlings at a spacing of 20 x 10 cm (for early and medium duration varieties) with 2-3 seedling per hill.
- Apply lime and / or potash in acid soils to alleviate iron toxicity.
- For effective spilt application of nitrogen, drain out water prior to top dressing and irrigate after 24 hours.
- Apply coated fertilizers such as neem-coated urea or adopt 3 or more splits of nitrogen in soils with excessive percolation.
- Apply zinc sulphate @ 30-50 kg/ha to ameliorate zinc deficiency.
- Ensure adequate irrigation at critical crop growth stages such as panicle initiation and flowering.
- Under late conditions, planting may be done at 10-15 cm apart using 5-7 seedlings per hill.
- Timely use of recommended dozes of weedicides and insecticides to control weeds and pests.

Wheat

For Assam and plain areas of other NE states

Varieties

Production conditions

Normal sown	Late sown	Rainfed	Sodic soils / Others
CBW 38, Raj 4120, K 0307, NW 1012, HUW 468, PBW 443, HD 2733, HD 2824, K 9107	HD 2643, HP 1633, HP 1744, NW 1014, HW 2045, DBW 14, NW 2036	HDR 77, K 8962, K 9465, K 8027, HD 2888, MACS 6145	RAJ 3077, KRL - 19

Other Recommendations

- The area is prone to brown rust and leaf blight diseases. Therefore, the resistant varieties like CBW 38, NW 1014, NW 2036, K 9107, HD 2733, MACS 6145, DBW 14, HD 2888 and HUW 468 should be encouraged.
- For Irrigated conditions timely sown (Mid November): seed rate of 100 kg/ha and fertilizer doze of 150:60:40 kg NPK /ha (1/3rd N at sowing and 2/3rd at first node stage i.e. 35-40 DAS) is recommended.
- For Irrigated late sown (First Fortnight of December): seed rate of 125 kg/ha and fertilizer doze of 120:60:40 kg NPK / ha (1/3rd N at sowing and 2/3rd at first node stage i.e. 35-40 DAS) is recommended.
- For Rainfed (Second fortnight of October): a seed rate of 125 kg/ha and fertilizer doze of 60:30:20 kg NPK / ha at the time of sowing is recommended.
- For control of weeds, proper doze and time of applying of the recommended weedicides should be followed or hand weeding should be done to have good yields.

Maize

Varieties

Extra early maturity		Early-maturity	Medium maturity		Late maturity	
Hybrids	**Composites**	**Hybrids**	**Hybrids**	**Composites**	**Hybrids**	**Composites**
Vivek 21, Vivek 25, Pusa Extra Early Hybrid 5	NLD white (rabi)	Parkash JKMH 1701, X 3342	DK 701, HQPM 1, HQPM 5	Pratap Makka 4, Pratap chari-6, African tall, J 1006	Pro311, Bio 9681, Seed Tech 2324	Vijay, NLD white, Shakti 1. VL Baby Corn 1, Madhuri, Win orange, Priya, Jawahar, Amber, Pearl, VL pop corn

Other Recommendations

- Use of medium to early maturity hybrids and composites recommended for Kharif and Rabi.
- Weeds may be controlled by using Atrazine @ 1 kg to 1.5 kg/ha with 24-48 hours after sowing.
- Weeding and hoeing should be done before top- dressing and earthing-up at knee high stage.
- Stem Borer: *Chilo partellus* can be controlled by spray of 2 ml Endosulfan per litre of water after 10 days of germination.

Forages

Varieties:

Crop	Varieties
Cowpea	UPC 625, UPC 618, UPC 622, UPC 628
Rice bean	Bidhan Rice bean – 2
Coix	Bidhan Coix – 1
Oats	JHO – 99-2, Bundel Jai
Berseem	Bundel berseem – 3
Pearl Millet	JHPM 05-2, NDFB – 2, NDFB- 3
Sorghum	Single cut: CSV-21; Multi cut: CSH 20 MF & CSH 24 MF

Other Recommendations

- One rice bean variety SHYAMALEE has also been recommended for Assam.
- In Setaria, a new variety PSS-1 has been recommended.
- Seed treatment with *Trichoderma viride* @ 5 g/kg seed + FYM @ 4 t/ha followed by foliar spray of NSKE @ 3 % at 30 and 40 days after sowing increased cowpea green forage yield by 32.28 per cent over untreated control with minimum pests and diseases incidence.
- Inoculation of Azotobacter / Azospirillum to sorghum and maize in normal pH with moderate doses of nitrogen (40-60 kg N/ha).

COMMERCIAL CROPS

Important Crops in the Region

The region comprises states of Assam, Sikkim, Mizoram, Arunachal Pradesh, Nagaland, Tripura, Meghalaya and Manipur. Sugarcane is an important crop of Assam in North East region, while Jute, Mesta and Ramie are the other important commercial crops in this region.

Area, production and productivity

With an area of 28000 hectares and production of around eleven lakh tonnes of sugarcane, there is further scope for improvement of sugarcane productivity from the present level of 38 tonnes per hectare in Assam. Similarly, productivity enhancement is desired in Jute from the present level of 1974 kg/ha so that production can be increased from the present level of seven lakh bales (180 kg each bale). Concerted efforts are called for improvement in production and productivity of Jute and Mesta in respect of other States like Tripura, Meghalaya and Nagaland.

Area, production and productivity of Sugarcane in Assam

Year	Area ('000 hectare)	Production ('000 tonnes)	Productivity (t/ha)
2005-06	23	871	37.2
2006-07	27	1055	39.1
2007-08	26	980	37.7
2008-09	28	1100	38.4
2009-10	28	1076	38.4

Source: *Cooperative Sugar August, 2010*

Research Support in the Region

Sugarcane

In Assam region, research network on sugarcane is organised with the involvement of Buralikson centre of Assam Agricultural University, Jorhat through the All India Coordinated Research Project on Sugarcane.

Jute, mesta and ramie

Ramie Research Station, Central Institute for Research on Jute &Allied Fibres of ICAR is located at Sorbhog, Assam and extends research support on various aspect of jute, mesta and ramie cultivation. All India Network Project on Jute & Allied Fibres of ICAR has a centre in Assam Agricultural University at Nagaon and carries out trials for developing location specific technologies for jute, mesta and ramie.

Major Achievements

Recommended varieties

Sugarcane

Early maturing varieties for Assam : CaBIn 9101, CaBln 9102 and CaBln 9103
Mid-late maturing varieties for Assam : CaBln 9104 and CaBln 9605

Jute

C. capsularis - JRC-80, JRC-7447, JRC-698, Bidhan Pat-I,2,3
C. olitorius- JRO 524, JRO-632, JRO-8432, JRO-66, JRO-7835, JRO- 878

Mesta

AMV-I, AMV-2, AMV-3, AMV-4, HS-4288, HS-791O, AMC 108, HC-583, MT-150

Ramie

R-67-34 (Kanai)

Important Package of Practices

Sugarcane

In order to sustain higher cane and sugar yield through integration of nutrient sources and maintaining soil health status, sugarcane crop should be fertilized with 100% of the recommended NPK fertilizers + 25% N through FYM + biofertilizer *(Azotobacter* + PSB) and 100% of the recommended NPK through inorganics + trash incorporation with cellulolytic culture + biofertilizers in ratoon crop. This improves significantly soil health by enriching the

organic carbon content. Single super phosphate (SSP) and diammonium phosphate (DAP) are both equally effective and sugarcane crop should be fertilized with 60 kg P_2O_5/ha. As regards zinc nutrition, 20-30 kg $ZnSO_4$/ha is sufficient.

Pre-planting conservation tillage techniques in sugarcane based cropping system

Pre-planting tillage operations can be economized to the extent of 50% by using rotavator twice over conventional tillage in late-planted sugarcane crop following wheat crop in light soils.

Ratoon management

For multiple ratooning, integrated use of agro-technologies *viz*., stubble shaving, gap filling, trash mulching and cultivation in alternate rows with use of phorate (15 kg/ha) has been found effective to sustain higher ratoon yields. Keeping ratoon beyond third crop does not appear to be economical. As component technology, trash mulching and gap filling have been identified as critical technologies to sustain multiple ratoon productivity.

Weed management

Metribuzin 1.0 kg a.i./ha or ametryn 2.0 kg a.i./ha or atrazine 2.0 kg a.i./ha as pre-emergence application followed by 2,4-D @1.0 kg ai/ha at 60 days after planting and one hoeing at 90 days after planting has been found effective and recommended for effective and economic weed control in sugarcane.

Integrated pest management

Soil application of chloropyriphos 20 EC or endosulfan @ 1.0 kg ai/ha at planting, removal of shoot borer infested dead-hearts, removal of egg masses of top borer in I and II brood and release of parasites emerging from egg masses in the field, application of carbofuran 3 G @ 1.0 kg ai/ha against III brood of top borer, removal of lower dry leaves in November and late/water shoots at 30 days interval from November onwards in stalk borer prone areas were effective in reducing the insect-pest infestation in sugarcane crop and sustained cane yield.

Jute, mesta and ramie

Fertilizer schedule

C. olitorius: Under rainfed upland condition - N: P_2O_5:K_2O (40:20:20 kg/ha) + FYM @ 5 t/ha; Liming @ 2.5 t/ha in acid soils (once in 3 years) Dolomite @ 10 -15 kg/ha for soils having pH 5.5 or below; $ZnSO_4$ @ 5 kg/ha depending upon Zn deficiency symptom and Nitrogen to be added in 2 splits: 4-5 WAS & 6-7 WAS.

C. capsularis: Under rainfed lowland condition - N: P_2O_5:K_2O (60:30:30 kg/ha) + FYM @ 5 t/ha+borax @ 10 kg/ha; Liming @ 3 t/ha (once in 3 years) Dolomite @ 10 - 15 kg/

ha for soils having pH 5.5 or below; $ZnS0_4$ @ 5 kg/ha depending upon Zn deficiency symptom and Nitrogen to be added in 2 splits: 4-5 WAS & 6-7 WAS.

Weed management: Trifluralin (0.75 - 1.0 kg a.i./ha) as pre - plant incorporation 1 day before sowing and / or post emergence application of Quizalofop ethyl (50 - 75 g a.i./ ha) at 21 DAS gives better control of grassy weeds. 2- 4 wheel hoeing (at 2, 3, 4 & 5 WAS) gives better weed kill. Mulching with paddy straw / organic wastes (10 t/ha) or intercropping with red amaranth has given better weed control.

Plant protection measures

Major insects and Control measures: Stem weevil (*Apion corchori*), jute semilooper (*Anomis sabulifera*), yellow mite (*Polyphagotersonamus latus*), Bihar hairy caterpillar (*Diacrisia obliqua*).

Endosulfan 1 ml or Chlorpyriphos @ 2 ml / l of water - 2 sprays (depending upon the intensity of infestation) at an interval of 15-20 days beginning from 45 days crop age. Phosalone (0.075%) 2-3 sprays (depending upon the intensity of infestation) at 15-20 days intervals.

Diseases and control measures: *Macrophomina phaseolina* diseases (seedling blight, damping off, collar rot, stem rot, root rot); Anthracnose caused by *Colletotrchum corchorum* in *C. capsularis* is a major disease.

Seed treatment with Carbendazim (1 g kg of seed) or Mancozeb (5 g kg seed) or *T. viridi* (10 g /kg of seed) for protection from *Macrophomina phaseolina* disease. Liming @ 2-3 t/ha in soils having pH 5.5 or less - controls root- rot caused by *Rhizoctonia bataticola* Application of potash prevents stem rot *(M. phaseolina)* and root rot. Improved drainage, crop rotation (jute-paddy in rainfed condition and jute-paddy-wheat in irrigated condition) and 2 - 3 sprayings of Carbendazim (0.2%)/copper oxychloride (0.75%) - need based; alternate spraying of both at 10 days interval can be done in case of severe infection.

Seed Production: 550 q breeder seed of improved varieties of sugarcane was produced by the centre in Assam. Ramie rhizomes are produced in Ramie Research Station, Sorbhog, Assam and distributed to the North eastern states as well as in non-traditional areas like Goa, Dapoli, etc. Novel True Ramie Seed (TRS) Technology has been developed for the rapid popularization and extension of ramie even in the non conventional areas of the country. True ramie seed was produced (12 kg) for distribution.

Major Constraints

Sugarcane

Insect pests *viz.*, early shoot borer, plassey borer, top borer as well as water logging and drought adversely affect the production of the crop in different areas. Inadequate availability of good quality seed of improved varieties and lesser awareness among farmers for adoption of latest technologies are the major constraints in sugarcane cultivation. In Assam, acidic soils are the major constraint in increasing sugarcane productivity.

Jute, mesta and ramie

Non-availability of good quality seeds, higher cost of cultivation particularly for inter-culture operation, retting process and non-availability of clean water for retting besides lack of proper marketing facility of the fibres act as impediment in enhancing area and production. There is a felt need for mechanised farming in order to overcome drudgery and also to reduce cost of cultivation besides ensuring timely operations.

Suggestions for Improvement

Sugarcane

- Further impetus to development of varieties with high sugar and high cane yield together with tolerance to red rot.
- Development of varieties tolerant to water logging, drought and acidic soils.
- Mechanization in sugarcane production as per location specific need.
- Training of farmers and development workers on improved technologies.
- Strengthening of development work by State Govt. Departments.

Jute, mesta and ramie

- Development of varieties for quality fibre and resistance/tolerance to biotic and abiotic stresses with timely adoption of INM and IPM practices in Jute and Mesta.
- Provision of incentives to farmers on purchase of machines - seed drill, bast fibre extractor, etc.
- Adoption of mechano-microbial method of retting for lesser water requirement and better fibre quality.
- Speedier purchase of fibres during the peak season of fibre marketing with stress on farmers to form cooperatives for the purpose of marketing.

OILSEEDS & PULSES

Rapeseed-Mustard, Soybean, Sesame, Groundnut, Pigeon pea, Urd bean, Mung bean, Lentil and Chickpea are some of the oilseed and pulse crops cultivated in the region.

Research support in the region

The following All India Coordinated Research Projects (AICRP) of ICAR operate in the region for providing necessary support to research needs of the region in specific reference to the crop.

Crop	AICRP Centres
Soybean	CAU, Imphal, Manipur; COA, Medzipharma, Nagaland; AAU Bishwanath Chariali, Assam
Rapeseed-Mustard	CAU, Imphal, Manipur; AAU, Shillongani, Assam
Linseed	AAU, Shillongani, Assam
Groundnut	CAU, Imphal , Manipur
MULLaRP	AAU, Shillongani, Assam; CAU, Imphal, Manipur; ICAR Research Complex, Agartala, Tripura
Pigeon pea	COA, Medzipharma, Nagaland; CAU, Agartala, Tripura
Chickpea	AAU, Shillongani, Assam; CAU, Imphal

Major Achievements and Recommendations

Varieties of Oilseeds and Pulses Crops that have been developed and recommended for the region are given below:

Crop	Improved varieties
Rapeseed-Mustard	Sej-2, JD 6, Kranti, NDRE 4 (early duration), NPJ-112, Toria: PT-507; Yelollow sarson: Ragini, Subinoy, NRCYS 05-02, YSH - 401
Groundnut	TG-38 B, Vasundhara (Dh 101), TG-51, Vijetha (R 2001-2), Girnar-3(PBS-12160), GPBD-5
Soybean	NRC 2, JS 80-21, PK 472, MAUS 71, Pratap Soya (RAUS 5), Bragg, Indira Soya 9, Pusa 16, JS 335, RKS 18, JS 97-52
Linseed	Shekhar, Sweta, Shubhra, T- 397
Sesame	Uma, Rama, Krishna, JTS-8, TKG-21, TKG-22, TKG-55, Nirmala-22
Niger	JNS-9 , Biras Niger-2, BNS-10, NRS 96-1
Lentil	KLS 218, HUL 57, WBL 77, K 75, VL 507, VL 126
Urdbean	Azad Urd 1, Utara, WBU 109, NDU 99—2, Pant U 31, Pant U 40
Rajmash	Amber, Utkarsh, PDR 14, Hur 15
Mungbean	Pant M-4, HUM 12, Meha, TMB 37, HUM 16, AAU 34, Pusa 0672, KM 2241, Pant M-6
Pigeon pea	Bahar, Pusa 9 and UPAS 20
Chickpea	JG 74, KWR 108, Radhey, KPG 59, Pusa 372

Major Package of Practices

Rapeseed-Mustard

The recommended spacing is 30 cm row to row and 10 cm plant to plant for irrigated and 45 cm row to row and 15 cm for plant to plant for rainfed situation. Half of the fertilizer dose of nitrogen of (80: 40:40 Kg/ha. N,P, K.) is to be given at the time of sowing and remaining half of the nitrogen is to be applied after first irrigation. Two irrigations, first at 35 DAS and other at 65 DAS are recommended.

Control of mustard aphid: Balanced fertilization (NPK @ 80:40:40 kg/ha) is suggested as overdose of nitrogenous fertilizers attract aphid attack in mustard; Plucking and destruction of infested twigs is essential and should be done 2-3 times at ten days interval in the crop season; Use dimethoate 30 EC @ 0.1% for three sprays at fifteen days interval.

Control of alternaria blight: Spray the crop with mancozeb @ 0.2% at 50-60 days after sowing followed by two more sprays at 30 days interval depending upon severity of the disease; Collect and burn the diseased plants debris to minimize the primary source of inoculum. For control of white rust, use the seeds from disease free plants to avoid carry over of spores through seeds and treat the seeds with Apron 35 SD @ 6 g/kg seeds and destroy the diseased plant debris.

Groundnut

Row to row spacing for Spanish bunch type should be kept 30x10 cm and for Virginia types 15x15 cm. For effective weed management, pre-emergence application of pedimethalin @ 1.0 kg a.i/ha plus one hand weeding at 40 days after sowing is recommended. Sesame+Spring groundnut (4:2) inter cropping is suggested.

Pulses

Integrated nutrient management strategy with 18-20 kg N, 40-60 kg P_2O_5 and 20 kg k_2O and 20 Kg S per ha alongwth inoculation using rhizobium culture. Basal application of 25 kg $ZnSO_4$ is suggested for zinc deficient soils. For effective weed control, two hand weeding at 30 and 60 days after sowing with pre-emergence application of pendimathalin @1 kg a.i./ha is recommended.

Chick pea:

Planting time

Rainfed condition	:	2nd fortnight of October
Late sown condition	:	1st fortnight of December

Seed rate spacing

Rainfed condition	:	60-70 kg/ha	30x10 cm
Late sown condition	:	80 kg/ha	30x10 cm

Lentil

Rainfed : 40-45 kg/ha, 25x5 cm spacing
Utera : 50-55 kg/ha in standing crop of rice

Late sown lentil crop in rice fallow can be taken successfully with 20 % enhanced seed rate. Spray 2% urea solution at the time of flowering.

Urdbean and Mungbean

Planting time : *Kharif:* 25 July – 15 August, Spring 2nd fortnight of February to 1st fortnight of March.
Seed rate : 15 kg for *kharif* and 20-25 kg for spring season.
Irrigation : 1st irrigation at 30 DAS and 2nd and 3rd after 10 days intervals in spring crop.
Insect pest : Spray of emidachloprid at the time of flowering to control thrips.

Pigeonpea

Soil application of lime @ 200 kg/ha and seed inoculation with molybdenum @ 4 g/kg of seed was found to enhance the yield of pigeonpea in acid soil.

Cropping system: Intercropping Pigeonpea with millets/ Munbean/Urdbean / Sesamum by pairing Pigeonpea row at 40/60 cm and planting one row of intercrop.

Major Constraints

Rapeseed-Mustard

Crop is cultivated in marginally poor soil.
Lack of awareness among farmers about the latest technologies.
Problem of diseases (Alternaria blight and white rust) and insect pest (aphid).
Delayed sowing of crops in the rice based cropping system.

Groundnut

Rapid loss of viability in the produce of *rab*i-summer groundnut which renders kernels unfit to be used as seed for sowing in next rabi summer season in Groundnut.

Chickpea

Non –availability of certified seed of high yielding varieties.
Pulses are mainly grown in acidic soils.
Non-availability of improved technology of zero tillage in rice fallow.

Pigeonpea

Long spell of foggy weather resulting in flower and pod drop.
Most genotypes are photo thermo sensitive also having low harvest index.

Mungbean and Urdbean

Non availability of seeds of improved varieties resistant to major diseases.
Flower drop due to high infestation of thrips at flowering resulting in excessive vegetative growth.

Production and yield of total oilseeds in North Eastern States

State	Area 000 ha		Production 000 tones		Yield kg/ha	
	2007-08	2009-10	2007-08	2009-10	2007-08	2009-10
Assam	266.0	404.0	139.0	215.9	522	784.9
Manipur	2.1	570.4	0.9	442.6	428	775.0
Meghalaya	10.0	10.3	6.7	6.94	670	620.4
Nagaland	76.0	104.2	68.1	860.0	896	825.0
Sikkim	8.6	10.0	7.5	8.2	953	820.0
Tripura	4.0	4.3	2.7	6.2	675	1124

Rapeseed Mustard area, production and yield in Assam

State	Area 000 ha		Production 000 tones		Yield Kg/ha	
	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10
Assam	226.4	233.0	122.9	121	542	519

Production and yield of total pulses in North Eastern States

State	Area 000 ha		Production 000 tones		Yield kg/ha	
	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
Arunachal Pradesh	7.7	8.5	8.3	9.0	1078	1059
Assam	113.0	113.7	63.0	64.5	558	567
Manipur	14.5	12.9	7.2	6.5	497	504
Meghalaya	4.0	4.5	3.3	3.9	825	867
Mizoram	5.1	4.0	2.7	3.6	529	900
Nagaland	35.0	33.0	41.6	39.7	1180	1203
Sikkim	12.5	12.6	11.6	11.8	928	937
Tripura	6.8	6.1	4.7	4.4	691	721

PROGRESS OF RESEARCH IN PLANT PROTECTION

The direct involvement/commitment of plant protection programme in the region (Assam, Sikkim, Mizoram, Arunachal Pradesh, Nagaland, Tripura, Meghalaya & Manipur) are as follows:—

Assam

The following All India Coordinated Crop Improvement Project are in operation:

1. Plant parasitic nematodes with integrated approach for their control (AICRP)	AAU, Jorhat
2. Biological control of crop pests and weeds (AICRP)	AAU, Jorhat
3. Honey bee & pollinators (AICRP)	AAU, Jorhat
4. White grubs and other soil arthropods (AINP)	AAU, Jorhat
5. Rodent control (AINP)	AAU, Jorhat

Major Achievements

Ufra nematode, (*Ditylnchus angustus*) on rice from North Lakhimpur, Dhemaji, Jorhat and rice root-knot nematode, *Meloidogyne graminicola* and rice root nematode *Hirschamaneilla oryzae* from Barpeta, Dhubri, Goalpura, Bongaigaon, Golaghat, Jorhat, Darrang, Sonitpur, Sibsagar, Tinsukia, Nalbari, Lakhimpur and Dhemaji districts of Assam were the major economically important nematodes causing appreciable losses on rice in the state. The rice varieties *viz*., INRC-7040, W-1263, INRC-9061, INRC-9523 and INRC-7948 were identified to be resistant to *M. graminicola*. *M.graminicola* was effectively managed by carbofuran application in nursery bed @ 1 kg a.i./ha followed by main field treatment with the same chemical and at the same dose 40 days after transplanting thus resulting in enhancement of yield by 18.35 per cent over untreated control.

Large scale IPM based demonstration trials showed that the IPM package resulted in lower population of GLH and reduced damage by stem borer and leaf folder than in farmers' plots. Cost-benefit analysis showed a net return of Rs.8,550 per ha in IPM package over farmers practice.

Germplasm of *Apis cerana* has been evaluated for brood area, which was found maximum (1810.5cm) during February, 2010. Significant increase in fruit set (70.25%) in guava by placing *Apis cerana* hives (5 hives/ha) was observed.

Lepidiota mansueta has appeared as key pest of potato, sugarcane, blackgram and *Colocasia* affecting almost ten villages in Majuli of Jorhat district of Assam. The preliminary investigation carried out on this species of whitegrub revealed that this species leans towards biennial life cycle, which is first of its kind from North East India. An entomophilic nematode has been isolated from the grubs of *Lepidiota mansueta* from Majouli, Jorhat. While evaluating microbial control against whitegrubs in green gram, it was found that *Metarhizium anisopliae* treated plots recorded lowest plant mortality (11.83%) as compared to the untreated control after days of sowing of the crop the field evaluation of some liquid insecticides against whitegrubs in Colocasia crop revealed lowest crop damage in fipronil 5 SC @ 150g/ha treated plots (6.4%) as compared to the untreated control (21.57%).

Maximum rodent damage was recorded in Bao paddy (13.75 %), however sugarcane fields recorded highest burrow density of 35.8/ha. The appropriate time of application of the rodenticide in irrigated summer or "Boro" rice was found to be the panicle initiation stage.

Mulching in potato fields was found to provide very conducive microclimate to rodent as maximum damage and rodent abundance was recorded in potato mulched with water hyacinth. Similarly, potato intercropped with pumpkin also registered higher rodent attack. *Vitex nigundi* followed by *Polygonum* sp leaf powder mixed with rice @ 20 g/kg showed anti rodent properties. Improved metallic rat guard, on pillars of local storage structures (Lakhmi Bhoral), was found effective in protecting stored grains from rodents.

Tripura

The following Network Research Project is in operation:
Network Project on Insect Biosystematics at Tripura University, Tripura

Major Achievements

Field surveys covered 41 locations in 13 districts of 4 states; 2751 insects collected from 51 economically important plants of 30 families; from these 142 species and 117 genera under 84 families of 9 order indentified, including 27 species of *Aphididae* (*Hemiptera*) and 24 species of *Coccinellidae* (*Coleoptera*). Five taxonomic keys for crop infesting aphid prepared. Morphological characterization of the mustard aphid, *Lipaphis erysimi* and cotton aphid, *Aphids gossypii* was done with reference to host plant specialization and seasonal forms, and phenotypic plasticity was documented. Illustrated keys were prepared for *super families* and families of *Auchenorrhyncha*. Fact sheets of 8 aphid species were prepared. Thirty insect species were documented on brinjal, which revealed that 12 species cause damage, and 5 species are natural enemies. Species richness and abundance of butterflies in urban and rural locations of Tripura was studied.

Meghalaya

The following Network Research Project is in operation:
Network Project on Biosystematics at NEH Region, Barapani

Major Achievements

Field surveys covered 2374 ha in 6 states using modern techniques. Collected specimens were indentified up to order, and morphological characterization done in *Lipidoptera* (butterflies), *Diptera* (*Tephritidae*) and *Coleoptera* (*Chrysomelidae* and *Apionidae*). Sixty six species (*Coleopdtera, Hemiptera* and *Lepidoptera)* identified from IARI, New Delhi. 110 species of butterflies (new to collection) identified through morphological characterization. Identification service was provided to two users.

Arunachal Pradesh

The following All India Coordinated Crop Improvement Project are in operation

Rodent Control (AINP)	CAU, Pasighat
Agricultural Ornithology (AINP)	CAU, Pasighat

Major Achievements

The lesser bandicoot rat, *Bandicota bengalensis*, was reported from crop fields in wetland rice crop areas. Eight other rodent species collected from the state were sent to ZSI for identification. Incidence and damage of rodents in wet land rice crop indicated live burro density/ha, trap index and tiller damage to the tune of 15.3, 13.3 and 2.20%, respectively whereas, the same in *jhum* rice were 5.87,19.6 and 7%, respectively. Pineapple crop experienced 11.8-15.5 % rodent damage in East Kameng and West Kameng of Arunachal Pradesh district.

A total of 470 species of birds were recorded in Arunachal Pradesh and 274 in Manipur region. Documented different species of owls and their importance in agricultural landscape, especially in the context of rodent management. Distribution pattern of agriculturally important bird fauna in relation to different crops were documented.

Nagaland

The following All India Coordinated Crop Improvement Project is in operation:

Honey bee & Pollinators (AICRP) at SARD, Medziphema

Major Achievements

This centre was sanctioned in May, 2009 and morphometric studies on sting bees revealed the presence of *Trigona canifrons*, *T. lutea* and *T. iridipennis* in Nagaland. Bee forage plants of *Apis cerana* and stingless bees of the Medziphema region have been identified.

Mizoram

The following Network Research Project is in operation:

Pesticide Residues (AINP) at Central Agriculture University, Selesih, Aizawl, Mizoram

Major Achievements

The Network Coordinator guided the PI in the College of Veterinary Sciences and Animal Husbandry, CAU, Selesih, Aizawl, Mizoram for the establishment of voluntary centre of All India Network Project (AINP) on Pesticide Residues in NE region. Centre will initially take up vegetable and rice as main commodities for analysis of pesticide residues.

B. STATUS OF RESEARCH ON NATURAL RESOURCE MANAGEMENT

The NRM Division of ICAR has been progressively looking in to the overall agricultural research in the region through its constituent institute. ICAR-RC-NEH Region, Barapani that looks after the researchable issues of agriculture in the north-eastern hill region excluding Assam. Assam Agricultural University, Jorhat has been addressing the agricultural issues in Assam. The recently established Central Agricultural University (CAU), Imphal having its colleges in different north-eastern hill states has also been contributing to agricultural research and education in the region.

The Research Complex at Barapani is administered by NRM Division of ICAR with a mandate of holistic and integrated research agenda to improve production, productivity and sustainability through viable and eco-friendly technologies through appropriate natural resource management.

The challenges of the NE Region

- Problems of low productivity and food insecurity.
- Improvement of productivity of *jhum* areas and conservation of agri-biodiversity.
- Soil acidity and water scarcity during lean season were two major hurdles for improving productivity.
- Alternate farming systems through agroforestry and/or integrated farming systems models.

Outcome of NRM research in the region III have been listed below

A. Agri-biodiversity, variety development and release

- 3000 agri-horti crop germplasm were collected, screened and identified; 1400 of them were preserved in gene bank.
- 274 ornamental fish species were collected and identified from the region. Their captive breeding is presently being taken up.
- Seven paddy varieties, four for mid-altitude and three for valley land ecosystems with yield potential of 3.5 – 4.0 and 5.5 to 7.0 t/ha, respectively were developed and released. Since 2005, these varieties are being grown by the farmers of these two ecosystems particularly in Meghalaya and Manipur states.
- Three varieties of tomato with yield potential of 53.3 to 63.7 t/ha were released and also put under All India Vegetable Improvement trials.
- One variety of turmeric, Megha Turmeric – 1 having yield potential of 25.0 t/ha and curcumin content of 6.8 per cent was released. The variety, due to its higher yield (25 t/ha against 15.5 t/ha from the existing ones), has become very popular.
- Two composites (RCM 1-1 and 1-3) and one popcorn (RCM 1-2) are ready for release.

- Two genotypes of high altitude rice (RCPL1-10C & RCPL1-12C) are ready for release.
- Two genotypes of tomato (Megha Tomato 1 & 2) have been proposed for release.
- Two genotypes of brinjal developed by the institute (RCMB-1 & Sel-5) are in the last year of AICVIP trial.
- Two high yielding genotypes of ricebean, two of blackgram, two of pea and one of pigeon pea are under multi-locational trials for release.

B. Agronomic Practices

- Needed package support for production and protection of developed and screened varieties were developed.
- Zero tillage methodology for rice cultivation standardized. Raised and sunken bed technology for marshy lands standardized.
- Technology development for organic agriculture - the institute is taking lead in the region.
- Developed bio-organics from weed flora as crop growth promoter.

C. Soil Management

- Liming has been recommended for acid soil management.
- Developed software for acid soil amelioration measures.
- Soil fertility map of north-eastern region was prepared on the basis of information available from different soil testing laboratories of the region.

D. Water Management

- Water requirement for tomato and capsicum for cultivation in terraces computed.
- A low cost micro rainwater harvesting structure *Jalkund*, has been designed and standardized for hill tops.

E. Agroforestry & Integrated Farming Systems

- Multi-tier agroforestry system like multipurpose trees + Pineapple + Black pepper has been developed and introduced.
- Intensive Integrated Farming System (IIFS) technology benefiting from system approach and complementarities of crop-livestock-fish systems was developed.
- Farming system technology developed could reduce the soil erosion from 46 t/ha/yr earlier to the level of 8 – 10 t/ha/yr.

F. Horticulture

- Citrus rejuvenation package was developed to address the issue of citrus decline.
- Package of high density pineapple planting with 55,000 suckers/ha against the practice of 25,000 suckers/ha was developed.
- Strawberry was introduced in mid-hill situations in Meghalaya and Sikkim. In Meghalaya, it is currently being grown by farmers leading to the opening up of scope for diversification.

- Passion fruit was introduced among farming communities in Manipur, Nagaland and Sikkim.
- Kiwi fruit was popularized in Sikkim.
- Cole crop like broccoli was introduced.

G. Animal Science & Fisheries

- Developed DNA-based animal disease diagnostic technique for faster diagnosis and control of animal diseases.
- Developed DNA-based parasitic disease diagnosis kits for field veterinarians and also software of for protozoan parasitic profile.
- Developed DNA-based protocol for sexing of ducks and chicks.
- Perfected artificial insemination technology in pig and popularized it at village level.
- Standardized fish breeding programme and addressed the issue of non-availability of fish fingerlings.
- Two hundred and seventy four fish species belonging to 27 families were identified in NEH region. Technologies for paddy-cum-fish culture, composite fish culture and production of common carp seeds were developed.
- Introduced Vanaraja dual-purpose birds in the region to promote backyard poultry.

H. Agricultural Implements

- Improved farm tools and implements are being manufactured in the institute and introduced in the region.

The regional researchable issues have also been addressed through coordinated projects by different research institutions and universities in agriculture sector. The outcome of the different centres/institutions/universities have been summarised below:

Outcomes of Project Mode Research in Agriculture Sector in Region III

1. AICRP on farming system rsearch

In the Regional Committee-III comprising of NE States (Assam, Megahalya, Manipur, Tripura, Arunachal Pradesh, Mizoram, Sikkim and Nagaland), the AICRP on Integrated Farming Systems has done integrated farming systems research at Assam Agriculture University, Jorhat and ICAR Research Complex at Barapani.

1.1 AAU, Jorhat

- The highest rice equivalent yield (REY) of 16.5 t/ha was obtained with winter rice-cabbage-greengram sequence followed by winter-rice-cauliflower-blackgarm sequence (15.2 t/ha). Under farming systems research programme, work on integrated farming system - crops (field crops + horticultural crops) +cattle+ fishery+ apiary as subsidiary enterprise is in progress.

- At Karimganj, under on-farm trials the highest productivity and profitability were recorded (i) with the application of recommended doses of NPK fertilizers followed by N & P, N& K and N in descending order, (ii) in the diversified/intensified cropping systems compared to the existing systems and (iii) by following improved package of practices (improved variety, line sowing, optimum spacing and plant population, recommended NPK, weed management/plant protection measures, etc.) compared to farmers' practices.

1.2 ICAR Research Complex –Barapani

Integrated intensive farming system model and an integrated silvi-pasture system have been developed for demonstration.

2. AICRP on agro-meteorology: All India Coordinated Research Project on Agro-Meteorology (AICRPAM) has one centre at AAU, Johrat.

2.1 AAU, Jorhat

- Crop-weather relation studies in potato showed significant positive relation of tuber yield with soil temperature during stolon formation stage and sunshine hours at maturity stage.
- Yield of rice was observed to be influenced positively by accumulating mean temperature during maturity stage, maximum temperature & relative humidity during flowering stage and rainfall during maturity and panicle initiation stages.
- The effect of weather conditions on the number of days to attain different phenological events under three dates of sowing in respect of three varieties of Sali rice *viz.*, Mahsuri and Maniram and Piolee was less in short duration Mahsuri compared to other long duration varieties.

3. AICRP on dryland agriculture: The AICRP on Dryland Agriculture coordinating centre Jorhat has done work on rainwater management, integrated nutrient management, energy management and cropping systems. The salient achievements are given as under:

3.1 AAU, Jorhat

3.1.1 Rain water management

- The yield of the potato (Kufri Megha) was significantly affected by date of sowing and mulching. The highest yield (12.06 t/ha), BC ratio (1.51) and rain water use efficiency (123.3 kg /ha/mm) were obtained when potato was sown on 23rd November and grown under mulch. The lowest yield (8.46 t/ha) and BC ratio (1.10) were obtained with 14th December sowing under no mulch. The yield of potato decreased by 7.54 and 20.6% when sowing was developed by 10 and 20 days, respectively. Mulching with rice straw increased the potato yield by 9.3 to 18.0%. However, the effect of mulching reduced with delayed sowing. Mulching

conserved more soil moisture by 5.7 to 13.3% over no mulch under different dates of sowing.

3.1.2 Integrated nutrient management

- The grain yield of kharif rice ranged from 2630 to 4060 kg/ha. Maximum grain yield, gross income and B:C Ratio were attained by 50% RDF (inorganic) + 50% N (organic), followed by 50% N (inorganic) + 50% N (organic) + PK treatment.
- The yield of niger (NG-1) grown after kharif rice ranged from 48 to 283 kg/ha, the highest attained with 50% RDF (inorganic) + 50% N (organic) and RWUE of 4.61(kg/ha mm).
- In a soil test crop response correlation study, highest yield of kharif rice (Ranjit) was recorded with the application of 40:80:40 kg/ha NPK. The treatment gave a yield of 5533 kg/ha and RWUE of 5.86 kg/ha mm.

3.1.3 Energy management

- Maximum yield (713 kg/ha) of *toria* (TS-38) was obtained under two harrowing + one pulverization by power tiller. The treatment gave maximum B:C ratio (4.06) and RWUE of 26.41 kg/ha mm.

3.1.4 Cropping system

- Rice-Pea cropping system resulted in the highest rice equivalent yield of 5079 kg/ha and net return of Rs. 30348/ha with B:C ratio of 2.54. The grain yield of *kharif* rice under the sequence remained at par with the rice-linseed sequence.

4. AICRP on weed management: AAU Jorhat centre has carried out weed management research in rice and other crops.

***4.*1 AAU, Jorhat**

- Weed Atlas for different ecologies has been prepared.
- Utilization of aquatic weeds for agricultural purposes are being worked out.

5. AICRP on agroforestry: AAU (RS), Mandira and ICAR-RC-NEH Region have developed suitable agroforestry models for the valley and the hilly environments.

5.1 AAU, RS, Mandira

- Pasture-based agri-silvicultural systems have been developed for valley systems.

5.2 ICAR Research Complex, Barapani

- Several agroforestry sytems such as Agri-Sivil, Silvi-horti and Agri-Silvi-Medicinal systems have been developed for intervention as an alternative to *jhum* cultivation in the hilly states.
- Quality planting materials of different multipurpose trees and medicinal and aromatic plants were raised and distributed to progressive farmers.

6. AICRP on water management:

6.1 AAU, Jorhat

- In sandy loam soils, provision of surface drainage at a spacing of 6 m showed encouraging result in increasing yields of *sesamum.*
- In sandy loam soils, banana (Cv.*Borjahaji*) should be irrigated through drip at 0.75 PE during lean period from November to March for higher fruit yield and should be fertigated with 75% recommended dose (RD) of N & K.
- Improved water management practice of 7 cm irrigation at 3 DAD in check basin recorded about 104, 29 and 41% higher yield of rice over farmers' practice in head, middle and tail reaches, respectively.
- Improved practice of 5 cm irrigation at 3 DAD produced 3.53 t/ha rice yield which saved 45% water and produced at par with the yield with farmers' practice of continuous submergence.
- Improved practice of reduced tillage (one cross ploughing with poor tillage) and optimum irrigation schedule produced 3.4 t/ha rapeseed yield which was as par with conventional tillage practices but saved 20-25% irrigation water.
- Improved irrigation practice of 4 cm irrigation in 20 days interval produced 10.4 and 24.5 t/ha yield of cabbage and tomato, respectively which was 18 and 20% higher than farmers practice thus saving 37 and 42% irrigation water.

6.2 ICAR Research Complex, Barapani

- In a maize-mustard sequence, maize stalk cover along with poultry manure and *Ambrossia* spp. @ 5t/ha produced 737.6 kg/ha mustard equivalent yield of the sequence.
- Application of straw mulch resulted in 14-30% increase in yield of vegetables like tomato, potato and pea indicating that irrigation could be saved without significant reduction in crop yield by applying straw mulch. Combination of weed (*Ambrosia sp*.,) and maize stalk applied as mulch enhanced moisture retention and nutrient supply capacity of soil thus enhancing the yield of vegetables and mustard during winter.
- Grain yield of rice was about 24 % higher in zero tillage adopted for all crops with residual retention compared to conventional tillage with residue removal mainly due to the higher organic carbon content and microbial biomass carbon.

7. Network project on organic farming: The NPOF has one centre at ICAR Research complex, Barapani.

7.1 ICAR Research Complex , Barapani

Organic nutrient supply gave better productivity of rice, maize, mustard, groundnut, potato, tomato, carrot and frencbean crops as well as quality of produce and soil health followed by integrated (organic+ inorganic) sources of nutrients.

8. AICRP on micro and secondary nutrients

8.1 AAU, Jorhat

- About 1600 soil samples were collected from four districts, namely Jorhat, Sibsagar, Golaghat and Dibrugarh and its analysis revealed that about 31 % samples were deficient in Zn and 18% in B.
- Iron toxicity problem observed in rice is one of the major constraints in reducing yield in low land rice.

9. Network project on BNF: In the region, only one centre of NPBNF is functioning at Assam Agriculture University, Jorhat. The centre has carried out studies on exploring soil biodiversity for biofertilizers, development of INM Package for rice based cropping systems and impact analysis of biofertilizer agents developed in different KVKs of Assam.

9.1 AAU, Jorhat

9.1.1 Exploring soil biodiversity for biofertilizers

Total 116 efficeint cultures of *Rhizobium* (45 cultures), *Azospirillum* (18 cultures), *Azotobacter* (21 cultures), PSB (27 cultures) and *Fluorescent pseudomonas* (5 cultures) from diverse agro-climatic zones of NE region are preserved for use as biofertizer agent.

9.1.2 Development of INM package for rice based cropping systems

(a) Development of bio-enriched compost

- Use of developed package of biofertilizers with compost @ 1t/ha could minimize the recommended nitrogenous and phopshatic fertilizers to 50% without any yield loss of crops in rice-toria and rice-wheat sequence.
- Biofertilizers with increased dose of compost @ 2 t/ha more specifically enriched compost could reduce recommended NP fertilizers below 50% in subsequent year due to cumulative effect of INM package.
- Incorporation of either enriched compost (EC) or biofertilizers with subsequent reduction in fertilizers resulted in higher biological activity in terms of greater microbial biomass carbon (MBC), higher dehydrogenase phosphomonoestease and FDA activity in soil.

(b) Azola dual culture in rice

- 7% increase in rice yield (4.2 t/ha) resulted from Azolla dual culture with 50% of mineral fertilizers (NP) over recommended dose of N and P (3.9 t/ha).
- Exhibited clear increase in biological activity in etrms of MBC, organic carbon, dehydrogenase and FDA.

9.1.3 Impact analysis of biofertilizer agents developed in different KVKs of Assam

- Average yield of s*ali* rice increased to 4.0-5.0 t/ha due to inoculation of *Azospirillum* & PSB with 50% N&P fertilizers over farmers practices of 2.5-2.8 t/ha with B:C ration of 1.6 to 4.0.

- In *boro* rice, 6.5 t/ha yield was obtained with combined inoculation against 6.0 t/ha through farmers practice.
- *Azospirillum* & PSB increased *toria* yield by 26% with average yield of 1.6 t/ha against 1.3 t/ha under farmers practice with B:C ratio ranging from 1.4 to 2.2.
- *Azospirillum* and PSB as seed treatment enhanced the fibre yield of Jute by 20.4% with B: C ratio of 1.9.

10. Future research programmes

Apart from furthering the ongoing research programmes, improvement in Agro Advisory Services (AAS) and downscaling of AAS to block level will be taken up under National Initiative on Climate Resilient Agriculture (NICRA).

C. STATUS OF RESEARCH ON HORTICULTURAL CROPS

North-Eastern Region comprising of states *viz*., Sikkim, Mizoram, Arunachal Pradesh, Nagaland, Tripura, Meghalaya and Manipur is highly productive for Horticulture. There has been substantial progress in fruits and vegetables sectors in last decade bringing self-sufficiency in many states of the country. There has been substantial increase in production of spices particularly turmeric and ginger and tuber crops. The research system has provided appropriate varieties and technologies through various research institutes/AICRPs/Network Projects located in north-eastern region.

I. FRUITS AND PLANTATION CROPS

Among fruits and plantation crops, mandarin variety Khasi Mandarin CRS-4 and coconut varieties Kamrupra, Kahikuchi Coconut Hybrid-1, KKHC-1, KKHC-8 and MGD were found suitable for north-eastern region.

Package of Practices

Banana (Jorhat)

- High density planting with three suckers per pit at a spacing of 2m X 3m (5001 plants/ha) has recorded higher yield and cost benefit ratio in cv. Jahaji.
- Application of 250:50:250g N:P_2O_5:K_2O per plant per crop with bunch spray of 2,4-D (10 ppm) has recorded higher yield and B:C ratio for cv. Borjahaji (AAA).
- The crop sequences of Knolkhol – Elephant foot yam or French bean – Colocasia – Spinach as intercrop under banana is beneficial.
- For the control of scarring beetle, suckers dip in chlorpyriphos (0.05%) and spray of chlorpyriphos (0.5%) or pouring Quinalphos (0.05%) 20 ml in heart is recommended.
- For the management of pseudostem weevils, chopped pseudostem pieces spread at ground level attracted maximum weevils in all the seasons under Jorhat conditions.
- Spray with propiconazole (0.05%) with petroleum based mineral oil (1%) was found to be the most effective treatments to manage Sigatoka leaf spot.
- Planting disease free suckers from disease free fields along with dipping in carbendazim (0.2%) for 45 minutes followed by carbendazim (0.2%) drenching at 5^{th}, 7^{th} and 9^{th} MAP was effective against soil borne diseases such as Panama wilt at Jorhat. Further, the disease map of six agro climatic zones of Assam for banana has been prepared.

Pineapple (Jorhat)

- Planting of Kew, Queen and Mauritius varieties with suckers of 5-6 month old having 500-750 g weight with an ideal planting time of April to Oct was recommended.

- Planting at 30cm X 45cm X 60cm in two-row beds (44,444 plants) with a nutrient dose of 12g N, 2g P_2O_5 and 12g K_2O per plant was recommended.
- Uniform flowering in the main season was achieved with spray of with Ethrel @100ppm and for delayed harvest by a few days (10-15 days) with spray of 300 ppm of NAA.

Khasi mandarin (Tinsukia)

- Inclusion of VAM (500 g/plant), PSB (100 g/plant), *Azospirillum* (100 g/plant) and *Trichoderma harzianum* (100 g/plant) with 450g N, 225g P_2O_5, 450 g K_2O and 5.625 kg neem oil cake (75% RDF) per plant per year has been recommended.
- Foliar application of copper oxychloride (0.3%) or carbendazim (0.1%) in combination with 2, 4-D (10 ppm) or NAA (30 ppm) recorded significantly higher fruit retention in Khasi mandarin.
- Orchard efficiency analysis at Tinsukia centre has indicated high soil and leaf NPK status of high yielding orchards as compared to low yielding orchards of mandarin.
- For the control of leaf miner, spray of imidachloropid 200 SL or acephate (0.1125%) and single application of thiodiocarb 75WP (75%) has been recommended.

Arecanut

Comparative study of the seasonal vegetables in areca interspaces and open condition: Six vegetables were grown in each season (summer/kharif and winter/rabi) with organic treatments *i.e.* cow dung, vermicompost and vermiwash. During summer season (April-July); okra, pumpkin, *Amaranthus tricolor,* ridge gourd, bitter gourd and chilli were grown whereas cabbage, carrot, peas, cauliflower, spinach and french bean were the winter season (November-February) vegetables. Benefit: cost ratio obtained from the average data of two years of summer vegetables grown in summer season revealed that, bitter gourd recorded the highest B: C ratio (6.41:1) followed by ridge gourd (4.68:1) in open condition whereas, ridge gourd recorded the highest B: C ratio (2.30:1) followed by bitter gourd (2.27:1) under areca interspace.

Water requirement and comparative efficiency of different systems (drip, sprinkler, basin) of irrigation in arecanut at different fertilizer levels: A field trial on "water requirement and comparative efficiency of different systems of irrigation in arecanut" is in progress with five irrigation treatments (I_0= no irrigation, control; I_1= drip at 33% E_0, I_2= 66% E_0, I_3= 100% E_0, I_4= sprinkler @ 0.75 IW/CPE, I_5= sprinkler @ 1.0 IW/CPE and I_6- basin irrigation) combined with four different fertilizer doses (F_0= no fertilizer, F_1= 1/3rd, F_2= 2/3rd and F_3= full fertilizer dose). Observations on the vegetative and inflorescence characters, and nut yield of arecanut palms under treatments has been recorded. Drip irrigation at 100% pan evaporation found effective in growth, yield (3.5 kg challi/palm/year) and moisture distribution/ utilization.

Development of *in situ* water conservation measures of arecanut suitable for watersheds of NE Region: For the development of *insitu* water conservation measures

suitable for watersheds of N.E. Region, the arecanut garden is maintained in the farmer's field with imposition of different soil and water conservation measures treatments like catch pit filled with coconut husk, catch pit with pineapple in downstream, staggered contour trenches, half moon trenches, and without any conservation measures. Among the different treatments catch pit filled with coconut husks showed best result producing 1.85 kg challi of arecanut per palm per year.

Developing Arecanut based cropping system model: Two arecanut based HDMSCS models (Model-1-arecanut (Kahikuchi selection) + pepper (Karimunda) + banana (Chenichampa) + citrus (Assam lemon) + clove (Improved variety) and Model-2-arecanut (Kahikuchi selection) + pepper (Panniyur- 1) + banana (Chenichampa) + citrus (Gandharaj lemon) + nutmeg) are being mainatined. Maximum biomass (12.1 and 7.6 t/ha in Model-1 and 2, respectively) was obtained from the plots applied with 2/3rd dose of recommended chemical fertilizer. All the crops except banana performed better under 2/3rd dose of recommended fertilizer, whereas, banana produced maximum fruit in full dose of recommended fertilizer irrespective of the models. Highest B:C ratio (2.98 and 2.11, respectively) was observed under 2/3rd dose of recommended fertilizer for both the models.

Eco-friendly IPM and IDM: Survey was undertaken in Boko, Singra, Bakrapara, Bakta and Kaharpara villages of Kamrup district and parts of Darrang district during the period. The incidence of bud rot in arecanut ranged from 0.5. to 1%, Ganoderma wilt was observed as high as 15% in Kaharpara village; in coconut the incidence of stem bleeding ranged from 2% to 10.12%, and as high as 8% infestation of rhinoceros beetle was observed in Darrang.

IDM for Ganoderma wilt/Basal stem rot of arecanut: A field trial on management of Ganoderma wilt/Basal stem rot of arecanut was initiated during 2009 to study the efficacy of different treatments. The treatment soil drenching with captan 0.3% (30 g/10 lit of water) + neem cake (2 kg/palm) and root feeding with 100% culture filtrate of *Trichoderma viride* (25 ml/palm) showed lowest mortality percentage (17%), highest annual leaf production & fewer drooping leaves (1.67).

II. VEGETABLES

The recommended varieties on vegetables are as under:

Onion: In case of onion, selection 126 and NRCWO-1 and NRCRO-2 have performed well.

Potato: High yielding varieties like Kufri Jyoti, Kufri Megha, Kufri Giriraj, Kufri Kanchan, Kufri Girdhari, Kufri Himalini and Kufri Himsona have been recommended for the NE states. The varieties like Kufri Jyoti and Kufri Giriraj are predominant in the region. Besides, Kufri Megha (late blight resistant) is popular in Meghalaya and Assam and Kufri Kanchan (red skinned variety) is preferred in Sikkim. The newly released varieties Kufri Giridhari, Kufri Himalini and Kufri Himsona are also being adopted by the farmers in the region.

Package of Practices

Production technology: Planting of potato in ridges with a spacing of 20 cm between plants and 60 cm between rows has been found optimum for Meghalaya. Major emphasis has been given to organic farming of potato and application of vermi-compost has been encouraged through establishment of vermi-compost units. Trials have shown that inorganic fertiliser could be substituted to the extent of 25% with organic sources as yields obtained were comparable with entirely inorganic sources. Remunerative potato based cropping systems have been recommended for Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, and Tripura *e.g.* potato – paddy – french bean, potato – paddy – carrot, potato – potato – vegetable in lower and higher hills and paddy – potato, black gram/green gram/kharif vegetable – potato, paddy – potato – vegetable in plains. Suitable varieties for early and late planting have been identified. Kufri Megha performed best irrespective of planting dates in the region.

For Assam, irrigation at 25-30 mm CPE and mulching with paddy straw or any other locally available organic mulch material @ 5 t/ha is recommended for higher yield of potato and net returns.

For Arunachal Pradesh, irrigation at 25-30 mm CPE and mulching with paddy straw or any other locally available organic mulch material @ 5 t/ha is recommended for higher yield of potato and net returns.

Protection technologies: Combinations of systemic and contact fungicides (2 sprays of 2.5% metalaxyl and 3 sprays of 2% mancozeb) were found most effective and economic in management of late blight disease in autumn TPS grown potato in the hills of this region. Potato tuber moth (PTM), a major problem at farmers' level storage, can be effectively checked using dried and chopped *Lantana camera* leaves, which is easily available in the locality.

Prophylactic spray (just at the time of canopy closure with Mancozeb @ 0.2% followed by Cymoxanil + Mancozeb @ 0.3% or Dimetnomorph 0.3% after one week and one more spray with Mancozeb @ 0.2% after another week should be adopted for late blight management in Assam and Arunachal Pradesh.

Storage technology : Farmers of NE states are unaware of scientific storage methods for both table and seed potatoes and the scarcity of cold storages prompts them to use various indigenous methods for *in situ* and *ex situ* storage. Through on-farm demonstrations, farmers have been trained on scientific methods of harvesting, tuber treatment and storage of seed under diffused light. The farmers have also been given the demonstrations on low cost table potato storage at their house holds in 5 villages in Meghalaya. Kufri Himsona with high dry matter, low sugars, phenols and resistance to late blight is likely to fulfil the aspirations of the region for a processing variety.

SEED PRODUCTION

In case of potato, disease free planting material of Kufri Jyoti, Kufri Giriraj, Kufri Himalini, Kufri Himsona, Kufri Giridhari and Kufri Megha are being produced through micro-plants and micro tubers under controlled condition and are being supplied to various states in

NEH region. About 160 quintals of disease free seed was supplied during 2009-10 and 208 quintals of seed was supplied during 2010-11 to different states of NEH region.

Impact of Improved Technology

In Assam, area under potato has been increased from 69600 ha to 865600 ha and production from 353700 tonnes to 589700 tones during 2005-06 to2009-10 respectively. Whereas, in Arunanchal Pradesh, production has been increased from 29800 tonnes to 31700 tonnes, though the area remained almost unchanged.

III. SPICES

Evaluation of local accessions of black pepper*:* Thirteen locally collected pepper accessions are being evaluated for growth and yield. All accessions flowered in the fourth year. Growth and yield data, and pests and disease incidence are recorded regularly. It was observed that KKHP-8 recorded maximum fresh berry yield (4.7 kg/vine) followed by KKHP-3 (4.5kg/vine) and maximum spike length was recorded in KKHP-3 (156.25 cm) followed by KKHP – 8 (140 cm).

IV. FLORICULTURE

Recommended Varieties

HRS, Kahikuchi, Assam

I. Tuberose: Shringar, Prajwal, Vaibhav and Suvasini

II. Gerbera: Rosalin, Sun Blast, Canary, Jawahar, HRS-G-White 40, Fame, Pride of India, Pink Melody, Red Gem, Red Monarch.

III. Orchids: Arundina, Aerides, Aranda, Arenthera, Bulbophyllum, Cymbidium, Dendrobium, Epidendrum, Oncidium, Phaijus, Rhyncostylis, Spathoglotis, Vanda and Vanilla.

IV. Gladiolus:

Very early variety: P-16-1, Suryakiran and Gold Beauty

Early variety: American Beauty, Novalux and Friendship

Early mid season variety: Tiger Flame, Her Majesty and Dhanwantry

Mid season variety: Red Candiman, Red Sea and White Prosperity

ICAR Research Complex for NEH Region, Barapani, Meghalaya

I. Gerbera: RCGH-117, Rosalin, Magnum, Cosmo and Black Jack.

Packages of Practices

HRS, Kahikuchi, Assam

Gladiolus

i. It may be recommended that a basal dose of bio fertilizer comprising of FYM 2 kg/ m^2 /year+ Mustard oil cake 200 g/m^2/year+Bio-fertilizers (VAM+*Azospirillum*+ PSB) @ 2g/plant at an interval of 2 months with *Trichoderma viride* 20g/m^2/year along with a common dose of inorganic fertilizer may be applied to increase flower and corm yield of gladiolus.

ii. Pre-planting dipping of gladiolus corms in the solution of *Trichoderma viride* (10^6 cfu /ml i.e. 10 g/l) for 45 minutes followed by the soil application of *T. viride* colonized on Neem cake (500 g/m^2) at the time of planting may be recommended for the management of *Fusarium* wilt in gladiolus.

Orchid

i. Standardization of biofertilizer doses: Application of NPK ratio of 20:10:10 @ 0.2% along with *Azospirillum* and Phospho bacterium each of 2g per plant at two month intervals may be recommended for suitable growth and flower production in *Dendrobium* spp.

ii. Pulsing of *Dendrobium* Cv. White with 500 ppm of HQ along with 5 per cent sucrose either for 6 hours or for 12 hours may be recommended for better vase life of orchid before transit.

iii. Combining pulsing of 500 ppm of HQ and 5% Sucrose for 6 hours then holding the flower spikes in the holding solution containing 25 ppm of $Ag\ No_3$ along with 400 ppm HQ and 5% Sucrose significantly prolong the vase life of cut orchid spikes.

iv. The spikes wrapped with polypropylene sleeves along with $KMnO_4$ before transit improves the flower longevity of cut spikes of *Dendrobium* Cv. Pompadour.

NRC Orchid, Pakyong, following package of practices have been developed

i. In *Cymbidium*, 75% the shade and application of 50% water (300 ml) on 6 inches size pot improved vegetative growth of plant in terms of plant height (38 cm), number of leaves (7.8 cm), leaf area index (580.90 cm^2) and flowering (3.2 spike/pot).

ii. In *Cymbidium*, spraying of nutrient N, P, K 19:19:19 @ 0.1% concentration at an interval of 7 days produced maximum no. of shoots (4.07) and higher girth of pseudobulb (2.57cm) while same nutrient at 0.3% concentration at 7 days interval improved plant height (67.79 cm) and number of leaves (14.4) and flowering (1.5 spike /plant).

iii. Among the different *Cymbidium* hybrids highest vase life was recorded in 'Sleeping Nymph' 56.90 days followed by 'Valley Flower Powder Puff' (52.86 days) and Baltic Glacier Mint Ice (41.81 days). Vase life was lowest in 'Valley Pink Inspiration' (29.00 days).

iv. 60,000 plants of Cymbidium orchids were produced and distributed to the farmers under various programmes.

v. Among the seven modules, M-5 (tobacco extract 5%, neem oil 0.03% EC 5 ml/lit and bifenthrin 10EC 0.25%) was found best for reducing 99.0 % mite population.

Tuberose

i. It may be recommended that a basal dose of bio fertilizer comprising of FYM 2 kg/m 2 /year+ Mustard oil cake 200 g/m^2/year+Bio-fertilizers (VAM+*Azospirillum* +PSB) @ 2 g/plant at an interval of 2 months with *Trichoderma viride* 20 g/m2/year along with a common dose of inorganic fertilizer may be applied to increase flower and bulb yield of tuberose.

ii. Potassium permanganate (25 ppm) and Aluminum sulphate (300 ppm) alone and in combination with sucrose 5% may be commercially used to extend the vase life of cut spikes of tuberose.
iii. Pre-planting bulb dip treatment in captaf (0.3%) followed by soil drenching with captaf (0.3%) @ l.5 l/ m^2 bed area at monthly interval may be recommended for the management of Sclerotial rot of tuberose.
iv. Spraying of Quintal (Iprodion + Carbendazim) (0.2%) or Kavach (Chlorothalonil) (0.2 %) at ten days interval may be recommended for the management of leaf blight/leaf spot of tuberose.

Disease and pests control

HRS, Kahikuchi, Assam

i. The pre-planting dipping of gladiolus corm in the solution of Carbendazim (0.2%) for 30 minutes followed by soil application of *Trichoderma viride* (500 g/m^2) after mixing in 1 kg FYM at the time of planting recorded the less disease incidence of 17.40 per cent with the highest per cent disease control (71.80 %).
ii. For the management of Sclerotial wilt in tuberose, 15 days prior application of mustard oil cake (200 g/m^2) by mixing in upper 15 cm layer of soil followed by pre-planting dipping of bulbs in *Trichoderma viride* (10 g/l) for 30 minutes + soil application of *T. viride* (100 g/ m^2) after mixing in 1kg of FYM at the time of planting significantly recorded lowest disease incidence of 8.05% with corresponding highest per cent disease control of 72.64.
iii. The spraying of Iprodione + carbendazim (Quintal) (0.1%) and Difenconazole (Score) (0.1%) were found effective in managing the leaf spot disease of tuberose.
iv. The spraying of difenconazole (0.05%) and iprodion+carbendazim (0.2%) were found effective for managing the leaf spot/blight disease of gerbera.

V. HORTICULTURE MISSION (MM-I)

Programme I: Production of nucleus/basic seeds and planting materials.

Category	Type of planting materials	Target	Achievement	% of Achievement
Fruit Crops	Plantlets/Suckers/Grafts/Cuttings/ Seedlings/Runners/Layers/Budded (Nos.)	1140000	980556.00	86.01
Vegetable	Seed/Cormels (Kg)	1122	1190.17	106.08
Crops	Cuttings/Microplants (Nos.)	30000	66662.00	222.21
	Spawn (Pkts)	7600	8000.00	105.26
Flower Crops	Cuttings/Suckers/Plantlets/Bulbs/ Corms (Nos.)	351100	704217.00	200.57
	Seeds (Kg)	3.0	3.00	100.00
Plantation,	Grafts/Cuttings/Seedlings/Slips/	323000	512510.00	158.67
Spices and	Air layers (Nos.)			
Aromatic crops	Rhizome (Nos.)	165	77.00	46.67

Programme II: Standardization of improved production and protection technologies.

- In Khasi mandarin, peels were used for developing different value added products *viz*., peel oil, peel colour and peel candy etc. Peel oil was extracted with distillation method while colour was extracted with different solvents. Peel candy was prepared by making thin pieces of size 3-4 mm width and 30-35 mm length followed by boiling in water 5-25 minutes. Blanched pieces were dipped in sugar syrup (70% brix) along with 1% citric acid and heated slowly for 15 minutes to 75 minutes. Best quality peel candy in terms of organoleptic score (7.6) was obtained in the product with processing condition: boiling time (15 minutes) and heating time (60 minutes) in sugar syrup (70% brix) along with 1% citric acid. *(Barapani centre)*
- The banana cv. Giant Cavendish was planted at three spacing (3.0 × 3.0 m, 2.5 × 2.5 m and 2.0 × 2.0 m) to examine the effects of plant population on growth and yield of banana. Significant plant height, pseudostem girth, leaf area, number of suckers/ plant, bunch weight and number of fingers per plant were recorded at wider spacing. Although, bunch weight (10.87 kg) and total number of fingers/ bunch (85.4) was found more in 3.0 × 3.0 m but maximum yield of 446.5 q/ha was found in 2.0 × 2.0 m in uphill condition. (*Mizoram centre*).
- Seeds from the ripen *Sohshang* fruits were removed manually with the help of stainless steel knife. After removal of seed, fruit pieces along with 15% sugar were crushed with the help of laboratory grinder cum mixer to obtain uniform pulp. This pulp were uniformly spread at 5-6 mm thickness on polypropylene sheet (200 gauges) in aluminium tray and placed inside the tray drier at 60°C±2°C for 8 hours. Dried pulp was removed from the polypropylene sheet on aluminium tray and grinded into fine mesh of 50-60 size to obtain *Sohshang* fruits powder for preparation of value added products, fruit jam. *(Barapani centre)*
- In Strawberry (*Fragaria* × *ananassa* Duch) cv. 'Chandler', field study was done with three irrigation level *viz*., I_1 (1.0 *IW/CPE ratio*), I_2 (0.8 *IW/CPE ratio*) and I_3 (0.6 *IW/CPE ratio*) along with different mulch materials *viz*., black polyethylene (BPM; 40 µm), transparent polyethylene (TPM; 50 µm), paddy straw (PSM; 4t/ ha) and pine needles (PM; 4t/ha). I_1 favoured plant growth and enhanced flowering (67.5 days) which resulted in production of significantly larger fruit and higher yield (175.15 g/plant) with higher root numbers, fruit having higher TSS, and ascorbic acid content with lesser incidence of albinism (17.9%) and botrytis rot than other irrigation levels. Plants mulched with BPM have significantly better growth, flowered and fruited early, produced larger fruit and higher yield, with slightly higher incidence of albinism (19.8%), but with lower incidence of botrytis rot (14.9 %) than those mulched with other materials. *(Arunachal Pradesh centre)*
- While studying the effect of boron and molybdenum on growth and yield of cauliflower F_1 hybrid 'Sobha-158', the results showed that the maximum gross plant weight (1.272 kg) and curd weight (0.637 kg) was found in the treatment

combination of 20 kg borax and 2 kg ammonium molybdate over other treatment combinations. *(Mizoram centre)*

- In ginger, field experiment was conducted with six treatments *viz.*, T_1: Vermicompost (VC; 2.5 t/ha), T_2: Poultry manure (PM; 1.25 t/ha), T_3: Swine manure (SM; 3.0 t/ha), T_4: Cow dung manure (CDM; 10.0 t/ha), T_5: Farm yard manure (FYM; 10.0 t/ha) and T_6: control to study the effect of applied organic nutrients on growth and yield attributes of ginger. The physical parameters like porosity, maximum water holding capacity (MWHC), field capacity (FC), permanent wilting point (PWP), bulk density (BD) and moisture releasing pattern was better when the crop was supplied with FYM followed by CDM. Chemical parameters like pH, soil organic carbon (SOC), available N, P and K were recorded better on VC followed by PM over control. The gross and net return was recorded higher on VC followed by PM, whereas, B: C ratio was recorded higher on PM followed by CDM. However the lowest economic returns were recorded on control. *(Arunachal Pradesh centre)*
- Vermicompost @ 25t/ha were found to be better than 5 t/ha, 10 t/ha, 15 t/ha and 30 t/ha in increasing the number of leaves per plant, early flowering, number of flowers/plant, maximum stalk length, maximum size of flower & vase life of Gerbera. *(AAU, Jorhat)*
- While evaluating the organic fertilizer as a source of nutrient for *Cymbidium*, maximum plant height (51.47 cm), no. of leaves (40.55) and no. of pseudo bulbs (3.33) was recorded from the plants treated with Bone meal. Number of back bulb (1.48) and pseudo bulb girth (2.27 cm) was found highest in EM compost treated plants. However, maximum no of shoots (3.33) was found in Phospho compost and rural compost enriched with Bio-phos. *(NRCO, Pakyong)*
- Seven genotypes of gerbera were evaluated under polyhouse conditions. RCGH-65 produced maximum number of flowers per plant (3.22) and vase life (5.33days), maximum stalk diameter (4.41 mm) and longest stalk (49.68 cm) was recorded in RCGH- 226. The maximum flower diameter (10.63 cm) was recorded in RCGH-114, whereas RCGH-114 recorded maximum flower disc diameter (3.36 cm). Maximum plant spread (43.67 cm) was recorded in RCGH-22. Earliest bud bursting (52.00 days after planting) was recorded in RCGH-22.*(Barapani centre)*
- Black polythene mulch (50 micron) was found to be better than paddy straw, dried leaves, water hyacinth, wood shaving and dried banana leaves in improving the growth characteristics, cut flower and bulb production of tuberose. Mulching with dried leaves resulted in improvement of spike length, rachis length, shelf life and vase life of spike. *(AAU, Jorhat)*

Programme III: Technology refinement and imparting training to extension functionaries.

Sl.No.	Type of Training	Target	Achievement	% of Achievement
1.	On campus & Off campus training	185	127	68.65
2.	Demonstrations	262	197	75.19

VI. LIST OF ICAR INSTITUTES/NRCS/REGIONAL STATIONS IN THE REGION

(a) Institute

(i) National Research Centre on Orchids, Pakyong, Sikkim

(b) Regional Centres

(i) CPCRI Regional Centre, Guwahati, Assam

(ii) CPRS Regional Station. Shillong, Meghalaya

(c) All India Coordinated Research Project Centres :

(i) AICRP on Tropical Fruits (Tinsukia & Jorhat, AAU, Assam)

(ii) AICRP on Palm, Guwahati

(iii) AICRP on Spices

(iv) AICRP on Floriculture (Guwahati)

(v) AICRP on Vegetable (Jorhat)

(vi) AICRP on Tuber Crops (Jorhat)

(vii) AICRP on Potato (Jorhat, Passighat)

(viii) AICRP on Betelvine (Jorhat)

(d) Network Projects

(i) AINP on Onion & Garlic

(e) National Horticulture Mission

(i) Technology Mission (MM-I)

D. STATUS OF RESEARCH ON ANIMAL SCIENCE

ASSAM

Technological Interventions

Assam has 0.1 million crossbred cattle, 1.4 million non-descript cattle and 0.15 million buffaloes, producing around 0.8 million tones of milk; non-descript cows contributing the major share (0.5 million tonnes). Besides, 21.7 million poultry are contributing 0.5 billion eggs per annum. The state has sizeable number of goats (3.0 million) and pigs (1.5 million). The state has great potential to enhance productivity of cattle, goat and poultry by adopting following technologies:

- Improved germplasm of Frieswal cattle of 5% increase in milk production, Black Bengal goat for increased twinning percentage and backyard poultry (Vanaraja, Gramapriya, CARI Priya) for 100% increase in egg production over indigenous birds.
- Field based diagnostic kits (Brucella, TB, Peste des petitis ruminants, IBR) and vaccines (FMD, Goat pox, Raniket) for enhanced production and income.
- Complete feed blocks and urea treatment of paddy straw for 5-8 % increase in production.
- Value addition of milk (low cholestrol ghee, pizza cheese) and poultry products (nuggets, patties, pickles).

Achievements

1. Pig improvement

- AI in pig has been standardised at field level.
- Upgraded varieties of pigs were validated at farmers' field (pig village concept).
- More than 2000 piglets of improved germplasm distributed to the farmers, state Govt. and different NGOs of North Eastern India.
- A model retail bookshop suited for rural conditions designed.
- Growth performance studies replacing 50% maize with de-oiled rice polish indicated that cost of feeding per Kg live weight gain in pigs (between 15 – 90 days of age) ranged between Rs. 1539.00 to Rs. 1843.00 among four different groups. Further Zinc supplementation had significant effect on growth, reproduction and immune response with better feed utilization.

2. Feed resource management and utilization

- Region specific resource based feeding schedules developed.
- Area specific mineral mixture developed for raising animal production.
- Locally available feed resources assessed.

3. Animal Health Management

- Total of 27 serum were tested for PPR out of which 15 samples were positive for PPR in goats.
- 12195 doses of frozen semen have been preserved.
- Total of 45 outbreaks of FMD were recorded with the highest outbreak in Kamrup district.
- FMDV serotype O was diagnosed as causative agent for 30 outbreaks in Assam.
- Highest no. of outbreaks were recorded in the months of September like the previous year followed by August and February.
- Drug sensibility patterns against Pmultocida was studied which reveal maximum sensitivity against Cefotaxime, Enrofloxacin and less for Gentamicin and Ampicinnin.
- Methods for analysis of antibiotics and pesticides (chlorphyriphos, endosulphan in blood/tissues) standardised.
- Data on 30 medicinal plants of north east region have been documented.
- Certain plant extracts showed significant effect in reduction of Cystic Stones.

4. Conservation of animal genetic resources

- Infrastructure for the Core Lab has been created; samples of the pig strain have been collected for molecular genetic characterization.

5. Goat Improvement

- Field survey has been completed and information on production performance of Assam hill goat as well as socio-economic status of the farmers has been collected.

6. Adaptation strategies to climate change

- Data has been generated on variations in climatic variables during the last 30-40 years and the housing system used under field and farm conditions.

ARUNACHAL PRADESH

Technological intervention

The state has only 1,000 crossbred and 10,000 non-descript cows in milk, the average daily yield of which is 6.0 and 1.2 kg, respectively. The state has a strength in mithun (0.19 million) and yak (9,000) population besides, 0.33 and 1.7 million pigs and poultry, respectively. There is further scope to enhance productivity of pig, mithun, yak and poultry through the following technologies:

- Improved germplasm of crossbred pig for 125% increase in litter size and backyard poultry (Vanaraja, Gramapriya, CARI Priya) for 100% increase in egg production over indigenous birds.

- Al technology for mithun and embryo transfer for yak.
- Area-specific mineral (Mg, Cu, Mn) supplementation for 10-15% improvement in productivity.
- Health (FMD) and management (feeding, shelter) package for yak and mithun.

Achievements

1. Yak husbandry practices

- Protocols for freezing semen and improved post thaw motility standardization.
- Complete feed formulations in the form of feed blocks utilizing cost effective locally available feed resources field validated.
- Value added wool and fibre products from yak developed.
- Designer panner (insulin incorporated low fat panner) developed from yak milk which can be stored upto 12 days at refrigeration temperature (4±1°C).

2. Feed Resource Management

- Highest no. of outbreaks were recorded in the month of November followed by July and June. Sero type O was diagnosed to be causative agent in 13 outbreaks.

MIZORAM

Technological Interventions

In Mizoram, major livestock is pig (0.2 millions) and 1.1 million poultry contributing 32.6 million eggs per annum. The state has the potential to enhance productivity of pig and poultry with the following technologies.

- Improved germplasm of cross bred pig for 125% increase in litter size and backyard poultry (Vanaraja, Gramapriya) for 100% increase in egg production over indigenous birds.
- Artificial Insemination (AI) technology for pig.
- Total mixed rations (TMR) for better seed conversion efficiency in pigs.
- Field based diagnostic kits and vaccines (swine fever, Fowl pox) for enhanced production and income.
- Value adition of pok (smoked ham, pickle) and poultry (chicken chunkalona, nuggets).

Achievements

1. Pig Improvement

- More than 600 piglets have been produced and sold to farmers and develop mental agencies.

2. Animal Health Management

- Nine FMD outbreaks/incidence were recorded from three districts of Mizoram (Aizawl, Serchhip & Mamit) during the month of June, July and January.
- FMDV serotypt O in 8 outbreaks was indentified.

MANIPUR

Technological interventions

In Manipur, major livestock is pig (0.42 million) and 2.9 million poultry contributing 83.5 million eggs per annum. The state has the potential to enhance productivity of pig and poultry, with the following interventions:

- Improved germplasm of cross bred pig for 125% increase in litter size and backyard poultry (Vanaraja, Gramapriya) for 100% increase in egg production over indigenous birds.
- AI technology for pig and mithun.
- Complete feed blocks for increasing production efficiency.
- Field based diagnostic kit and vaccines for major decrease of livestock and poultry.

Achievements

Animal Health Management

- A total of 648 samples were tested for sero prevalence of IBR out of which 255 samples were positive indicating a positive percent of 39.
- Three outbreaks were recorded during 1st week of January and source of infection speculated to be beillegal import of buffaloes from Myanmar.

MEGHALAYA

Technological interventions

In Meghalaya, the major livestock comprises 0.3 million goat, 0.4 million pigs and 2.8 million poultry contributing 97.3 million eggs per annum. The productivity of pig and poultry could be enhanced with the following technological interventions.

- Improved germplasm of cross bred pig for 125% increase in litter size and backyard poultry (Vanaraja, Gramapriya) for 100% increase in egg production over indigenous birds.
- AI technology for pig.

- Field based diagnostic kit and vaccines (Swine fever, Fowl pox) for enhanced production and income.
- Value addition of pork (smoked ham, pickle) an poultry (kabbab, nuggets, pickles).

Achievements

1. Animal Health Management

- 11 farms were screened for Brucellosis out of which 46 samples were collected and only 3 samples indicated antibody litre ELISA.

NAGALAND

Technological interventions

In Nagaland, major livestock is comprised at 0.7 million pig and 2.8 million poultry contributing 86.8 million eggs per annum. The state has 40,000 mithun. The state has the potential to enhance productivity of pig, poultry and mithun by adopting following technologies:

- Improved germplasm of cross bred pig for 125% increase in litter size and backyard poultry (Vanaraja, Gramapriya) for 100% increase in egg production over indigenous birds.
- AI technology for pig and Mithun.
- Complete feed blocks for increasing production efficiency.
- Field based diagnostic kit and vaccines for major decrease of livestock and poultry.
- Value addition of mithun hide, skin and milk (bags, shoes, jacket, rasgolla, cheese).

Achievements

1. Mithun

- Higher daily body weight, dry matter intake, nutrient utilization and feed conversion efficiency obtained through inclusion of thumero (30%) tree foliage in total mixed ration.
- Biochemical profile of mithun semen assessed.
- *E. coli* sero groups in faecal samples of mithun suffering from diarrhoea assessed.

2. Pig Improvement

- More than 500 piglets have been produced and sold to farmers and development agencies.

3. Animal Health Management

- A total of 582 samples were tested using FMD - DIVA ELISA Kit out of which 134 samples were identified as positive indicating 23% FMD affected.

SIKKIM

Technological Interventions

The major livestock comprises of 0.13 million goats and 0.32 million poultry contributing 14.6 million eggs per annum. The state also has 7,000 yak population. The state has the potential to enhance productivity of yak and goat with the following technological interventions:

- Embryo transfer technology for faster multiplication of yak.
- Complete feed blocks for sustaining production.
- Health and management packages for yak and goat.
- Value addition of yak milk and hair (churpi, cheese, carprt, brooming brush).

Achievements

1. Animal Health Management

- Epidemiology studies on gastro intestinal parasitism of goats, cattle and yaks were carried out in four agro climatic zones in all the seasons.
- Highest prevalence of parasitic infestation was seen in Govt. Goat farm at Mangalbarey, West Sikkim (78-79%) with EPG ranging from 900-3900.

TRIPURA

Technological interventions

The major livestock comprises of 0.5 million goats and 0.2 million pigs and 3.1 million poultry contributing 0.1 billion eggs per annum. The state could enhance productivity of goat and poultry with the following technologies:

- Improved germplasm of backyard poultry (Vanaraja, Gramapriya) for 100% increase in egg production over indigenous birds and Black goat for improved meat production.
- Field based diagnostic kits and vaccines for major diseases for production and income enhancement.
- Goat/poultry based integrated farming system technology.

Achievements

1. Poultry improvement

- Distributed more than 1500 chicks (improved germplasm X local native) to farmers.
- Evaluated Tripura native germplasm (black) Gramapriya, coloured broiler, sire and dam lines and produced commercial stock for distribution to the farmers.

2. Animal Health Management

- A total of 27 FMD outbreaks were recorded in state which involved cattle and pigs, 12 outbreaks could be diagnosed using sandwhich ELISA, 3 were diagnosed retrospectively using LPB ELISA. All the 15 outbreaks were caused by FMDV serotype 'O' virus**.**

List of NRCs/ AICRP/ Network projects with location in North Eastern Region

Sl. No.	Name of the Project Scheme	Location
	ASSAM	
1	National Research Centre on Pig	Rani, Guwahati
2	AICRP on poultry breeding	AAU, Khanapara
3	AICRP on improvement of feed resources and nutrient utilization in raising animal production	AAU, Khanapara
4	AICRP on ADAMS	College of Vety. Science, Khanapara, Guwahati
5	Network project on buffalo improvement (Swamp Buffalo)	AAU, Khanapara
6	AICRP on FMI	AAU, Khanapara, Guwahati
7	Network programme on haemarrhagic septicaemia	AAU, Khanapara, Guwahati
8	Network programme on animal genetic resources	Core Laboratory, AAU, Guwahati
9	AICRP on goat improvement	Assam Hill goat (Field Unit) AAU, Khanapara
10	AICRP on Pigs	AAU, Khanapara
11	Network project on adaptation and facilitation of livestock to impending climatic changes through shelter management.	NRC Pig, Rani, Guwahati
12	Outreach programme on monitoring of drug residues and environmental pollutants	College of Vety. Sciences, Assam
13	Outreach programme on ethno veterinary medicine	AAU, Khanapara, Guwahaati
14	Mega seed project on pig	AAU, Khanapara

Sl. No.	Name of the Project Scheme	Location
ARUNACHAL PRADESH		
1	NRC on Yak	Dirang, West Kemang District, Arunachal Pradesh
2	AICRP on Improvement of feed resources and nutrient utilization in raising animal production	NRC Yak, Dirang
3	AICRP on FMD	DAH& VS, Itanagar
4	Outreach programme on monitoring of drug residues and environmental pollutants	NRC Yak, Dirang
MIZORAM		
1	Mega seed project on pig	Selesih Pig Farm, State Vety. Deptt. Govt. of Mizoram
2	AICRP on pigs	Central Agricultural University, Mizoram
3	AICRP on FMD	Deptt. of AHMVS, Aizawal
MANIPUR		
1	Poultry seed project	Cooperating Centre, Regional Centre of ICAR Res Complex for NEH Region, Imphal, Manipur
2	AICRP on ADMAS	Deptt. of vety. & AH, Imphal
3	AICFRP on FMD	Deptt. of vety. & AH, Imphal
MEGHALAYA		
1	AICRP on ADMAS	ICAR Res Complex for NEH, Barapani
NAGALAND		
1	NRC on Mithun	Jharnapani, Nagaland

Sl. No.	Name of the Project Scheme	Location
2	Poultry seed project	Cooperating centre, Regional centre of ICAR Research Complex for NEH Region, Jharnapani, Nagaland
3	Mega seed project on pig NEH Region, Jharnapani, Nagaland	ICAR Research Complex for
4	AICRP on FMD	Deptt. Of Vety & AH, Kohima
5	AICRP on pig Medziphema, Nagaland	Nagaland University
SIKKIM		
1	AICRP on cattle	Field progeny testing unit, ICAR NEH Region Gangtok
2	Network programme on gastrointestinal parasitism	Cooperative centre, ICAR NEH Region Gangtok
3	Poultry seed project	Cooperating Centre, Regional Centre of ICAR Res Complex for NEH Region, Gangtok, Sikkim
TRIPURA		
1	AICRP on poultry breeding Agartala	ICAR Res Complex,
2	AICRP on FMD	IRDD, DIC, Agartala

E. STATUS OF RESEARCH ON FISHERIES

Research activities in the Regional Committee No. III, covering the states of Assam, Sikkim, Arunachal Pradesh, Nagaland, Meghalaya, Tripura, Manipur and Mizoram, have been carried out by the Central Institute of Fisheries Technology (CIFT), Central Institute of Fisheries Education (CIFE), Central Inland Fisheries Research Institute (CIFRI) and Central Institute of Freshwater Aquaculture (CIFA) ICAR REsearch Complex for NEH Region, Meghalaya through local partners. The areas include fisheries, aquaculture, harvest & post-harvest technology, in this region. Some of the significant achievements made during the period under report are given below:

A. Central Inland Fisheries Research Institute, Barrackpore

Regional Research Centre of CIFRI, Guwahati

The Central Inland Fisheries Research Institute (CIFRI) is represented by its Regional Research Centre at Guwahati in Assam which caters to the research and development needs of open–water fishery resources in this region.

1. Standardizing fish stock enhancement protocols in floodplain wetlands

During the last two years the institute has been carrying out studies on various aspects of stock enhancement in beels of Assam with a view to standardizing stock enhancement protocols. All the beels were under the administrative control of the Assam Fisheries Development Corporation.

Candidate species

The main fish species stocked in the selected beels were the three Indian major carps (catla, rohu, mrigal), exotic carps (grass carp, bighead carp, common carp, silver carp, silver barb), minor carps (*Labeo gonius*, *L. bata*) and carnivorous clown knife-fish (*Chitala chitala*). This is a new development expected to help harvest the part of the primary food energy routed through small-sized miscellaneous fishes occurring in these beels. The main criteria for selection of candidate species in the selected beels were growth performance (e.g., grass carp, catla), consumer preference and market price.

Species ratio

For shallow beels (post-monsoon season depth range 3-4 m) a tentative species ratio of 40 SF: 30 CF: 30 BF was suggested, whereas for deeper beels (depth >4 m), a tentative species ratio of 2 SF: 1 CF: 1 BF was suggested. However, species ratio followed in the selected beels varied widely.

Stocking density

Stocking density in the selected closed beels varied from 2190 no./ha (Barundanga beel) to 10000 no./ha (Lakhanabandha beel). In seasonally open beels stocking density ranged from 833 no./ha (Kapla beel) to 8750 no./ha (Dandua beel). Higher stocking density was practiced in closed beels than that in seasonally open ones.

Fish production

Fish production from both stocked and natural fish stocks in the selected closed beels ranged from 149.3 (Puthimari beel) to 1387.8 kg $ha^{-1}yr^{-1}$ (Damal beel). Contribution of stocked fishes to fish production in these beels varied from 134.3 to 832.7 kg $ha^{-1}yr^{-1}$. Both total fish production and contribution of stocked fishes to fish production was higher in closed beels than that in seasonally open ones.

Contribution of stocked and natural fish stocks

The contribution of stocked fishes to total fish production was 60% or more in all the closed beels indicating that culture-based fisheries was practiced in these beels. The contribution of stocked fishes to total fish production was 50% or more in 11 out of 17 seasonally open beels indicating that culture-based fisheries was practiced in these beels.

Impact of stocking density on fish production

For arriving at the relationship of stocking density and fish production, the contribution of stocked fishes to total fish production was estimated to arrive at the fish production from stocked fishes. When fish production from stocked fishes was plotted against stocking density, a significantly high (at 5% level of significance) coefficient of determination (R^2x100) was obtained for this relationship indicating that 66.35% of variation in fish production from stocked fishes was dependent on stocking density.

2. Demonstration of enclosure culture technology

First set of pen culture demonstration: A moderate-sized rectangular pen of 741 sq. m (46 m x 16.1 m) was constructed using net lined split bamboo screens in Damal beel, Morigaon district, Assam. The pen was stocked with carried over seeds of Indian major and exotic carps @ 5 fingerlings per sqm during the last week of February, 2009. After 70 days of rearing, the highest specific growth rate (SGR) in terms of average length (from 9.6 cm to 16.2 cm) was recorded by rohu (SGR 68.8%) followed by mrigal (SGR 59.8%; ave. length increased from 10.2 cm to 16.3 cm) whereas catla recorded the lowest SGR (26.8%; ave. length increased from 14.2 cm to 18.0 cm) indicating that catla was the least suitable IMC species to be reared as carried-over seed in pens in Assam beels during the pre-monsoon season.

Second set of pen culture demonstration: The second set of pen aquaculture demonstration was initiated in Damal beel during February, 2010. For this, the net-lined split-bamboo screens of the existing pen enclosure (414 m^2) were repaired. In addition, another new enclosure (200 m^2) using only mosquito netting was erected in order to further reduce the cost of pen construction. Both the enclosures were stocked with carp seed during the first week of March @ 6 no./ sq. m. A species ratio of 40% surface feeders (35% catla, 5% silver carp), 30% column feeders (25% rohu, 5% grass carp) and 30% bottom feeders (15% mrigal, 15% common carp) was maintained in the pens. The stocking size was slightly on the higher side because only carried-over seed was available during the pre-monsoon season in the locality.

3. Refinement of cage culture

The Institute carried out cage culture experiments at Charan beel, Morigaon district, Assam with a view to refine the technology during 2010-11.

Determination of optimal stocking density: Fish production from both stocked and natural fish stocks in the selected closed beels ranged from 149.3 to 1387.8 kg $ha^{-1}yr^{-1}$. Based on the field data, optimal stocking density was estimated at 3000 and 3600 fingerlings/ ha for closed and seasonally open beels, respectively.

Optimization of stocking density in cage culture: The centre conducted cage culture experiments at Charan beel, Morigaon, Assam with a view to standardizing the stocking density of *Labeo rohita* fry. A battery of ten cages (individual cage dimensions 2 x 2 x 2 m and effective water volume 6 m^3) were stocked with *Labeo rohita* fry (av. length 4.0±0.04 cm, av. wt. 1.05±0.03 g) at five different stocking densities, *viz*., 50 (SD1), 100 (SD2), 150 (SD3), 200 (SD4) and 250 (SD5) fry/ m^3 with two replicates each.

4. Socio-economic evaluation of fishers

An unique practice was observed in the beels of Assam which was stocking carps weighing 300 - 400 g sizes (12.5 -17.5 cm long) in the month of February-March (after the completion of winter months). This is due to the reason that there is almost no growth in the harsh winter months and after winter the growth is vigorous resulting into quick growth of yearlings into plate size fish in the remaining six months.

5. Study on fish genetic stocks in river Brahmaputra

As part of the activity led by the National Bureau of Fish Genetic Resources (ICAR), Lucknow the institute was entrusted with the task of assessing genetic stocks of catla, rohu and mrigal occurring in the Brahmaputra. CIFRI Regional Centre, Guwahati collected data on length and weight and reproductive parameters for the targeted species mainly from Uzanbazar fish landing center of river Brahmaputra. Tissue samples of *Cirrhinus mrigala* (2 nos.) and *Labeo rohita* (3 nos.) were also collected from Dhubri landing centre of river Brahmaputra under the activity.

6. Nutrient profiling of fish

As part of the activity led by CIFRI, Barrackpore, CIFRI Regional Centre, Guwahati collected samples of Hilsa and mola fishes from Uzanbazar, Kolongpar and Amingaon landing centres and their proximate composition was determined.

7. Contract research work initiated in the region

- Investigation of minimum environmental flow required for the sustenance of ecology and biodiversity in Nyamjang Chhu river in Arunachal Pradesh was carriedout as part of a consultancy project sponsored by Bhilwara Energy Ltd was conducted.
- Investigation and suggestive measures in fish migration in river Kameng in Arunachal Pradesh as part of a CP sponsored by GMR Londa Hydropower Private Ltd.

- Feasibility studies were undertaken for designing fish pass and hatchery complex in the proposed dam in Lower Siang HE project as part of a CP sponsored by Jayprakash Associates Ltd., Noida during Aug. 2010-July 2011.

New Technologies for transfer

Technologies for scientific management of floodplain wetlands in the states of Assam and Manipur are ready for transfer.

II. Central Institute of Fisheries Technology, Kochi

Exploratory fishing in Ganga Lake, Arunachal Pradesh

1. Large mesh gillnetting in Ganga Lake (18-20 October, 2010) : To catch bigger fishes large mesh gill nets were fabricated and were successfully demonstrated in Ganga lake. Nylon gill nets (210Dx1x3) of size 100 m x 8 m and 100 mm, 150 mm, 200 mm and 250 mm mesh size were used. Silver carps, *Hypophthalmichthys molitrix* weighing up to 10 kg and *Catla catla* weighing around 5 kg constituted major share of the catch. These FRP coated canoe and large mesh gill net combination is suitable for all other lakes in the NEH regions which are having carp resources and are currently underexploited.

2. Fabrication of 10 COFISKI chambers: Ten COFISKI chambers and the accessories such as exhaust cowls, trays and stands were successfully fabricated for installation in Arunachal Pradesh.

3. To suit extreme low temperatures: Three out of ten smoking kiln chambers are fabricated to suit extreme low temperatures and hilly terrain.

4. Marble plaques: Marble plaques with engraving to fix in each unit of community fish smoking made at the cost of Rs.350/- per unit and the same costs Rs 3000/- in North East Region for each unit of COFISKI. Thus for eleven marble plaques with engraving the amount saved was Rs 29,150/-.

5. Impact assessment in TOT fishing hamlets: Impact assessment of Phase III initiated in nine remote fishing hamlets under adoption of CIFT and are located adjoining Hirakud Reservoir. The following outcome was observed.

- Fish catch scenario was assessed.
- Awareness on technological know-how showed that fisherwomen have realized the importance of hygienic handling of fish and maintenance of quality in preparation of value added products.
- In all nine fishing villages COFISKIs were employed. Minor repair works were attended and utilization patterns and product development were assessed.
- A technical component on development of canned fresh water fish has been included in the fish processing project. This work comprising a training programme will be taken up during the quarter April to June 2011.

III. Central Institute of Fisheries Education, Mumbai

Based on the recommendations of the committee, following projects were undertaken for prospering trade for wild ornamental fishes from the North East.

Standardization of breeding techniques of *Danio aequipinnatus* and *Puntius conchonius* collected from North East India

The survey was made in Assam and Arunachal Pradesh. Live specimens of *Danio aequipinnatus* and *Puntius conchonius* (30-40 mm in length) were collected from Guwahati, Tejpur and Itanagar. The study revealed that critical parameters *viz*., water hardness, pH and temperature played a key role in breeding performance of *Danio aequipinnatus* and *Puntius conchonius* . The percentage of hatching was 82.85 and 68.65 for *Danio aequipinnatus* and *Puntius conchonius*, respectively, when the water quality parameters were brought under the range of, hardness (37-50 mg/l) and pH (7.0-7.1) at 22.50^{0}C.The total number of seed produced was ten thousand.

Nutritional requirement, feed development and feeding strategies of indigenous freshwater ornamental fishes having export value

Nutritional requirement (especially for protein and lipid requirement) of four selected fishes-Jewel glass fish (*Chanda ranga*) and Titke punti (*Puntius ticto*), Giant gourami (*Colisa fasciata*) and Loach (*Botia macracanthia*) was studied. Feeds were formulated with available local feed ingredients fortified with feed supplement to enhance colour and growth of the selected fish. Breeding technique of two indigenous ornamental fish, *Puntius conchonius* and *Colisa lalia* has been developed by Kolkata center of CIFE.

Extension/Training/Education/Demonstration/Consultancy/Advisory

- Organized state level review workshop on technological, HRD and extension requirements for the development of fisheries in Assam, Manipur, Mizoram and Tripura at different dates in 2010.
- Additionally, three short term need based training programs were also conducted by CIFE for the State Fisheries Officials of the North East states.
- Training on "Carp and prawn culture to the farmers" was organized in Assam during 11-15 August, 2010 for 25 participants.
- Trainers training under New land unused policy programme in Mizoram to the officials of DoF, Mizoram during 30th September -2nd October, 2010 for 40 officers.
- Training on "Hatchery Management of Giant Fresh Water Prawn" to the Officials of Assam at Mumbai during 27th September- 18th October, 2010.

Technical guidance

- Established "Giant fresh water hatchery" at Mean Bhavan, Guwahati and was inaugurated by Hon'ble Minister for Fisheries, Govt. of Assam on 11th August, 2010. Trial operation was conducted. Two prawn hatcheries are under construction at Dubri and Cachar in Assam.

Diploma/Certificate courses for State Officials

Two important courses initiated at CIFE, Kolkata centre for the skill development of the state officials in 2009.

Under Professional Development Programme (PDP), the CIFE, Kolkata centre conducted the training sponsored by state Department of Fisheries, Nagaland, Tripura, Meghalaya and Arunachal Pradesh and funded by NFDB.

IV. Central Institute of Freshwater Aquaculture, Bhubaneswar

The CIFA is directly involved in the aquaculture development in the region through conducting training, demonstration, establishment of hatchery, capacity building, production of extension literature in local language, consultancy, exposure visits, survey and conducting workshop etc.

One of the important strategies was to develop a network of scientists working in the aquaculture in the region. A workshop for network formation was organized at 6-7, December, 2010. In the workshop all the state government, NFDB, fisheries colleges, NGO and other stakeholders participated. In the meeting initiatives were taken to formulate 5 network projects on the themes of seed, feed, culture, disease management and marketing in a network mode and it is proposed to involve around 30 researchers working in the region along with 10 scientists from CIFA.

Extension/Training/Education/Demonstration/Consultancy/Advisory

- CIFA has helped the Amalgamated Plantation Private Limited (a subsidiary of TATA TEA) to establish modern aquaculture in 110 hectares in the tea garden area of Assam. The work is under progress in the consultancy mode. CIFA is instrumental in setting up of FRP hatchery and development of the capacity of the company to manage aquaculture in the region.
- Consolidated programme at Silchar was organized during 24-27, Nov 2009. In this programme an operational ornamental hatchery unit developed with support of CIFA.
- Training on composite fish culture and ornamental fish farming and survey to assess constraints to aquaculture in Barak valley.
- An exhibition was organized during 6-7 December, 2010 at Guwahati.
- An exhibition was organized during Assam Matsyamahostava, Guwahati (Assam) during 27-29, January 2011 to show case the CIFA technologies.
- A training programme on "Aquaculture for Livelihood and Nutritional Security in Mizoram" was organized to train 50 farmers in fish culture during 11-13 January, 2011 in association with Directorate of Fisheries, Govt. of Mizoram, Aizawl. In addition, the institue is also helping in establishment of the soil and water testing laboratory in the state.
- Training on "Aquaculture for Livelihood" was organised at Nongpoh, Meghalaya during 3-4 Dec, 2010. A total of 37 farmers participated (18 female) in this training.

- A training programme on induced breeding and seed production of carps for 8 farmers from Arunachal Pradesh was organized at CIFA head quarter during 1-7 Sept 2010 with funding support from NFDB.

IV. Directorate of Coldwater Fisheries Research (DCFR), Bhimtal

- The breeding and rearing of trout has been carried out in Shergaon and Nuranang trout farm in Arunachal Pradesh.
- Rainbow trout farming in private sector has been initiated in association with Department of Fisheries, Govt. of Sikkim.
- Construction and establishment of golden mahseer hatchery has been carried out at Bagua fish farm, Sikkim and ABACA, Nameri National Park, Tezpur, Assam.
- A hatchery on breeding of chocolate mahseer has been established in Iduli fish farm, Rowing, Arunachal Pradesh.
- Chinese carp culture practices in mid Himalaya have been successfully practiced among the farmers in Manipur and Arunachal Pradesh.
- Eco-biology study of high altitudinal lakes and rivers were carried out in Sikkim and Arunachal Pradesh in collaboration with RGU, Itanagar, ICAR Research complex for NEH region, Sikkim centre, Manipur University and KVK Dirrang, Arunachal Pradesh.
- Hands on training on "Three-Pronged Fish Farming Technology for Upland Himalayas" was carried out in Rajiv Gandhi University, Itanagar, Arunachal Pradesh and ICAR Research Complex for NEH Region, Manipur centre.
- Program is initiated to provide HRD training in the state of Nagaland and Sikkim.

Fish production during the last five years in the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura (in 000 tonnes)

Majority of the human population residing in this region except Sikkim are fish eaters. The fish production increased from 2.20 lakh tones in 1999-2000 to about 2.73 lakh tones depicting increase of about 24%. But for the present human population of 4.56 crores (2011 census), the requirement of fish is about 5.93 lakh tones which is about 54% deficit from the present level of production. The trend in fish production from 2004-05 to 2008-09 is given below.

State	2004-05	2005-06	2006-07	2007-08	2008-09
Arunachal Pradesh	2.70	2.75	2.77	2.83	2.88
Assam	186.32	188.01	181.48	190.32	199.41
Manipur	17.80	18.22	18.61	18.60	18.80
Meghalaya	5.64	4.12	5.49	4.00	5.50
Mizoram	3.68	3.75	3.76	3.76	3.76
Nagaland	4.90	5.50	5.80	5.80	6.18
Sikkim	0.14	0.14	0.15	0.18	0.17
Tripura	19.84	23.87	28.63	36.25	36.00

F. STATUS OF RESEARCH ON AGRICULTURAL ENGINEERING

1. INFRASTRUCTURAL STATUS

The Region III, comprising of the states of Assam, Arunachal Pradesh, Meghalaya, Manipur, Nagaland Mizoram, Sikkim and Tripura has number of nstitutes under the SMD of Agricultural Engineering . However the following All India Coordinated Research Projects are in operation in different ICAR Institutes/Agricultural Universities.

Sl.	Name of the AICRP	Location of the Centre
1	Farm Implements and Machinery	ICAR Research Complex for NEH region, Umiam. Assam Agricultural University, Jorhat. College of Agricultural Engg. & Post Harvest Technology, CAU, Ranipool, Gangtok, Sikkim.
2.	Post Harvest Technology	Assam Agricultural University, Jorhat. Assam Agricultural University, Khanapara, Guwahati, Assam. Sugarcane Research Station, Assam Agricultural University, Buralikson. College of Agricultural Engineering and Post Harvest Technology, CAU, Ranipool, Gangtok, Sikkim.
3	Renewable Energy Sources	Assam Agricultural University, Jorhat. College of Agricultural Engineering and Post Harvest Technology, CAU, Ranipool, Gangtok, Sikkim.
4	Ergonomics and Safety in Agriculture	North Eastern Regional Institute of Science and Technology, Nirjuli, Itanagar. College of Agricultural Engineering and Post Harvest Technology, CAU, Ranipool, Gangtok, Sikkim.
5	Utilisation of Animal Energy for Enhanced System Efficiency	Assam Agricultural University, Jorhat. College of Agricultural Engineering and Post Harvest Technology, CAU, Ranipool, Gangtok, Sikkim.
6	Application of Plastics in Agriculture	ICAR Research Complex for NEH Region, Umiam, Meghalaya. College of Agricultural Engineering and Post Harvest Technology, CAU, Ranipool, Gangtok, Sikkim.

2. SALIENT ACHIEVEMENTS

2.1 Farm mechanization

i) Light weight power tiller for dry tillage and puddling of rice field (CAU, Gangtok)

Light weight power tiller was evaluated at Daramdin farm, Dist West Sikkim and at farmer's field at village Bhashmey near Rangpo, Dist. East Sikkim in dry field conditions for

its suitability in hilly regions. The field capacity was observed to be 0.012 ha/h at the forward speed of 1.2 km/h with tilling width of 0.3 m. The machine was also evaluated at Daramdin farm, Dist West Sikkim and at farmer's field at village Bhashmey near Rangpo, Dist. East Sikkim in wetland conditions. The machine is finding acceptance for its light weight and muti-purpose utility as mobile and stationary power source for different operations.

Lowland rice seeder (CAU, Gangtok)

A 4-row lowland rice seeder was demonstrated at the Daramdin farm, in District West Sikkim. About 0.5 ha area (two terraces) was covered. The capacity of the equipment was 0.038 ha/h. The farmers were of opinion that 2-row low land rice seeder would be better suited to terraces of Sikkim.

ii) Manual cono weeder in rice field (CAU, Gangtok)

Manual cono-weeder is very useful tool to help the farmers in reducing the labour requirement for weeding operation. But it requires transplanting/sowing in row with a spacing of 150 mm. Manual cono weeder was demonstrated at the Daramdin farm in District West Sikkim covering about 1.0 ha of area in four terraces. The capacity of the equipment was 0.02 ha/h. The farmers were impressed with equipment and were of opinion that handle of weeder should of shorter length to match local workers of the region. This suggestion was incorporated.

iii) Manual seed drill for high slope condition (ICAR-RC, Barapani)

Manual seed-drill adapted for high slope conditions has been developed with cup feed type seed metering mechanism. It weighs 14 kg and can be operated by two persons. It has a hopper of 2 kg capacity and is suitable for maize, pigeon pea and other bold seeds.

iv) 4-row pre-germinated paddy seeder (ICAR-RC, Barapani)

4-row paddy drum seeder has been developed for the wet paddy cultivation in the valley and terrace areas of the north eastern hills of India as an energy and cost effective option to the manual transplanting method. The machine weighs about 15 kg and can be pulled by a single person with a field capacity of 0.04-0.06 ha/h depending upon field size and soil condition.

v) Animal drawn light ridger plough (ICAR-RC, Barapani)

Animal drawn light weight ridger plough (5.6 kg without beam) has been developed which inverts the soil up to 80%. It is superior to local plough and can be adopted in light soils and hilly terrains and has a field capacity of 0.03 ha/h.

vi) Adjustable row marker (ICAR-RC, Barapani)

It is suitable for marking rows at different spacing according to the crops to be sown. Row spacing can be adjusted between 20 to 60 cm by sliding the tynes on a cross bar. The field capacity is 1.50 ha/day at 60 cm spacing and 70 mm depth of operation.

vii) Fruit harvester (ICAR-RC, Barapani)

Different types of manual orange harvesters were designed and tested *viz*., Push & Twist, Hold & Twist, and blade types. Approximately 300 fruits/man-hour could be harvested by using these devices with 4-12% damage rates.

viii) Manual rice seeder (AAU, Jorhat)

Different versions of drum seeders were tested for their feasibility in Assam land conditions and their performance was compared with manual line sowing. The plastic drum seeder with low weight was found to have the highest field efficiency. On the whole, man hour saving was found to be 78% to 95% over manual sowing. Field capacity varied from 0.139 to 0.283 ha/h.

ix) Paddy threshers (AAU, Jorhat)

The axial flow thresher was found to save 88% of man hours as compared to traditional method. It was used for more than 50 hours with output capacity of 600 kg/h with threshing efficiency of 94%. The transportation of the thresher to different sites was not a problem and has been recommended for adoption in Assam and other areas of similar hilly terrain.

A motorized hold on thresher was also tested using power tiller as prime mover with women workers. A cleaning fan was also adopted which was run using power from the tiller. The rate of threshing was higher by 72% compared to animal treading in which case separation of threshed grain as well as winnowing were done by other workers.

x) Tractor operated rotavator (AAU, Jorhat)

Commercially available rotavator was tested in *kharif* and *rabi* seasons in the cultivation of paddy for puddling and mustard for seedbed perparation. The puddling index achieved with the rotavator was 85% which was better than that generally obtained in different conventional puddling operations (60-70%). The field capacity was 0.3 ha/h with field efficiency 72%. Moreover, the quality of tilth was far better than that obtained with conventional tillage. Adoption of the rotavator reduced the number of operations needed to obtain the same tilth. This, in turn, improved the field capacity to 4 ha/h and field efficiency 81%. Rotavator is recommended for large scale mechanization except in heavy and problematic soil where tractor operation might be difficult.

xii) Standardization and promotion of multipurpose tool frame with matching attachments for bullocks and swamp buffaloes of Assam region

(AAU, Jorhat)

A non-wheeled tool frame was developed for small size bullocks of Assam. The tool frame is suitable for operation with single row implements. The tool frame was fabricated using pipe sections in order to make it light. All the attachments also had pipe sections welded to it. They could be attached to the tool frame by pushing the pipe section of attachment into the pipe section of tool frame. The draught coming on the working tool press it inwards and prevent it from coming out.

xiii) Development of improved package of animal drawn equipment with yoke and harness for cultivation in valleys, terraces and hill slopes (CAU, Gangtok)

On farm trial of improved iron plough was conducted in Kumrek Bhawre village for puddling operation for cultivation of rice. Shallow puddling was carried out with iron plough. Field capacity of iron plough was 0.147 ha/h as compared to 0.05 ha/h in case of traditional plough, with 25% saving in cost of operation. Manual rice transplanter was used for transplant operations. The package of equipment was found to be useful for the difficult terrain conditions of terraces and hill slopes.

xiv) Prototypes of farm equipment manufactured by the ICAR-RC, Barapani center for the promotion of mechanization in the region during 2008-10

Sl.	Prototype	Target Nos.	Achievement Nos.
1.	Manual seed drills	20	25
2.	Adjustable row marker	25	100
3.	Manual weeders	200	600
4.	Pedal operated paddy thresher	25	20
5.	Hand winnower	10	15
6.	Tubular maize sheller	200	300
7.	Groundnut decorticator	10	5

2.2 Post Harvest Technologies

i) Field level ready for commercialization post harvest technologies (AAU, Jorhat)

- Cauldron paddy parboiling technique
- Process for utilization of paddy soaked for days under flood water
- Value added products from ginger
- Process for storage of ginger rhizomes in fresh form
- RCC ring bin for paddy storage
- Drying racks for efficient sun drying of paddy
- RTS beverage from Jamun
- Banana Candy from Khasi mandarin peel

ii) Establishment of Agro Processing Centres (APCs) (AAU, Jorhat)

Three APCs have been established in Assam at Allengmora, Roha and Bihaguri for processing of oilseeds, spice grinding, turmeric boiling, jute ribboning and sugarcane crushing. These centres are running successfully through SHGs and are also being used for training and demonstration of technologies.

iii) Bio-control of storage insect pest of rice, green gram and black gram (AAU, Jorhat)

Effect of application of botanical 'C' on mortality rate and controlling infestation level of *Callosobruchus chinensis* on green gram has been effective on green gram during

storage. The method is higly cost-effective as botanical 'C' is very cheap (1 kg of green gram can be stored for a period of at least nine months at a cost of 10 paise only). The overall acceptability of botanical 'C' treated (dose 50 ppm) grain stored for nine months was found to be of four out of five in Hedonic scale.

iv) Technology for making Liquid / Powder jaggery (AAU, Buralikson)

Process protocol for making liquid and powder jaggery was standardized. The technology was demonstrated to the local farmers and information disseminated to the entrepreneurs. Manufacturing of liquid jaggery has been taken up at the two agro-processing centers on experimental basis.

v) Survey and documentation on traditional meat products of NE Region (AAU, Khanapara)

Four states, namely, Arunachal Pradesh, Assam, Meghalaya and Nagaland have been covered in the survey to document traditional meat products prepared by the different ethnic groups inhabiting these states. Some of the traditional meat products prepared by different tribes of the regions were analyzed for physico-chemical, microbiological and sensory properties.

vi) Development of pig slaughterhouse with state-of-the-art technology and evaluation and demonstration of various meat processing equipment (AAU, Khanapara)

A modern pig slaughterhouse is being established under the National Agricultural Innovation Project. As part of human resource development, two training programmes, in association with the State Institute of Rural Development, Guwahati, were conducted which were attended by 50 participants. The art of preparing sausage, meat nuggets, meat pakoras etc. and use of meat processing equipment like meat mixer grinder, bowl chopper, sausage stuffer, cure injector, cooking vat, band saw etc. were demonstrated.

vii) Value addition and preservation of spent chicken meat at room temperature by application of multi-hurdle technology (AAU, Khanapara)

Process technologies for the production of the following meat products standardized:

- Honey treated deep cried chicken nuggets
- Intermediate spent chicken meat
- Spent chicken meat pickle

3. Renewable Energy (CAE, Gangtok)

➢ Construction, evaluation and demonstration of
- insulated bio-gas plant (3 m^3)
- improved smokeless chulla (single and double pot)
- briquette making machine

➢ Development of improved ***sigri*** for roasting of fresh maize crop and portable metallic kiln

G. STATUS OF AGRICULTURAL EDUCATION

The Region III comprises of the States of Assam, Sikkim, Mizoram, Arunachal Pradesh, Nagaland, Tripura, Meghalaya and Manipur. The Education Division of the Indian Council of Agricultural Research (ICAR) coordinates, guides and supports activities related to agricultural education and training in the country. ICAR as such does not enjoy any statutory power to regulate agricultural education but it has the mutually shared goal and commitment for improving the agricultural education that binds ICAR, State Agricultural Universities and other institutions together in a close professional relationship. Financial support provided by the ICAR for strengthening and development of agricultural education helps in firming up this tie up. The Education Division jointly with State Agricultural Universities and others has taken a number of steps for institutionalizing reforms for streamlining and improving agricultural education in the country. Serious efforts have been made on strengthening quality and relevance of agricultural education through accreditation, periodic course curricula revision, in-service training and necessary infrastructure development etc.

The Education Division of ICAR co-ordinates the operation of following schemes/ activities for strengthening, development and quality assurance of agricultural education.

(1) Development and Strengthening of SAUs, DUs, and CUs
(2) Rural Awareness Work Experience
(3) Best Teacher Award
(4) Emeritus Scientist Scheme
(5) University Level Text Book writing
(6) National Talent Scholarship
(7) Summer/Winter Schools
(8) Centre of Advanced Faculty Training
(9) Admission of Foreign Students
(10) ICAR National Professors and National Fellows
(11) Admission in UG and PG programmes through All India Competitive Exam.
(12) Accreditation Board
(13) Niche Areas of Excellence
(14) Experiential Learning Unit
(15) Modernization of AU Farms and
(16) ICAR International Fellowships Programme.

Although investment by ICAR on effective improvement in agriculture education is supplementary in nature, it has unquestionably helped in removing major inconsistencies in educational norms and standards necessary to sustain uniformly high quality of agricultural education in the country. The funds released during last two years under the various activities including Development Grant, International and Girls Hostels, Educational Museum, RAWE, Niche Area of Excellence, Experiential Learning, Modernization of AU Farms and Human Resource Development scheme are as under:

Development Grant (Rs. in lakhs)

State	University	2008-09	2009-10	2010-11
Assam	AAU, Jorhat	1600	1111	2054
Nagaland	NU, Medziphema	265	395	300

Number of International and Girls hostels

State	University	No. of Girls hostels	International hostels
Assam	AAU, Jorhat	2 Hostels in X Plan and 2 in XI Plan	1 in XI Plan
Nagaland	NU, Medziphema	1 Hostel in X Plan and 1 in XI Plan	1 in XI Plan

Rural Awareness Work Experience (RAWE) (Rs. in lakhs)

State	University	2008-09	2009-10	2010-11
Assam	AAU, Jorhat	7.20	6.00	6.30
Nagaland	NU, Medziphema	3.00	3.00	-

In addition funds for construction of examination hall and developing existing sports facilities, at Medziphema and for construction of sports complex (AAU, Jorhat) were also provided.

Niche Area of Excellence

A Niche Area of Excellence on production of biofertilizer enriched organics for sustainable agriculture is functional at AAU, Jorhat w.e.f. 24.3.2007 with the initial budget of Rs.130.40 lakhs

(Rs. in lakhs)

State	University	2008-09	2009-10	2010-11
Assam	AAU, Jorhart	50.00	55.00	50.00

Experiential Learning – Hands-on Training (Rs. in lakhs)

State	University	2008-09	2009-10	2010-11
Assam	AAU, Jorhat	95.00	2.00	—
Nagaland	Medziphema	50.00	—	—

The following experiencial learning units have been sanctioned:

i) AAU, Jorhat

a. Production of ornamental, medicinal & aromatic plants and nurseries management
b. Post harvest technology and processing for value addition
c. Agro processing plant for cereals, pulses and oil seeds
d. Bakery and confectionaries for entrepreneurial development
e. Pig production for profitable enterprise
f. Hatchery management and commercial broiler production unit
g. Fish production technology unit
i. Production of biofertilisers, biopesticides and bioagents

ii) Nagaland University, Medziphema

a. Bee keeping and sericulture
b. Nursery production and management
c. Mushroom production unit
d. Establishment of dairy cattle farm

Modernization of AU Farms

Under the sub-scheme "Modernization of AU Farms", the council has provided financial support for the works related to farm structures and facilities including upgradation/renovation and procurement of farm implements/equipments for the agricultural universities as detailed below.

(Rs. in crores)

State	Name of the University	2008-09	2009-10	2010-11
Assam	Assam Agricultural University, Jorhat	4.94	5.75	2.21
Nagaland	Nagaland University, Medziphema	3.06	2.25	0.64

Accreditation

Assam Agricultural University, Jorhat has already been accredited by the ICAR.

Human Resource Development

Education Division of ICAR conducts a common entrance test at all India level to fill up the seats at UG and PG level available in all State Agricultural Universities.

Number of JRFs qualified (Graduated from universities located in NER) during 2009-10 and 2010-11 in the entrance examinations is as follows:

Name of the University	2009-10	2010-11
AAU, Jorhat,	4	2
NU, Medziphema	1	1
CAU, Imphal	20	21
Total	**25**	**24**

Number of NTS allotted in the AIEEA-UG examination are as follows:

Name of the University	**2009-10**	**2010-11**
AAU, Jorhat,	26	23
NU, Medziphema	15	23
CAU, Imphal	07	09
Total	**48**	**55**

H. STATUS OF AGRICULTURAL EXTENSION

The Zonal Project Directorate, Zone-III comprises of eight states namely; Assam, Arunachal Pradesh, Manipur, Meghalaya, Nagaland, Mizoram, Sikkim and Tripura. Presently the Zone-III has sanctioned and established 71 KVKs and 14 new KVKs are in the process of their establishment with 5 in Assam, 4 in Arunachal Pradesh, 3 in Nagaland and 2 in Meghalaya.

Activities of KVKs

The mandated activities of KVKs include on-farm testing to identify the location specificity of developed technologies under various farming situations, establishment of production potential of newly released technologies in the farmers' field through front line demonstrations, upgradation of knowledge and skills of practicing farmers as well as rural youth and orientation of extension personnel in the frontier areas of technology development through training. The major thrust areas of KVKs in the region as identified by KVKs before developing action plan to execute activities like training, demonstration, on-farmtesting etc are given below-

- Development of location specific farming systems
- Rain water harvesting structure/ water management
- Promotion of vermicompost and organic farming
- Integrated pests management
- Integrated disease management
- Rejuvenation of old orchards
- Integrated farming systems
- Promotion of off-season vegetable cultivation
- Women empowerment through SHGs
- Nutrition, drudgery reduction and income generation for rural women
- Promotion of low cost poly-houses for seedlings and planting materials raising
- Livestock production and management technologies in hilly areas
- Entrepreneurship development for rural youth
- Mushroom production and bee-keeping

A brief achievements of the KVKs in the region in respect of on-farm testing, front line demonstration, training and other extension activities, seeds and planting materials production and income generation etc., are given below-

1. On Farm Trials (OFTs)

During the year 2009-10, 556 technologies were taken up by the KVKs for their assessment and to identify location specific technologies under local farming situations with 1909 nos. of trials (Table-1). The major thematic areas included for assessment were varietal evaluation (171), integrated nutrient management (76), integrated crop management

(58), integrated pest management (48) and integrated disease management (57), weed management (24) and 122 nos. of technologies on water management, storage techniques, farm machineries, value addition, small scale income generating enterprises, seed production and drudgery reduction.

Table-1 Summary of agricultural technologies assessed and refined under different thematic areas

Sl. No.	Thematic area	No. of technologies assessed	No. of trials
1.	Varietal evaluation	171	612
2.	Integrated nutrient management	76	253
3.	Integrated crop management	58	200
4.	Integrated pest management	48	226
5.	Integrated disease management	57	268
6.	Weed management	24	66
7.	Water management	18	32
8.	Storage techniques	19	41
9.	Farm machineries	10	27
10.	Value addition	19	43
11.	Small scale income generating enterprise	18	79
12.	Seed/ plant production	27	30
13.	Drudgery reduction	11	32
	Total	**556**	**1909**
Sl. No	**Thematic area**	**No. of technologies refined**	**No. of trials**
1.	Integrated nutrient management	3	13
2.	Varietal evaluation	8	77
3.	Storage technique	3	3
4.	Integrated crop management	3	13
	Total	**17**	**103**

Sixteen technologies (Table-2) related to livestock enterprises (cattle, piggery, poultry, goatery and rabbitery) and fishery were taken up for assessment with 508 trials in different thematic areas such as disease management (69), evaluation of breed (134), feed and fodder management (67), nutrition management (91) and production and management (147).

2. Technology Refinement

A total of 17 technologies (Table-1) related to cereal, oilseed, vegetable and fruit crops were taken up for refinement with 103 trials at various locations. The major thematic areas were varietal evaluation (77), integrated nutrient management (13), storage techniques

(3) and integrated crop management (10). Three livestock technologies were refined under various thematic areas with 8 trials.

Table-2 Summary of livestock technologies assessed and refined under different thematic areas

Sl. No.	Thematic area	No. of technologies assessed	No. of trials
1.	Disease management	6	69
2.	Evaluation of breed	5	134
3.	Feed and fodder management	1	67
4.	Nutrition management	1	91
5.	Production and management	3	147
	Total	**16**	**508**

3. Front Line Demonstrations (FLD)

Frontline demonstrations were conducted to demonstrate the production potential of newly released technologies on the farmers' fields at different locations in a given farming system and organize farming and extension activities for farmers and extension workers for dissemination of various technologies. A total of 11640 frontline demonstrations on 1581.53 ha were conducted by KVKs during 2009-10 in close collaboration with farmers to establish production potential of improved agricultural technologies including oilseeds (8399), pulses (1086), other crops (1825) and livestock enterprises (330).

Oilseeds: During the year, 8399 demonstrations were conducted covering 951.54 ha on different oilseed crops including sesame, rapeseed and mustard, soybean, toria, groundnut, and linseed. Demonstration of AST-1 variety of sesame revealed 26.60% higher yield over local check. Rape seed and mustard varieties namely M-27 and TS-36 showed yield increase to the extent of 51.3% and 37.8% over the local check. While 48.2% yield increase was observed in case of variety Bragg of soybean, ICGV-86590 with 50% in groundnut and 37.9% in var. PL-406 of lentil over the local checks. On an average, the increase yield varied from 13 to 51% in rapeseed and mustard, 35 to 48.2% in soybean and 15 to 50 % in groundnut and on average, oilseed crops under demonstration resulted more yield percent compared to farmers practices.

Pulses: A total of 1086 demonstrations were conducted covering 258.49 ha on various pulse crops including pea, black gram, green gram and rajmah. Among the black gram varieties under demonstration in farmers field, var. Pant U-19 emerged with highest yield increase of 51.10% over the local check. Similarly, Arkel variety of pea and Pratap in green gram were found to be the most prominent varieties with yield increase percentage of 46.4% and 38.4%, respectively over the locals. The percentage increase in yield varied from 20 to 56% in pea, 18 to 51% in black gram and 20 to 38 % in green gram and on average, pulses crops under demonstration showed more percentage yield increase than that of farmers practice.

Table- 3 Frontline Demonstration on Oilseeds Crops during 2009-10

Crop	No. of farmers/ demonstration	Area ha	Average yield (q/ha)		% increase (Av.)	Average cost of cultivation (Rs/ha)		Av. Benefit-Cost ratio
			Demo	Check		Demo	Check	
Groundnut	361	9.33	17.35	11.45	53.05	39197.75	32064.50	2.39
Lentil	80	31.00	9.66	8.42	36.15	19929.00	9345.50	2.55
Linseed	40	30.00	8.9	6.35	34.5	9856.00	7925.00	2.90
Mustard	465	54.33	20.13	14.58	70.46	4885.99	4644.27	2.04
Rapeseed	965	110.66	23.18	16.92	98.54	5391.41	4890.27	1.88
Sesamum	1906	215.32	6.06	4.00	35.51	10356.00	9500.00	2.45
Soybean	3818	433.64	17.18	9.70	44	18903.00	14072.67	2.81
Toria	764	67.26	22.65	12.07	41.83	48496.50	10703.50	2.63

Table- 4 Frontline Demonstration on Pulse crops during 2009-10

Crop	No. of farmers/ demonstrations	Area ha	Average yield (q/ha)		% increase (Av.)	Average cost of cultivation (Rs/ha)		Benefit-Cost ratio
			Demo	Check		Demo	Check	
Arhar	21	4.86	11.00	7.00	57.00	23000.00	19000.00	2.86
Black gram	320	93.02	18.77	12.21	38.15	17992.25	13980.00	3.20
Cowpea	25	3.00	4.75	3.60	16.00	14250.00	12560.00	1.02
Field pea	45	14.80	13.20	13.20	17.49	14460.00	12250.00	1.56
French beans	40	7.40	25.75	23.48	7.95	11175.00	9342.50	2.13
Green gram	117	30.04	14.29	10.05	33.82	14937.25	10420.00	5.90
Peas	431	83.52	31.19	22.48	38.29	23666.83	20123.67	3.54
Rajmah	79	18.85	13.58	11.24	20.82	25650.00	18565.00	3.06
Ricebean	8	3.00	12.80	10.65	20.17	18453.00	14396.00	3.06

Other crops

The frontline demonstrations on cereal crops such as rice, maize and wheat were conducted during the period. A total of 1825 demonstrations covering 371.50 ha were taken up and increase in yield varied from 14 to 58 % in rice, 23 to 48% in maize and 20% in wheat. Maniphou-10 and Pariphou varieties of rice developed by ICAR, Manipur Centre were observed with yield increase of over 40.5% and 37.65% over the existing local varieties in valley areas of Manipur. FLD results also showed that var. Ketakijoha, a scented rice variety, yielded to the extent of 29.20% and Anjali variety yielded 26.67% more than the farmers practice. Both are recommended for large scale adoption in plain areas of Assam. On an average, cereal crops under demonstrations gave higher percent increase in yield than

farmers practice. A total of 223 frontline demonstrations were conducted on different vegetable crops *viz*., potato (14), cabbage (62), cauliflower (3), tomato (102), brinjal (23), pumpkin (15) and french bean (15).

The percentage increase in yield in different vegetable crops ranged from 25 to 65% over the farmers practice. In the livestock sector, total number of 322 demonstrations were conducted including dairy (27), poultry (225), goatery (40) and piggery (6). Twelve numbers of demonstrations in each of fishery and duckery were also undertaken during the period.

Livestock and other enterprises

As many as 330 nos. of front line demonstrations were conducted by KVKs in the region during 2009-10. Maximum demonstrations were conducted in poultry rearing (245) followed by goatery (40), dairy (27), duckery (12) and piggery (6). Four demonstrations on mushroom production were also undertaken during the period. Parameters like milk yield, colostrums feeding, growth rate (body wt.), mortality rate etc. were considered during demonstration on dairy and dairy management. The demonstration showed that on an average, 25-50% changes/ improvement in identified parameters were observed in demonstration farm compared to farmers' practices in dairy farming while 30-40% change in selected parameters like growth rate, egg laying, incidence of disease and mortality were found in poultry farming in case of demonstration than local check. Similarly, in case of goatery, 40% changes over local check was observed in parameters such as rate of animals conceived, litter size at birth and weaning, body wt. and mortality rate.Changes of 4.47% over local checks were observed in demonstration of duckery in selected parameters like body wt., egg laying and mortality. In case of piggery, 15-20% improvements was reported by KVKs in the results of demonstration over local practices in selected parameters like litter size at birth and weaning, body wt. and mortality.

Farm implements

Demonstrations of farm implement *viz*., maize sheller, cono-weeder, wheel hoe, paddle paddy thresher, land hoe etc, were conducted in different crops like rice, maize, mustard, chilly, ginger, field pea, tomato, soybean, green gram and turmeric. These demonstrations were spread over 39.13 ha area in which 503 farmers participated.

Training programmes

A total number of 3289 training programmes were conducted during 2009-10 which covered 79658 beneficiaries including farmers, rural youth and in-service extension personnel in different areas of agriculture and allied sectors. KVKs in the region conducted 1801 training courses which benefitted a total of 51854 farmers, 775 courses for rural youth (10966) and 141 courses for extension personnel (3103) during the period.

Trainings for farmers

During the year, a total of 1801 training courses were conducted for the benefit of 51854 farmers and farm woman on various agricultural technologies. The total beneficiaries included male (30876) and female (20978) in different areas such as productivity enhancement

of field crops (11729), vegetable crops (2689), commercial production of fruits (3830), ornamental plants (681), plantation crop management (222) and 45 training courses in tuber crops, spices and medicinal and aromatics plants. Training programmes for farmers including farm women were conducted to benefit 4075 participants in soil health and fertility management, 6700 in livestock production and management, 5897 in home science/ women empowerment, 540 in agricultural engineering, 4009 in plant protection, 3327 in fisheries, 3466 in production of inputs at site, 2291 in capacity building and group dynamics and 1571 in agro-forestry.

Trainings for rural youth

As many as 775 skill oriented training programmes were organized by KVKs for 10966 rural youths during 2009-10. The major thematic areas of the training programmes include livestock with 142 nos of training courses benefitting 2138 participants, 140 courses in horticulture (2151), 90 in integrated farming system (967), 89 in fishery (696), 88 in home science and women empowerment (1423), 46 in integrated pest management (213), 20 in farm management (86), 18 in integrated nutrient management (387) 17 in capacity building and group dynamics (325), 3 in soil and water conservation (24), 2 in integrated crop management (35), 2 in plant protection (33), 1 in sericulture (15) and 117 in others which included training programmes on income generating activities like bee keeping, vermin-compost, mushroom production etc. In the livestock sector, production and management of piggery, dairy, goatery and rabbitery were included.

Trainings for extension personnel

A total of 141 training programmes were conducted benefiting 3103 in-service extension personnel including NGOs in the region. The training was imparted to upgrade their knowledge and skills in frontier areas of agriculture technologies development. Maximum number of training programmes was imparted on integrated nutrient management (28) followed by advances in capacity building and group dynamics (25), others (24), plant protection (14) and horticulture (10). Of the total beneficiaries (3103), 739 women extension personnel were trained up for their up-gradation of knowledge and skills in the broad field of agriculture.

Sponsored trainings

KVKs in the region also conducted 572 training courses sponsored by different agencies/organizations which benefitted a total of 13735 participants during the period. Participants in sponsored training programmes include farmers, farm women, rural youth, in-service extension personnel and members of different NGOs who were associated in agricultural and rural development activities. Trainings were imparted to upgrade their knowledge and skills in major areas of productivity enhancement of crops, commercial production of vegetables including organic farming, value addition and post harvest technologies of fruits plants, ornamental, aromatic and medicinal plants, soil health and nutrient management, farm machinery, tools and implements including storage loss minimization, livestock production

and management, fisheries, child development and nutritional security, economic empowerment of women, capacity building, entrepreneurs development and drudgery reduction of women.

Extension activities

The KVKs in the region organized 19743 nos. of extension programmes/ activities, benefiting 190309 farmers and other target groups including school children in the region on different aspects of improved agricultural technologies and their application in field. The activities include field days, group meeting/ interactions, kisan mela, kisan gosthi, exhibitions, demonstrations, exposure visits, film shows, advisory services, diagnostic visits, organizing farm science club and formation of self help groups (SHG) etc. In addition, 507 news paper coverage, 405 extension literature, 292 radio talks and 102 television talks were also taken up by the KVKs during the period. A detail of extension activities including number of beneficiaries is given below:

Table- 5 Summary of extension activities organized by KVKs under Zone-III

SI. No	Activities	No. of Programmes	Beneficiaries (No.)
1.	Diagnostic visits	2679	11616
2.	Advisory services	3098	11083
3.	Animal health camp	92	6202
4.	Training manual	192	4452
5.	Celebration of important days	84	9902
6.	Exhibition	106	13578
7.	Exposure visits	123	3283
8.	Extension literature	405	18452
9.	Farm science club conveners meet	109	3452
10.	Farmers seminar	21	1159
11.	Farmer visit to KVK	3731	13886
12.	Field day	214	8229
13.	Film show	278	8140
14.	Group meeting	261	6454
15.	Kisan gosthi	50	2430
16.	Kisan meal	51	12642
17.	Lectures delivered as resource persons	1226	20830
18.	Mahila mandal convener's meetings	22	213
19.	Method demonstrations	585	6100
20.	Newspaper coverage	507	1002
21.	Popular articles	398	378
22.	Radio talks	292	1956
23.	Scientists visit to farmers field	4844	17001
24.	Self help group conveners meetings	134	2486
25.	Soil health camp	9	202
26.	Soil test campaigns	73	858
27.	TV talks	102	2430
28.	Workshop	57	1893
	Total	**19743**	**190309**

Gender issues for technological empowerment of farm women in agriculture

Different activities related to the empowerment of farm women in agriculture such as capacity building, skill improvement, drudgery reduction, formation of SHGs and resource mobilization etc. were organized by the KVKs in the region during the period. A total of 25254 farm women were imparted training programmes during the year through organization of 2603 training courses. These training programmes were in the thematic areas of use of farm implements and tools, tailoring, mushroom cultivation, bee keeping, nursery raising, goatery, piggery, poultry, dairyi, floriculture, vermin-composting, post harvest technologies and value addition. Trainings were also conducted on formation of farm women club and self help groups (SHG) for performing location specific and demand driven activities for self-employment, income generation and sustainable livelihood security in rural and hill areas.

Production of seeds, planting materials and bio-products

KVKs of the zone are presently producing quality seeds, planting materials and bio-products for the benefit of the farming community. These seeds and planting materials are also used for on farm trials and other demonstrations. During the year, 809.00 qt seeds of cereals, 387.9 q of oilseeds, 480.6 q of pulses, and 41.3 q of vegetables and 1556.88 q of other crops were produced by KVKs in the region. Likewise, planting materials of fruits (67561 nos), plantation crops (51870) and vegetables (218185) were produced for supply and distribution to farmers. In addition, KVKs also produced 32.96 q of bio-fertilizers, 10.45 q of bio-agents and 1.1 liters of bio-pesticides.

Table-6 Production of seeds, planting materials and bio-products during 2009-10

SI. No	Major group/ class	Quantity
A.	Seed (q)	
1.	Cereals	809.00
2.	Oilseeds	387.90
3.	Pulses	480.60
4.	Vegetables	41.30
5.	Others	1556.88
	Total	3275.68
B.	Planting materials (Nos)	
1.	Fruits	67561.00
2.	Plantation crops	51870.00
3.	Vegetables	218185.00
	Total	337616.00
C.	Bio-products	
1.	Bio-fertilizers (q)	32.96
2.	Bio-agents (q)	10.45
3.	Bio-pesticides (q)	1.10
	Total (excluding bio-pesticides)	**33.06**

SPECIAL PROGRAMMES

Water Harvesting Structure

Two KVKs under Zone-III namely Senapati in Manipur and Dimapur in Nagaland had been provided Rain Water Harvesting Structures during Xth Plan. Extension activities like training, demonstration, farmers field visits, farmers-scientists interactions etc. were organized for knowledge and skills empowerment to farmers on construction and harvesting of rain water in KVKs for future use during lean seasons. As many as 25 training programmes and 40 nos. of demonstrations were conducted for farmers on construction and harvesting of rain water using available local resources in KVK Senapati in Manipur. This could irrigate 9 ha in farmers' field for cultivation of crops like paddy, maize, kiwi and production of planting materials, oilseeds & pulses and floriculture. KVK Dimapur conducted 15 and 10 nos. of training programmes and demonstrations, respectively during 2009-10, benefiting 125 farmers in the district.

Seven KVKs under Zone-III namely East Sikkim, South Sikkim, West Sikkim, Bishnupur, Kohima, Mokokchung and Tuensang have been sanctioned for providing Rain Water Harvesting Structure during 11th plan.

Soil and Water Testing Labs

During Xth plan, 19 KVKs were provided with the facility of Soil and Water Testing Labs in North East for scientific testing of farmers' soil and water quality and subsequently, recommend nutrients requirement for different crops. A total of 1248 soil samples, 117 water samples and 74 plant samples collected from farmers were tested in KVK labs during 2009-10 which could benefit 987 farmers covering 267 villages in the region.

Innovative Technology Delivery Mechanism

In order to transfer technology and rapid delivery of information, the Zonal Project Directorate, Zone-III has taken up the following mechanism-

- Internet (Website, Online Reporting System, E-mail, Fax, Tele-fax)
- SMS Based services (Kisan Mobile Phone Advisory Service)
- Journals, Books and other Publications
- Electronic media (Audio/Video CDs/DVDs)
- E-Connectivity facility

In general, this directorate uses to collect time bound information from KVKs through e-mail and fax which helps to compile and submit the required report/ information to the council in time. For immediate delivery of information to large number of KVKs in the region, mobile service delivery system is used, video conferencing session has been introduced with the help of E-Connectivity facility for face to face interaction with KVKs staff and farmers of the region.

New KVKs to be established during XI plan under Zone-III

Out of 85 districts in North East Region, 71 districts are covered with KVKs and the KVKs for the remaining 14 districts are in the process of their establishment except 2 districts

namely; Kurung Kumey and Dibang Valley in Arunachal Pradesh which were not recommended during the current five year plan. The state-wise distribution of the new KVKs to be established are Longleng, Kiphire and Peren in Nagaland, Udalguri, Baksa, Bongaigaon (the already existing KVK of Bongaigaon now falls in Chirang district), Morigaon and North Cachar in Assam, East Garo Hills and South Garo Hills in Meghalaya and Changlang and Anjaw in Arunachal Pradesh. While two districts namely Kurung Kumey and Dibang Valley in Arunachal Pradesh were not recommended for establishment of KVK during XI plan. Visits by Site Selection Committee to the proposed sites of KVKs are already over except Anjaw in Arunachal Pradesh. While no proposal for establishment of KVK in the district of North Cachar Hills in Assam has been received from any host organisation.

Details of infrastructure facilities created up to 31.3.2011 (2010-2011)

Out of 71 KVKs established upto 2010-11, Administrative Building in 33 KVKs, Farmer's Hostel in 21 KVKs, Staff Quarters in 10 KVKs and Demonstration Unit in 14 KVKs have been completed while Admn. Building in 20 KVKs, Farmers Hostel in 6 KVKs, Staff Quarters in 27 KVKs and Demonstration Units in 17 KVKs are on-going which are likely to be completed by the end of 2010-11. The following special programmes approved in 11th plan were also completed up to 2010-11 i.e. SWTL in 6 KVKs, Rain Water Harvesting Structure in 6 KVKs, Portable Carp Hatchery in 9 KVKs, Integrated Farming System in 4 KVKs.

I. STATUS OF NATIONAL AGRICULTURAL INNOVATION PROJECT

National Agricultural Innovation Project (NAIP) funded by the World Bank, was approved on April 18, 2006 and became effective for implementation on September 18, 2006 with closing date as December 31, 2012. At present, there are 188 sub- projects in four components at different stages of implementations with an average budget of about Rs 60 million.Two approaches *viz*., competitive mode and sponsored mode were used in inviting, peer reviewing and approving sub- project proposals. First concept notes (CNS) were invited and then the full proposals were invited for approved concept notes. The sub- projects under component- 1 were processed under sponsored mode.

Objectives of the NAIP

The overall objective is to contribute to the sustainable transformation of Indian agricultural sector from an orientation of primary food self-sufficiency to one in which a market orientation is equally important for poverty alleviation and income generation. The specific objective is to accelerate the collaborative development and application of agricultural innovations between public research organizations, farmers, private sector and other stakeholders. The specific objectives envisaged are:

(a) To build the critical capacity of the ICAR as a catalyzing agent for management of change in the Indian NARS (Component- 1).

(b) To promote 'production to consumption systems research' in priority areas/ themes to enhance productivity, nutrition, profitability, income and employment (Component- 2).

(c) To improve livelihood security of rural people living in the selected disadvantaged regions through technology-led innovation systems, encompassing the wider process of social and economic change covering all stakeholders (Component- 3).

(d) To build capacity to undertake basic and strategic research in frontier areas of agricultural sciences to meet challenges in technology development in the immediate and predictable future (Component- 4).

Activities in North Eastern Hill Region

NAIP is playing a key role in bringing pluralism in the National Agricultural Research System (NARS) as 38% of the implementing institutes are from outside the ICAR-State Agricultural University (SAU) system. The ICAR has effectively used NAIP to integrate non-traditional partners in the NARS, particularly for harnessing the research and development skills which are not available in the ICAR-SAU system. The approved sub-projects are addressing a diverse array of national agricultural research and development priorities, including food and nutritional security, agricultural diversification and commercialization, livestock and

fisheries production, genetic resource enhancement and bio-prospecting, natural resource management, adaptation to climate change, post-harvest management, value addition, policy analysis and marketing. The project is capturing some of the latent creativity and innovation in the agricultural scientific community and is making significant progress in building an environment that encourages partnerships and building capacity for taking a holistic approach to research and solving the problems in agricultural production/ marketing chains.

In NEH Region, 31 projects, are being undertaken in various sub-projects. The fund allocated for these projects are Rs.4930.77025 lakh. Projects in all the four components are running in this region. Five sub projects (three in Assam, one each in Meghalaye and Sikkim) are being coordinated from this region.

S. No.	State	No of Projects	Funds (in lakhs)
1.	Arunachal Pradesh	1	81.79915
2.	Assam	13	1812.01780
3.	Manipur	2	414.70650
4.	Meghalaya	9	1927.80630
5.	Mizoram	1	129.97460
6.	Nagaland	1	134.30560
7.	Tripura	1	141.30870
8.	Sikkim	3	288.85140
	Total	**31**	**4930.77025**

Human Resource Development is an integral part of NAIP. Twelve scientists from various universities and research institutes in this region have been selected for international training (three months duration) in frontier areas of science. Seven scientists have completed their training. Six scientists have been selected for international training in their projects. Two have completed their training. Sixty one, National Training are being organized in twenty seven frontier areas of science, scientists from this region may participate in these trainings.

Sustainability of Post Project Activities

A major emphasis of NAIP was on developing a mechanism of sustaining project activities beyond the project activities. This is particularly important in the context of the projects running in the backward districts of India which lacks adequate infrastructure and the target vulnerable section of the society *viz*., landless community, small and marginal farmers, which may need continued support for sustainable livelihood beyond the project period. Some of the efforts made in this direction are as follows:

Development of sustainability fund

Creation of sustainability fund where beneficiary farmers' contribution for the goods and services delived to them individually under the project would carry forward the actions in long run after withdrawal of the project. This is an innovative approach of the component, particularly keeping in view the poor paying capacity of the partners in progress. This money is of the farmers, will be with them (in bank) during the project period, for use by them (beyond the project period) and also its use to be decided by them. The lead centre and consortium partners will continue to provide technical guidance.

Bank Accounts for every cluster have been opened. A complete guideline for operation of Sustainability Fund has been prepared. The joint signatories are members of village level committees/ cluster level committees and representatives of lead centre and / or consortium partners. This fund will be used only after withdrawal of the project.

Although, at this stage fund may be small but it has created a deep sense of ownership among the participating community. This is very encouraging and signifies the mobilization of community. The fund generated at various consortia is given below.

Status of selected proponents on development of Sustainability Fund

S.No.	Lead Centre	Fund, Rs lakhs
1	AFPRO, Guwahati	14.95
2	AAU, Jorhat	1.02
3	ICAR Research Complex for NEH Region	0.50

Need based capacity building and creation of service providers

In the operational areas, youth are being trained as Service Providers for providing technical services in the field of Animal Husbandry, Agriculture and Horticulture. These will remain in their villages and work as Technology Agents for dissemination of new technologies. Entrepreneurship trainings on motor rewinding, pump repair, black smithy, electrician, para-vet, primary processing of farm produce have not only resulted in livelihood of trainee but has also created large number of skilled workers to cater to the need at the village level. Seed production activity at village/ cluster level is being undertaken to ensure continued availability of good quality seed. Infrastructure to the extent possible is being supported.

Building the chain, Revolving fund approach

The concept of Building the chain approach is being practiced for continuation of project activities. Potential trainees are identified and encouraged to become trainers.

The pig was introduced as an integral component of the Pig-Fish-Vegetable Farming System by AAU, Jorhat. One improved male pig of Hampshire breed and two female pigs were given to each farm household. As agreed, the beneficiary farm families are expected

to return three numbers of piglets out of sixteen piglets to be bred in two reproductive cycles in a year. At present, the piglets given in the first to the beneficiaries have just started producing piglets. One of the significant additional achievements is that the non-beneficiary farm families in the project sites are now hiring the service of the male Hampshire pigs provided under the NAIP project with a precondition that one piglet borne from this will be given to the owner of the male Hampshire who is a beneficiary farmer of the NAIP in the mode of payment in kind for the service by his male Hampshire pig. Thus, two distinct benefits are accrued- there is a continuous horizontal extension through pig breed improvement activity and additional income generation for the farm families of the NAIP sub-project.

Formation of village level commodity Banks

Innovative Village level Commodity Banks are being formed and popularized under some of the sub projects. These banks will continue to provide support beyond the project period.

Environmental and Social Safeguard Aspects

The environment friendly technologies like agro-forestry, water harvesting, organic farming etc. are being encouraged wherever required and possible. In case of the interventions with negative impacts such as excessive use of farm machines, use of insecticides, pesticides etc, and methods to mitigate their effects is recommended, planned and implemented.

Environmental safeguards

The purpose of various sub- projects of component-3, is to improve the livelihood, without adversely affecting environment existing in the target districts. The screening of environmental issues has been done to enhance positive impacts and minimize negative impacts through appropriate mitigation measures. Some of the environment friendly interventions are use of bio pesticides, promotion of vermi compost, emphasis on conservation agriculture etc. Under component-2, waste disposal is major concern for environmental pollution. This is properly addressed through waste utilization and making value added products.

Social safeguards

Under the project, interests of poor and disadvantaged groups, indigenous people and other stake-holders as relevant to various components are being adequately addressed. The sub- projects are also intervening for women empowerment. Proposed interventions are either through augmenting or making adjustments in the indigenous livelihood system of the people without causing any major changes in their way of life.

9. RESPONSE OF DIRECTORS/HEADS OF REGIONAL RESEARCH STATIONS/ AICRPs

A. ICAR RESEARCH COMPLEX FOR NEH REGION UMROI ROAD, UMIAM 793 103, MEGHALAYA

Background

ICAR Research Complex for NEH Region was established on 9th January 1975 as a premier institute in the field of agriculture and allied sector research, development and extension in tribal and backward areas. It has completed 35 years of its service to the tribal farmers, development departments, NGOs and other stakeholders. The Council's research has been action-oriented and location-specific, thus striving to solve farmers' problems associated with agriculture, agroforestry, fishery and livestock management. The institute was set up with the following research objectives.

- To undertake basic and applied research for delivering technologies for sustainable farming system under different agro-climatic regions and practices of farmers with diverse socio-economic conditions.
- To improve the productivity of crops, livestock and fishery.
- To act as a repository of information on natural resources, different farming and land use systems.
- To impart training in research methodology and application of improved technologies for enhancing agricultural productivity.
- To collaborate with the State Departments for agricultural development in the region and testing and promotion of improved farming and land use systems.
- To collaborate with National and International agencies for agriculture and development.
- To provide technical consultancy for policy making and innovations.

The Strength

As per the last QRT recommendations, the then existing 18 disciplines have been clubbed into 8 divisions, including bio-technology. Proposal for two more divisions *viz*., Plant health/ Protection and Fisheries have been sent for consideration. The scientists of the institute are engaged not only in technology generation and dissemination, but also in teaching of post-graduate classes of CPGS, CAU, Barapani (25 PG students guided). To promote the open and distant mode of education, the ICAR has also signed a MoU with IGNOU in 2007 and established a programme study centre for agriculture and allied sciences. Six new courses were initiated in 2008-09 under IGNOU partnership programme with ICAR-RC-NEH Region.

Presently, 10 students are enrolled in two courses, namely, Diploma in Value Added Products in Fruits and Vegetables and a Certificate course in Organic Farming. IGNOU is also making efforts to convert the programme study centre into regular study centre in agriculture sciences.

The strength of scientists has increased in the recent recruitment drive to cope up with the new challenges for frontier research and technological backstopping for enhancing farmers' livelihood security. Several in-house and ongoing research projects, most of them of inter-disciplinary nature, have been initiated. As on date, about 20 sponsored funded projects (DST, DBT, NAIP, NABARD, NHB etc), 12 AICRP, 5 Network, and 13 collaborative projects are operational under ICAR-RC-NEH region. Recently, strategic research for climate change adaptation and mitigation has been initiated under NICRA scheme.

Major achievements and their social impact

The overall impact of research in areas of responsibility has been quite satisfying. The farming system models developed have been able to check the soil erosion to the extent of 8 t/ha against soil loss report of 46 t/ha besides being able to conserve water *in-situ*. The gradual process of conversion of the contour bunds into terraces over a period of three to four years achieved under the system exhibited a positive impact on farmers who have resorted to these methods on account of economy and labour saving. Cropping intensity has increased from an average of 114% to 150%. After observing the benefits, different state government agencies, NGOs and farmers have started the development of waste lands through agro-forestry interventions.

Rice varieties developed by the institute for both the valley land and upland ecosystem had a positive impact on increasing the productivity and production of rice in the region basically due to enhanced coverage of 30% by rice growing areas in upland of Meghalaya and Manipur and around 30% area of valley land ecosystem of Manipur. Since the new and improved varieties have been giving almost twice the yield compared to existing varieties, the average productivity of rice increased from 1.8 t/ha to 2.1 t/ha. Another notable impact is increase in the number of certified seed growers in the region. Turmeric varieties developed by the institute are in great demand by farmers, NGOs and various government agencies.

In animal science sector, the per hectare on-farm income has increased from Rs.35000 to Rs.46000 due to improved pigs recommended by the institute. Besides, the employment has also increased from 150 to 240 days per annum and the per capita pork availability from 1.7 to 2.3 kg/week.

Due to successful breeding and production of fish fingerlings and development of economic fish culture both under integrated and pond culture system, the farmers of the region have been attracted towards aquaculture. A large number of artisans have shown interest in making improved tools and machineries as demonstrated by the institute. These are the result of the sound technology dissemination programmes.

Specific achievements of the ICAR Research Complex for NEH Region during the last 2 years are summarized below.

Varieties

- Developed and released 5 varieties of rice, 1 variety of tomato and 1 variety of pea. Three composites of maize, one line of pea, two composites of toria, three hybrids of guava and two genotypes of brinjal are in pipeline for release.

Crop management

- Crop management technologies like SRI / ICM for hills, ratoon rice for double cropping, Rapid Soil Health Testing Kit (RSHTK), integrated nutrient management, enriched vermi-composting, bio-organic for various crops were developed.

Soil and water management

- Soil and water management technologies like liming at the rate of 2-4 q/ha (every year) in furrows, application of paper mill wastes @ 2 q/ha every year, micro rainwater harvesting, *in-situ* moisture conservation in maize-mustard cropping system etc. were developed and popularized through demonstrations.

Horticulture

- Horticultural technologies like value addition of chow-chow, ginger candy, rejuvenation of old peach orchard, bio-organics for ginger production, post harvest and multiplication technologies for less-utilized horticultural crops like *Prunus nepalensis*, *Myrica nagi*, chow-chow, sweet gourd, tree tomato, Parkia, Dolichos beans; *in vitro* multiplication of rare and endangered native orchids etc. were developed.

Animal science and fisheries

- Artificial insemination technique of pig was perfected, new poultry species like Turkey and Japanese quail were introduced, various local ingredients like sweet potato, jackfruit leaves, elephant apple leaves, paddy straw as feed supplement were tested and suitable per cent additions were standardized.
- PCR-based detection of group A rotavirus, classical swine fever virus (CSFV), bovine rhinotracheitis (IBR) in cattle, ELISA-based detection of parasites in goats, detection methods for haemo-protozoans in cattle, Bioclimatograph of *Haemonchus contortus* and *Trichostrongylus* spp. infections in goats, diagnosis *Nematodirus helvetianus* infection in cattle were standardized.
- Captive breeding experiment on medium carp Pengba, *Osteobrama balangeri* at Imphal, Manipur and genetically improved common carp for evaluation under mid-altitude conditions were taken up.

Extension

- Under the NAIP programmes technology extension and demonstration programmes were taken up in the backward districts of the component states.

In addition to field activities, several on-site and off-site training programmes have been organized by the scientists and good numbers of technical manuals and synthesis volumes have been published from the region. The scientists are also encouraged to publish their results in cited journals in the area of research. Technically sound innovations/practices have been taken up for possible patenting.

The farmers' have always welcomed the research and development activities of ICAR and in order to further agricultural research in the north-eastern hill region, the following thrust areas have been identified.

- To evolve sustainable integrated farming systems to replace/improve jhum cultivation for increased productivity.
- Restoration of degraded/jhum fallow lands through tree based farming.
- Development of feed and fodder resources including locally available fodder for livestock.
- Improvement of citrus plantation to rejuvenate the citrus industry.
- To increase the overall productivity of different crops through research in cereals, pulses, oil seeds, horticultural crops, fisheries and other economical crops.
- Animal health coverage and improvement of livestock production system.

The salient achievement of the different centers of ICAR Research Complex for NEH Region are given below:

1. ICAR Research Complex for NEH Region - Arunachal Pradesh

- Under low input condition VL 61 performed well. Among the various cropping sequences, rice + French bean sequence was the most promising.
- Mung bean variety IPM-02-03 when sown in the last week of May yielded 1.09 t/ha.
- The highest maize equivalent yield was recorded when when maize was intercropped with cowpea at 1:5 ratio.
- Mustard cultivated with maize stubble mulches with minimum tillage yielded 1.28 t/ha.
- A farming system with integration of different types of food and horticultural crops supplied 56% of the nutritional requirement of crops and feed for 3 cattle.
- Pig farming practices and adoption level of improved technologies by pig farmers in West Siang district indicated that 98.6% of the farmers rear pig under low input condition.
- Technologies like rejuvenation of citrus orchards, preparation of 'Taktir' squash, osmotic dehydration of bamboo shoot slices, etc. were demonstrated and perfected for field level application.

2. ICAR Research Complex for NEH Region - Manipur centre

- A high yielding genotype for valleys of Manipur and mid altitude areas of Meghalaya, Nagaland and Mizoram was released as RC Maniphou 11 by the CVRC. Seeds of released varieties of rice were also produced for popularization of the varieties.

- Rabi maize along with intercrops like pea and potato was introduced in the irrigated areas.
- Zero tillage rapeseed (identified variety M27) has been successfully introduced and at present covers about 40% of the rice fallow.
- Kavery variety of passion fruit has been identified as suitable for Manipur condition.
- Besides developing induced breeding of *Clarius magur* and *Bangana dero*, the centre produced 2 lakh fingerlings of these carps.
- The centre also runs five KVKs.

3. ICAR Research Complex for NEH Region -Mizoram Centre

- The Bhalum series of upland rice were identified as suitable for Mizoram. Sowing during 1st week of June and FYM application at 15 t/ha was the best combination for higher yield. Among the lowland varieties Shasarang, Lampnah and RC Maniphou 11 were the the best genotypes. Shasarang was suitable for double cropping and gave a total yield of 7.7 t/ha. Here also, FYM@ 15t/ha was the best organic manure.
- Moong and mustard after rice was the best system upland rice based cropping system with spring moong followed by rice recorded highest rice equivalent yield.
- Among the QPM genotypes tested, Vivek QPM 9 was the best (7.0 t/ha) and among the hybrids Vivek Hybrid 31 (6.99 t/ha) was the best.
- In banana, maintenance of 2 suckers / plant of cv. Giant cavandish at 3x3 m spacing and NPK @ 300:100:300 g/plant was the best package for realizing good yield.
- In passion fruit the package containing cv. Purple, spacing 3 x 3m and N:P:K 50:125:60 g/plant + vermicompost @ 4-5 kg/plant + poultry manure 4-5 kg/plant was found the best.
- Citrus orchard rejuvenation by organic mulching, liming, Bordeaux mixture pasting and NPK application were perfected and demonstrated.
- Packages for pineapple, chow-chow, tomato, frenchbean, cauliflower etc. were developed.
- Traditional small holders dairy cattle production was documented. A non-conventional feed 'Anaska' was evaluated for replacement in feed concentrate. Fresh water giant prawn culture was found promising. Cultivation of all Indian and Chinese major carps in IFS was demonstrated.

4. ICAR Research Complex for NEH Region - Nagaland Centre

- Rice varieties RCPL1-113, RCPL1-117, TRC-87-251 and RCPL1-128 were identified as suitable varieties for mid to low altitude conditions. Cross made with Wonder Rice and improved varieties were advanced to F4 generation.
- Maize genotypes RCM-75 and RCM-76, ground nut genotypes ICGS-76, FESG-10, rapeseed variety PT-303 were also identified as promising.
- Maximum rice grain yield was recorded with crop residue + vermicompost + bio-fertilizer. Maximum maize grain yield was recorded with crop residue + FYM +

Biofertilizer. Rice + Finger millet combination gave maximum LER and grain yield (4.5 t/ha).

- Agri-horti-silvi-pastoral system was the best land use system where 70% soil erosion could be checked. INM and IMP packages for rice was developed.
- Water balance study for Nagaland has been completed and monthly and weekly deficit-surplus models have been developed. Traditional method of soil conservation 'Echo' was improved upon. Under NWDPRA, about 508 ha area of jhum fallow, marshy and abandoned land was rehabilitated.
- Evaluation of 25 local varieties/entries of colocasia and 13 local Rajma (entries) are in progress.
- 'Jahaji' was found as the best banana genotype and covering bunches with transparent or blue polythene reduced maturity period by 21 days and improved yield by 17 – 23%. In banana, intercropping with cowpea and ginger was most profitable. Quality seed / planting material of Khasi mandarin, Assam lemon, Rough lemon, black peper, French bean and rajmash were produced.
- Large black cross pig was the best in terms of growth and reproductive performance as compared to indigenous pigs. Water soluble fraction of *M. phlei* (WSA-MP) was formulated and standardized as immuno-stimulator.
- The centre took leading role among ICAR institutes/centres in organizing NE Agri Expo.

5. ICAR Research Complex for NEH Region - Sikkim centre

- Indigenous germplasm of rice, maize, finger millet, black gram, ricebean, rajma, chillies, chow-chow, ginger and large cardamom, citrus were collected from Sikkim and adjoining areas and conserved in the national gene bank.
- Agro-techniques such as sowing time, spacing, fertilizer doses and crop protection measures have been developed / standardized for major crops of Sikkim.
- For increasing cropping intensity and higher return maize-blackgram-pea, maize-blackgram-cabbage /cauliflower cropping sequences were found remunerative.
- Soybean inoculated with biofertilizer *Rhizobium* along 20 kg N / ha produced 18.04 q/ ha seed. Two hymenoptera parasitoids *viz.*, *Apanteles* sp. and *Chelonus* sp. (Braconidae: Hymenoptera) were identified against maize army worm, *Mythimna separata.* A larval parasitoid, *Cotesia* sp. (Braconidae: Hymenoptera) was identified against the cabbage semilooper, *Trichoplusia ni.* Spray application of biopesticide Delphin 3G @ 500 g/ha is most effective for checking the population of cutworm and cabbage semi looper in cole crops. Pestoneem 0.5 EC @ 1000 ml /ha can effectively control the population of army worm and defoliator in maize whereas Dipel 8 L @ 500 ml / ha may provide effective control of maize stem borer.
- Pod type radish was more remunerative if sown during October-November. October sown crops escape from powdery mildew.

- Standardized propagation and pruning techniques for Kiwi. Treating Kiwi vine cuttings first in FYM followed by IBA 4000 ppm (65%) gave highest rooting percentage. Fruit yield in terms of kg per vine was highest (13.48) in Kiwi cv. Allison. The fruits of Allison were highest in TSS (15.37 %) and lowest in acidity (1.31%).
- Standardized package of practice of Strawberry cultivation in the mid hills of Sikkim. The early flowering variety Ofra was found high yielding.
- An improved technique for raising large cardamom seedlings has been developed. A high yielding large cardamom clone (Clone 4) was identified by this Centre which is suitable for culinary and confectionary purpose; tolerant to chirkey and foorkey diseases. Pink Golsey is suitable for mid and high hills.
- Inter cropping turmeric with maize, ginger with maize, relay cropping of rice bean and French bean after maize harvest (leaving maize stover as support for beans) maximize C/B ratio.
- Studies on inter cropping turmeric and ginger under the shades of MPTs revealed that yield of turmeric was the highest (8.5 t/ ha) when grown under shades of *A. nepalensis* followed by *Pinus petula* (7 t/ ha). Ginger yield was maximum in under shade of *Alnus nepalensis* (5.0 t/ ha) followed by *Schima wallichii* (3.5 t/ ha).
- Buckwheat variety VL Ugal 7 is a suitable intercrop in Sikkim mandarin orchard. A ready reckoner for lime requirement to attain soil pH of 5.5 has been formulated.
- Agro-techniques for citrus orchard rejuvenation have been successfully demonstrated in the farmer's field. Citrus tree above 40 years should be replaced and application of Dolomite @ 3 kg/ tree is advised if soil pH is below 5.5. Application of fertilizer: Urea 75 kg /tree up to 3 years old tree is recommended.
- Management practices for achieving optimum productivity of Sikkim local Goat has been standardised. Stall feeding with Nevaro (*Ficus hookeri*) was suggested during Winter. Important diseases and causal organism of cattle, goat, sheep and poultry has been identified. Health calendar including year round schedule of prophylactic control measures for major diseases of cattle, Goat, poultry have been suggested. Antibiograms of pathogenic bacterial isolates of enteric and respiratory infections of these animals have been determined.
- Standardized silage making techniques using HD polythene bags. Technologies for feed block making have been perfected; low cost feed block making machine has been designed and fabricated to reduce loss of roughages as residues.
- Twining incidence in Sikkim local goat was observed to be 41 %. Feeding kids without concentrated feed supplements shows stunted growth with average daily gain of 3 g as against 40 g ADG when supplemented with 200 g concentrate mixture.
- Biomass yield of Amliso (*Thysanolaena agrostis*) was high (262 q/ha) in double cutting - first in July second in February as against single cutting (187 q/ha).
- Silvipasture and alley cropping system with the following tree-grass combination was found suitable for Sikkim. *Ficus hookeri*-Napier grass; *Ficus hookeri–Setaria-Thysanolaena*.

6. ICAR Research Complex for NEH Region – Tripura Centre

- A variety of field pea TRCP – 8 (Gomoti) was released by the CVRC. In addition varieties of rice, maize, pea, mung etc. were developed and identified. Most prominent among them is TRC87-251 (rice) and TRM -7 and TRM -11 (maize) which were found to be highly stable within the region.
- Staggering of pineapple (var Queen) under 2% urea + 200 ppm NAA standarised and staggering programme already adopted in Tripura.
- Eight varieties of Litchi viz. China, Shahi, Swarnaroopa, Early Bedana, late Bedana, Rose Scented, Bombai and Seedless introduced in Tripura.
- A papaya variety (Local x Honey Dew) tolerant to ring spot virus (55 kg fruit/plant) developed.
- Out of 19 hybrids of tomato tested, the hybrids such as All rounder, Swarasksha, Samrudh, BWT-3, BT-207 and CS-714 have shown resistant to bacterial wilt (< 5 per cent mortality).
- Integrated nutrient management through the use of vermicompost, animal based manure and incorporation of green tree leaf conducted in various cropping systems. Soil Health card (2000 nos) introduced in West and South Tripura. Farming system models for various land configurations were developed and demonstrated in a pocket-based approach.

B. NATIONAL RESEARCH CENTRE ON ORCHIDS PAKYONG, GANGTOK

- Germplasm accessions (2,350) collected from various parts of North Eastern Region, Darjeeling district of West Bengal and other parts of India are maintained at the center. Hybrids of *Cymbidium* (100), *Dendrobium* (30), *Phalaenopsis* (6), *Vanda* (30), Aranda (17), Mokara (9), *Paphiopedilum* (6), *Oncidium* (15), cattleya (9) and *Arachnis* (4) as well as 7 species of vandaceous orchids, 12 species of *Cymbidium* and 15 species of terrestrial orchids are maintained for evaluation and improvement.
- Works on standardization of protocols for mass multiplication of important orchid species have been initiated and protocols of *Cymbidium* 'Golden Girl', *Cymbidium* 'Lunavian Atlas' and *Cymbidium* 'Baltic Glacier Mint Ice' were developed. Pre-hardening and hardening of plantlets using various potting mixture were also studied.
- Among 59 crossed/selfed species, embryos from 27 crosses responded and formed plbs, while others did not respond to any media. The media and its supplements had played an important role for early swelling, germination and Plbs development.
- In order to get complete protocol of *Cymbidium* Baltic Glacier 'Mint Ice' from meristem culture an experiment was set up with basal media as MS (Murashige and Skoog) Medium combined with different hormones like NAA (0.1, 0.2, 0.3 mg/l), BAP (0.2, 0.4, 0.6 mg/l). Development of 1st plb in Baltic Glacier 'Mint Ice' took place within 28 days of inoculation. A mass of protocorms have developed within 90 days.
- RAPD technique was used for analyzing 10 endangered species. Total 458 distinct bands were generated of which 98.9% were polymorphic. The molecular analysis grouped all the 10 species into 3 distinct clusters.
- Molecular relationship of 16 Vandaceous orchid species was determined using ISSR primers (UBC) and the results showed multiband pattern.
- NRCO-Coll-77 of red vanda (INGR 10113) and NRCO-42 (No. 09131/IC 574581) has been registered by Plant Germplasm Registration Committee (PGRC) of Indian Council of Agricultural Research on May 18, 2010.
- In *Cymbidium*, 75% shade and application of 50% water (300 ml) on 6" size pot improved vegetative growth of plant in terms of plant height (38 cm), number of leaves (7.8 cm), leaf area index (580.90 cm^2) and flowering (3.2 spike/pot) .
- In *Cymbidium*, spraying of nutrient N, P, K 19:19:19 @ 0.1% concentration at an interval of 7 days produced maximum no. of shoots (4.07) and higher girth of pseudobulb (2.57cm) while same nutrient at 0.3% concentration at 7 days interval improved plant height (67.79 cm) and number of leaves (14.4) and flowering (1.5 spike /plant).
- Among the different *Cymbidium* hybrids highest vase life was recorded in 'Sleeping Nymph' 56.90 days followed by 'Valley Flower Powder Puff' (52.86 days) and Baltic Glacier Mint Ice (41.81 days). Vase life was lowest in 'Valley Pink Inspiration' 29.00 days.

- Nearly 50,000 plants of Cymbidium orchids were produced and given to the farmers under various programmes from NRCO Darjeeling campus.
- Polyclonal antibodies against CymMV and ORSV have been developed using bacterially expressed recombinant coat protein as immunogen. Antisera of CymMV and ORSV detected the viruses by direct antigen coated-enzyme linked immuno sorbent assay (DAC-ELISA) from orchid samples.
- Association of a plant parasitic nematode on *Cymbidium* hybrids, *Helicotylenchus microcephalus* Sher, reported for the first time from India.
- Seven IPM modules consisting of botanical products, biopesticides and chemical insecticides were evaluated for their efficacy against mite, *Tatranychus urticae* on *Cymbidium* under polyhouse condition. Results showed that all the modules were significantly superior over untreated check. Among the seven modules, M-5 (tobacco extract 5%, neem oil 0.03% EC 5 ml/lit and bifenthrin 10EC 0.25%) was found superior to rest of the modules which reduced 99.0 percent population.

Thrust Areas

- Collection, conservation, characterization and evaluation of orchids.
- Development of hybrids/ varieties of internationally acceptable qualities.
- Standardization of standard production technology for commercial cultivation of orchids.
- Standardization of protocols for mass multiplication of important hybrid and species.
- Development of package of practices of commercial orchids.
- Development of integrated pest and disease management strategies.
- Production of diagnostics against viruses of orchids.
- Dissemination of technology to the growers by conducting trainings.

C. NATIONAL RESEARCH CENTRE ON PIG GUWAHATI

The farm complex of the NRC on Pig has started functioning since August, 2007. institute has completed a survey on pig husbandry practices in North Eastern Region of India and the findings were documented. Genetic characterization and evaluation of indigenous pig germplasm and their conservation programme are going on and presently the institute farm maintains 2 nos. of indigenous breeds of pigs (Niang-Megha and Ghungroo) and 2 nos. of exotic breeds (Hampshire and Duroc) and their crosses. In order to popularize the Artificial Insemination and to reduce the cost of maintaining the male pigs at farmer's field, the institute has standardized the technologies for semen collection and preservation in different extenders and work on AI has been undertaken and the work is in progress. More than 500 nos. of AI has been carried out till date iat the institute farm/ university pig farm/ and nearby farmer's field.

Considering the importance of upgraded variety of pigs for the farmers, a cross breeding programme between Niang Megha x Hampshire and Ghungroo x Hampshire has been undertaken and both the crossbreds are performing well. Also, inter-se-mating between 50% Niang-megha x HS and 50% Ghungroo x HS has been undertaken to find out a suitable animal for the farmers. For development of designer pork with low back fat content, a three breed cross between Ghungroo x Hampshire x Duroc has been undertaken and the work is in progress. NRC on Pig has standardized the technologies for genetic screening of Pale-Soft-Exudative condition in breeding as well as commercial pig stock to detect rapid pH fall (i.e. a pH of less than 6.1 in 45 minutes postmortem), which results in pale, soft and exudative (PSE) meat.

A research programmes to develop good management practices (GMP) for improved pig production and development of pig health management protocols and isolation, identification and characterization of important bacterial pathogens of pig are in progress. Under Institute Village Linking Programme (IVLP), the upgraded varieties of pigs were distributed to the nearby progressive farmers for validation of improved varieties at farmers field in order to establish pig villages. Three numbers of patents were filed so far at Kolkata Patent Office on 29th December, 2009. A total of above 1500 piglets were produced and sold to the farmers, state Govt. and different NGOs of North Eastern India. A state of the art R&D pork processing plant, equipped with essential facilities to ensure hygienic slaughter and processing of value added pork products is in function for the first time in North East Region under ICAR system.

Besides this, the institute is coordinating the pig production programme for the benefit of the farmers through AICRP on Pig in the states of Assam, Nagaland and Mizoram. Further, to bridge the gap of availability of improved varieties of pigs, the institute is also coordinating mega seed project on improved varities of pigs in Assam, Mizoram and Nagaland.

Future thrust

In order to strengthen the piggery sector of the country, the institute has envisaged to undertake the following programmes in coming years (1) production of improved variety of piglets for the farmers, (2) mass popularization of artificial insemination in the field, (3) creation of pig villages in and around the institute, (4) conservation of indigenous pigs, (5) development of economic feed formulations using non-conventional feed resources, (6) development and popularization of good management system including health cover practices and (7) processing of value added pork products through entrepreneurship development.

D. NATIONAL RESEARCH CENTRE ON MITHUN JHARNAPANI, NAGALAND

Research Achievements of the Institute (September, 2009 to March, 2011)

- Two calves of Mithun by using AI protocol born in 2010 in village (field) conditions.
- Superovulation protocol has been standardized in order to do embryo transfer in Mithun.
- Dentition patterns of Mithuns for determination of age under field conditions have been established.
- Cytogenetic screening and analysis of all the Mithuns in the institute farm were completed.
- First ever R- and C-banded karyotypes of Mithun were prepared in this institute.
- Characterization of kappa casein (milk protein gene) and leptin gene (gene controlling meat traits) has been progressed and a number of sequences being parts of these genes were sequenced and submitted to GenBank.
- Genetic polymorphisms were identified in Mithun kappa casein and Leptin genes and animals were genotyped based on these polymorphims.
- Morphometric (phenotypic) characterization of all four strains of Mithuns has been completed.
- Estrus synchronization protocols in Mithun standardized for fixed time insemination and implemented successfully at field level.
- Preservation of liquid semen of Mithun at refrigeration temperature has been standardized.
- The PCR based technique to detect Fertility Associated Antigen (HBP and Osteopontin) transcript in Mithun seminal plasma has been standardized.
- Established the physiological growth pattern of Mithun of either sex. Myostatin gene found to inhibit body growth of Mithun.
- Study on physiological, haematological and biochemical parameters of Mithun under stress due to load carrying capacity has been assessed.
- More than 260 tree leaves/ shrubs available in NEH region of India for feeding of Mithun has been identified, chemically analyzed and nutritionally evaluated.
- Macro and micro minerals analysis were done in tree leaves / shrubs, soil samples and blood of animals.
- Area specific mineral mixture suitable for Mithun was developed based on the information generated by various studies in the institute.
- The protein requirement of growing Mithun has been determined and was found to be lesser than cattle as per NRC requirement.
- Different types of feed blocks based on total mixed rations for Mithun were developed.
- Feeding of breweries waste (spent grains) in Mithun was found to improve growth rates and economized feeding cost.

- Important bacterial, viral and protozoan diseases identified in Mithun and control measures were evolved for some of the diseases.
- The hide of Mithun was compared with that of cattle and it was found that Mithun hides and its products were better as compared to that of cattle.
- Different leather products of mithun like jacket, shoe, portfolio bag, *etc* were prepared successfully for demonstration purpose and found to be of superior quaility.
- Isolation of alpha lactabumin and beta lactoglobulin fractions of whey protein and alpha, beta and kappa casein fractions of Mithun milk has been accomplished so far towards identifying bioactive properties of Mithun milk.
- Two locations were selected in Nagaland for establishing ONBS herd of the Mithun under participatory mode with the local tribal community in the native tract of Mithun and population survey has been completed.
- Technology developed in the Institute in feeding, breeding and health care has been implemented in the Mithun rearing areas for better Mithun husbandry practices.
- Technology Injection programme (Transfer of technology) like dissemination of scientific Mithun husbandry practices, conducting health camps for vaccination of important disease of Mithun helped to transmit the information to the farming community.

E. NATIONAL RESEARCH CENTRE ON YAK DIRANG, ARUNACHAL PRADESH

- Genetic characterization of yaks for morphological and productive traits indicated high genetic variability in production and reproductive traits.
- Five types of yaks have been identified based on phenotypic characteristics.
- Family wise DNA has been isolated.
- Selective breeding is being carried out to improve the performance of yaks.
- Yak experiences heat stress during summer when ambient temperature exceeds 10°C and RH more than 90%.
- Cryopreservation of yak semen has been developed and AI is successfully practiced.
- ETT in yaks has been standardized, and a calf by ETT was born at the centre for the first time in the world.
- Synchronization of oestrus, with progesterone impregnated vaginal sponge developed by CSWRI, Avikanagar, followed by Artificial Insemination (A.I.) resulted in 100% oestrus response with 80% conception and 60% calving rate.
- Yak and yak hybrid embryos could be produced *in vitro* up to blastocyst and compact morula stage and cryopreserved by vitrification.
- Area specific mineral mixture formulation for yak feeding is prepared with zinc (Zn), copper (Cu), cobalt (Co) and manganese (Mn) in the ratio of 40:20:2:1.
- Optimum performance with economic advantage was achieved in growing yaks on feeding Complete Feed Block supplemented with limiting micro-nutrients.
- Exploratory trial on different grasses have been tried at high altitude (9000 ft above msl) at different places of Arunachal Pradesh and Sikkim.
- Epidemiological studies on parasitic diseases have been carried out.
- Some commonly used ITK in NE India are being identified, validated and documented.
- Socio-economic status of yak herdsmen has been evaluated in yak inhabited states for possible improvisation on the present economic condition of the pastoral communities.
- Yak hair fibres are blended with the sheep wool and angora rabbit wool at 50%, 25% and 25% level and prepared various value added products *viz*., cap, doormat, carpet, wall hanging etc.
- Functional panner is prepared from low fat (1%) yak milk with enhanced natural dietary fibers.
- A Krishi Vigyan Kendra for Lohit district (Arunachal Pradesh) was established at Chongkham which has been functioning since 26th March, 2007.

F. RAMIE RESEARCH STATION BARPETA, ASSAM

In order to promote Research and Developmental activities of World's oldest, longest and strongest natural fibre crop *i.e.,* Ramie in the country as a whole and North Eastern States in particular, the Indian Central Jute Committee on April, 2nd 1960 established Ramie Research Station at Village Kamargaon, P.O. Sorbhog, District Barpeta (earlier in Kamrup District), Assam under the Jute Agriculture Research Institute (JARI), Kolkata (WB). In 1966 JARI was taken over by Indian Council of Agriculture Research (ICAR) and in 1990 Jute Agriculture Research Institute (JARI) was renamed as Central Research Institute for Jute and Allied Fibres (CRIJAF).

Mandates

1. Improvement of Ramie (*Boehmeria nivea* Gaud) for fibre yield and quality.
2. Improvement of Ramie (*Boehmeria nivea* Gaud) for biotic and abiotic stresses.
3. Development of economically viable and sustainable production technology and cropping systems with ramie.
4. Development of post-harvest technology (decortication, degumming and storage) for improving the quality of fibre.
5. Transfer of technology and human resource development in relation to ramie.

Salient Achievements

1. **Germplasm collection & evaluation**: Fifty two ramie germplasm lines were collected from the different districts of Assam during, 2009 and total 131 germplasm lines were characterized and documented.
2. **Breeding and varietal development**: Nine promising entries of ramie are being tested under AINPJAF trials (AVT-2) at three locations. Floral biology and flowering behavior in ramie has been studied, which will strengthen the genetic improvement programme of ramie in the country.
3. **Planting material**: The technology for propagation of ramie through True Ramie Seed (TRS) and Ramie Seed Production has been standardized which will reduce the cost of plating material (rhizome) and will be convenient for supply and storage in the remote places. A modified propagation method with waste-stalks of ramie has been standardized which has shown promise over the rhizome-propagation and will be a future technique for large scale area expansion. A Total of 45 quintals rhizome was produced and distributed to the farmers of Assam and Nagaland states during last two year. Mechanical ramie planting technique with newly designed tractor operated furrow opener will be helpful in large scale ramie plantation.
4. **Farmers Training:** One week farmers training on ramie cultivation was organized at RRS during 22nd to 28th Nov., 2010.

G. CPCRI, REGIONAL CENTRE KAHIKUCHI, GUWAHATI, ASSAM

The CPCRI Research Centre at Kahikuchi is undertaking research on coconut and arecanut for development of location specific technologies for NE Region. Evaluation of arecanut varieties in the NE Region resulted in the release of high yielding arecanut variety 'Kahikuchi'. The production and protection technologies have been standardized for arecanut for the region. The centre has established an arecanut based high density Multi-species cropping system suited for this region to enhance the productivity and profitability from arecanut gardens. The centre is implementing a central sector scheme titled, "Technology Mission for Integrated Development of Horticulture in NE states including Sikkim" (Mini Mission – I) under the sponsorship of Ministry of Agriculture. Transfer of technology programmes and production of quality planting materials are also being undertaken at this centre. The salient achievements are as follows:

1. Standardization of production technologies for improved varieties of spices and plantation crops

(A) Comparative study of the seasonal vegetables in arecanut interspace and open condition: A comparative study of the performance of seasonal vegetables in areca interspace and open condition crop is in progress since 2009 in organic condition. Six vegetables were grown in each season (summer/kharif and winter/rabi) with organic treatments *i.e.* cow dung, vermicompost and vermiwash. During summer season (April-July) okra, pumpkin, *Amaranthus tricolor,* ridge gourd, bitter gourd and chilli were grown whereas cabbage, carrot, peas, cauliflower, spinach and french bean were the winter season (November-February) vegetables. Benefit: cost ratio obtained from the average data of two years of summer vegetables grown in summer season revealed that, bitter gourd recorded the highest B: C ratio (6.41:1) followed by ridge gourd (4.68:1) in open condition whereas, ridge gourd recorded the highest B: C ratio (2.30:1) followed by bitter gourd (2.27:1) under areca interspace.

(B) Evaluation of local germplasm of coconut: Data on growth, inflorescence, and nut characters of 13 locally collected coconut accessions are being recorded. KKHC-8 recorded the highest trunk height (1.93 m) whereas the highest collar girth, no. of functional leaves produced as well as no. of spadices/ palm was recorded in KKHC-2. The highest no. of nuts produced/palm was recorded in 2 accessions (KKHC-1 and KKHC-8).

(C) Evaluation of Coconut varieties/hybrids under Assam conditions: A field trial on the performance of 12 coconut hybrids and HYVs under NE condition is in progress. The hybrid WCT x GB recorded the highest no. of spadices (5.59) and nut yield/palm (23) on 6th year of planting and MGD recorded maximum number of fruit production (14 nuts/palm) during 2010.

(D) Evaluation of local accessions of black pepper: Thirteen locally collected pepper accessions are being evaluated for growth and yield. All accessions flowered in the fourth year. Growth and yield data, and pests and disease incidence are recorded regularly. It was observed that KKHP-8 recorded maximum fresh berry yield (4.7 kg/vine) followed by KKHP-3 (4.5 kg/vine) and maximum spike length was recorded in KKHP-3 (156.25 cm) followed by KKHP – 8 (140 cm).

2. Micro-irrigation and water management practices (Plantation crops- Arecanut)

(A) Water requirement and comparative efficiency of different systems (drip, sprinkler, basin) of irrigation in arecanut at different fertilizer levels : A field trial on "water requirement and comparative efficiency of different systems of irrigation in arecanut" is in progress with five irrigation treatments (I_0= no irrigation, control; I_1= drip at 33% E_0, I_2= 66% E_0, I_3= 100% E_0, I_4= sprinkler @ 0.75 IW/CPE, I_5= sprinkler @ 1.0 IW/CPE and I_6- basin irrigation) combined among four different fertilizer doses (F_0= no fertilizer, F_1= 1/3rd, F_2= 2/3rd and F_3= full fertilizer dose). Observations on the vegetative and inflorescence characters, and nut yield of arecanut palms under treatments has been recorded. Drip irrigation at 100% pan evaporation found effective in growth, yield (3.5 kg challi/palm/year) and moisture distribution/ utilization.

(B) Development of in- situ water conservation measures of arecanut suitable for watersheds of N. E. Region: For the development of *in-situ* water conservation measures suitable for watersheds of N.E. Region, the arecanut garden is maintained in the farmer's field with imposition of different soil and water conservation measure treatments like catch pit filled with coconut husk, catch pit with pineapple downstream, contour staggered trenches, half moon trenches, and without any conservation measures. Among the different treatments catch pit filled with coconut husks showed best result producing 1.85 kg challi of arecanut per palm per year.

3. Development of organic farming practices

(A) Developing Arecanut based cropping system model: Two arecanut based HDMSCS models {(Model-1-arecanut (Kahikuchi selection) + pepper (Karimunda) + banana (Chenichampa) + citrus (Assam lemon) +clove (Improved variety) and Model-2-arecanut (Kahikuchi selection) + pepper (Panniyur- 1) + banana (Chenichampa) + citrus (Gandharaj lemon) + nutmeg)} are being mainatined. Maximum biomass (12.1 and 7.6 t/ha in Model-1 and 2, respectively) was obtained from the plots applied with 2/3rd dose of recommended chemical fertilizer. All the crops except banana performed better under 2/3rd dose of recommended fertilizer, whereas, banana produced maximum fruit in full dose of recommended fertilizer irrespective of the models. Highest B:C ratio (2.98 and 2.11, respectively) was observed under 2/3rd dose of recommended fertilizer for both the models.

(B) Organic farming technology for arecanut : Experiment on "Substitution of chemical fertilizer with vermicompost" is under progress with seven nutritional treatments

and five released varieties (Mangala, Sumangala, Sreemangala, Kahikuchi and Mohitnagar) of arecanut. Quantification of biomass generated from treatments are in progress for making vermicompost.

4. Eco-friendly IPM and IDM

Survey was undertaken in Boko, Singra, Bakrapara, Bakta and Kaharpara villages of Kamrup district and parts of Darrang district . The incidence of bud rot in arecanut range from 0.5. to 1%, Ganoderma wilt was observed as high as 15% in Kaharpara village; in coconut the incidence of stem bleeding range from 2% to 10.12%, and as high as 8% infestation of rhinoceros beetle was observed in Darrang.

IDM for Ganoderma wilt/Basal stem rot of arecanut

A field trial on management of Ganoderma wilt/Basal stem rot of arecanut was initiated during 2009 to study the efficacy of different treatments. The treatment soil drenching with captan 0.3% (30 g/10 lit of water) + neem cake (2 kg/palm) and root feeding with 100% culture filtrate of *Trichoderma viride* (25 ml/palm) showed lowest mortality percentage (17%), highest annual leaf production & fewer drooping leaves (1.67)

5. Technology refinement and imparting training

- Two on-farm trials in five farmers' fields were carried out to assess the performance of rabi and summer vegetables as inter crop in arecanut garden under rain fed condition in 5 farmers' fields. Average data of two years revealed that in the summer season cow pea was the best intercrop with the B:C ratio of 3.12 followed by okra (3.05) and *Amaranthus tricolor* (2.63). Accordingly, in the rabi season; carrot gave the best result with the highest B:C ratio of 3.18 followed by cabbage (3.05) and french bean (2.79).
- An on-farm trial on the effect of integrated nutrient management in arecanut palms has been initiated in a farmer's field at Nahira village of Kamrup district of Assam this year.
- On-farm trial to assess the performance of two varieties of cinnamon under arecanut (Navasree and Nithyasree) as intercrop in adult arecanut garden under rain fed condition was initiated in 5 farmers fields.
- Three new arecanut based HDMSCS demonstration gardens were developed in farmers field at Manikpur (Rani), Nahira and Balizori (Choygaon) villages in Kamrup district.
- Eleven on-campus and 12 off-campus training programmes were organized for 828 farmers, extension workers, unemployed youth and SHGs during the year.
- Five field visits and 3 numbers of exposure visits were arranged for more than 370 extension personnel, students and NGOs.
- Organized a two days workshop on "Production, management and post harvest technology in major spices in Assam" sponsored by IISR, Calicut. Speakers from IISR, CPCRI and ICAR Complex for NEH Region, Barapani, and subject matter

specialists from KVKs of different districts of Assam participated. Besides 30 nos of farmers and representatives of different self help groups also took part in the programme. An interaction session of farmers with research and developmental agencies and field visit and technology demonstration will also be executed as a part of the session.

- A two days workshop was organized on "Technological advances for enhancing productivity of arecanut and coconut in Assam" during 10^{th}-11^{th} March,2011. The workshop was attended by 200 farmers from different district of Assam. The programme included technical session on scientific technologies for coconut and arecanut cultivation, inter mixed cropping with vegetables, spices, fruit crops and ornamentals in arecanut and coconut gardens. In addition, the avenues available for product diversification in coconut was also dealt in the workshops. Experts from CPCRI, RC Kahikuchi, Horticultural Research Station Assam Agricultural University, Kahikuchi, ICAR Research Complex for NEH Region, KVK, Kamrup, AAU, COCONUT Development Board handled the classes in the workshop. Field visit and technology demonstration were also executed as a part of the session.
- A television programme was prepared on scientific cultivation of arecanut, arecanut based high density multi species cropping system and disease pest management which was broadcast through Krishi Darsan Programme in Doordarsan-1.

AICRP ON TROPICAL FRUITS

In north eastern region, three centres are functioning under AICRP on Tropical Fruits. Under AAU, Jorhat two cantres (Jorhat centre with mandate crop of banana, jackfruit and pineapple (now phased out) and Tinsukia centre on Khasi mandarin). During XI plan, one new voluntary centre at Pasighat (under CAU, Impal) has been added to work on citrus. The significant achievements made are furnished below:

Banana (Jorhat)

- A total of 97 accessions were maintained. Performance of tissue cultured plants was found superior as compared to conventional suckers. High density planting with three suckers per pit at a spacing of 2m X 3m (5001 plants/ha) has recorded higher yield and cost benefit ratio in cv. Jahaji.
- Application of 250:50:250g N:P_2O_5:K_2O per plant per crop with bunch spray of 2,4-D (10 ppm) has recorded higher yield and B:C ratio for cv. Borjahaji (AAA).
- The crop sequences of Knolkhol – Elephant foot yam or French bean – Colocasia – Spinach as an intercrop under banana is beneficial.
- For the control of scarring beetle, suckers dip in chlorpyriphos (0.05%) and chlorpyriphos (0.5%) spray or Quinalphos (0.05%) 20 ml pour in heart is recommended.
- For the management pseudostem weevils, chopped pseudostem pieces spread at ground level attracted maximum weevils in all the seasons under Jorhat conditions.

- Spray with propiconazole (0.05%) with petroleum based mineral oil (1%) was found to be the most effective treatments to manage Sigatoka leaf spot.
- Planting disease free suckers from disease free fields along with dipping in carbendazim (0.2%) for 45 minutes followed by carbendazim (0.2%) drenching at 5th, 7th and 9th MAP was effective against soil borne diseases such as Panama wilt at Jorhat. Further, the disease map of six agro climatic zones of Assam for banana has been prepared.

Jackfruit (Jorhat)

- A total of 10 promising accessions of jackfruit has been identified besides evaluating seven different varieties. Epicolyl grafting during September had showed success.

Pineapple (Jorhat)

The crop has been phased out and the achievements made are as follows:

- Planting of Kew, Queen and Mauritius varieties with suckers of 5-6 month old having 500-750 g weight with an ideal planting time of April to Oct was recommended.
- Planting at 30 cm X 45 cm X 60 cm in two-row beds (44,444 plants) with a nutrient dose of 12g N, 2g P_2O_5 and 12g K_2O per plant was recommended.
- For uniform flowering in the main season with Ethrel @100 ppm and for delayed harvest by a few days (10-15 days) with spray 300 ppm of NAA was recommended.

Khasi mandarin (Tinsukia)

- A total of 48 germplasm lines of local and exotic types were collected and maintained at CRS, Tinsukia.
- The selection of Khasi mandarin, CRS - 4 has consistently recorded the highest yield and found promising.
- Inclusion of VAM (500 g/plant), PSB (100 g/plant), *Azospirillum* (100 g/plant) and *T. harzianum* (100 g/plant) with 450 g N, 225 g P_2O_5, 450g K_2O and 5.625 kg neem oil cake (75% RDF) per plant per year has been recommended.
- Foliar application of copper oxychloride (0.3%) or carbendazim (0.1%) in combination with 2,4-D (10 ppm) or NAA (30 ppm) recorded significantly higher fruit retention in Khasi mandarin.
- Orchard efficiency analysis at Tinsukia centre has indicated high soil and leaf NPK status of high yielding orchards as compared to low yielding orchards of mandarin.
- For the control of leaf miner, spray of imidachloropid 200SL/acephate (0.1125%) and single application of thiodiocarb 75WP (75%) has been recommended.

Citrus (Pasighat)

- A total of 18 different species/clones of citrus have been collected and are planted for further evaluation.

H. CENTRAL POTATO RESEARCH STATION SHILLONG, MEGHALAYA

Central Potato Research Station, Shillong was established in 1959 under the Central Potato Research Institute, Shimla as a potato experimental and trial center. The center was strengthened and upgraded to the status of a "Research Station" during the Vth Five-year plan to conduct research on the regional problems in potato cultivation. It is spread over an area of 12.6 hectares and is located in Upper Shillong in East Khasi Hills district which is an important potato growing district of Meghalaya.

Mandate of CPRS, Shillong

- Breeding for resistance to late blight and brown rot
- Seed production
- Standardizing agronomic and manurial practices
- Integrated pest management
- Evaluating the impact of potato production technologies

This station is equipped to conduct research on the above mentioned mandate and has field and laboratory facilities that include a tissue culture laboratory, poly houses, net houses, storage facilities, vermin-composting unit and library.

Constraints in potato production

- Inadequate & untimely supply of healthy planting material.
- Congenial environment for pest and diseases.
- Adoption of sub-optimal management practices.
- Rapid seed degeneration by viruses.
- Unorganized seed sector.
- Lack of knowledge on appropriate seed storage practices.

Achievements of Central Potato Research Station, Shillong

Development of varieties/ hybrids

- Potato varieties Kufri Jyoti and Kufri Giriraj are most popular in the region.
- Kufri Megha (late blight resistant) is popular in Meghalaya and Assam and Kufri Kanchan (red skinned variety) is preferred in Sikkim.
- The newly released varieties Kufri Girdhari, Kufri Himalini and Kufri Himsona are also gaining popularity among farmers.

Seed Production

- Disease free planting material of Kufri Jyoti, Kufri Giriraj, Kufri Himalini, Kufri Himsona, Kufri Girdhari and Kufri Megha are being produced through micro-plants

and micro tubers/mini tubers under controlled condition and are being supplied to various states in NEH region.

- About 160 quintals of disease free seed was supplied during 2009-10 and 208 quintals of seed was supplied during 2010-11 to different states of NEH region.

Production Technologies

- Potato production technologies have been standardised for sustainable cultivation under the acidic soil conditions of the region through on-station and on-farm evaluation trials.
- Planting of potato in ridges with a spacing of 20 cm between plants and 60 cm between rows has been found optimum for Meghalaya.
- Organic farming of potato and application of vermin-compost has been encouraged in the region through establishment of vermin-compost units. Trials have shown that inorganic fertiliser could be substituted to the extent of 25% with organic sources as yields obtained were comparable with entirely inorganic sources.
- Remunerative potato based cropping systems have been recommended for Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram and Tripura *e.g,* potato – paddy – french bean, potato – paddy – carrot, potato – potato – vegetable in lower and higher hills and paddy – potato, black gram/green gram/ kharif vegetable – potato, paddy – potato – vegetable in plains.
- Suitable varieties for early and late planting have been identified. Kufri Megha performed best irrespective of planting dates in the region.

Protection technologies

- Combinations of systemic and contact fungicides (2 sprays of 2.5% metalaxyl and 3 sprays of 2% mancozeb) were found most effective and economic in management of late blight disease in autumn TPS grown potato in the hills of this region.
- Potato tuber moth (PTM), a major problem at farmers' level storage, can be effectively checked using dried and chopped *Lantana camera* leaves, which is easily available in the locality.

Storage technology

- Farmers of NE states are unaware of scientific storage methods for both table and seed potatoes and the scarcity of cold storages prompts them to use various indigenous methods for *in situ* and *ex situ* storage. Through on-farm demonstrations, farmers have been trained on scientific methods of harvesting, tuber treatment and storage of seed under diffused light. The farmers have also been given the demonstrations on low cost table potato storage at their house holds in 5 villages in Meghalaya. Kufri Himsona with high dry matter, low sugars, phenols and resistance to late blight is likely to fulfil the aspirations of the region to have a processing variety.

Location specific technology generation

- Surveys in Assam, Meghalaya and Nagaland helped in collecting information on existing potato cultivation practices and understanding farmers' traditional/ indigenous production practices, associated rationale, level of gap in the adoption of recommended technologies and perceived constraints in the adoption to decide the appropriate farm interventions for potato cultivation.
- Verification trials were conducted to assess the farmers' traditional method of potato planting in comparison with recommended method through on-station and on-farm trials and the recommended technologies were refined to develop location specific technologies for wider acceptability and adoption among the farmers of this region.

On-farm demonstration

- On-farm demonstrations have been conducted in the farmers' fields to demonstrate production and protection technologies.
- More than 1200 farmer beneficiaries received quality planting material and cultivation technology and this enabled them realise 36-180% yield increase over their own seed and technology.
- Farmers favourably perceived the newly introduced variety Kufri Giriraj on the attributes of plant growth, resistance to late blight, yield and better marketability of the produce.
- Front line demonstrations on TPS hybrids were conducted and TPS 92-PT-27 was found suitable due to its tuber uniformity, high yield and late blight resistance.

Training

- Training for knowledge and skill up-gradation in potato production technologies of the farmers as well as extension officers in this region is an ongoing activity of the station.
- More than 1,600 farmers and 80 extension officers have been trained.

Impact of improved technology

- Stable bleaching powder reduced incidence of bacterial wilt in low land/lower slope conditions from 10 – 20% to 1 – 2% with up to 15% yield advantage.
- Yield advantage of 15 – 20% was observed in Kufri Jyoti in Assam through late blight management with one prophylactic spray of Mancozeb followed by alternate sprays of Metalaxyl and Mancozeb

Incidence of Potato Tuber Moth in store, which was up to 80% in East Khasi Hills district of Meghalaya reduced to 4 – 5% after application of dried *Lantana* leaves.

AICRP ON POTATO

Following centers of AICRP (Potato) are located in the region.

Assam : Jorhat under AAU, Jorhat

Arunachal Pradesh : Pasighat under CAU, Imphal

Area, production and yield of potato in Assam and Arunachal Pradesh is given below.

Year	Assam			Arunachal Pradesh		
	Area ('000 ha)	Production ('000 t)	Yield (t/ha)	Area ('000 ha)	Production ('000 t)	Yield (t/ha)
2005-06	69.60	353.70	5.08	4.00	29.80	7.45
2006-07	78.00	505.00	6.47	4.00	31.70	7.93
2007-08	79.30	514.60	6.49	3.80	29.20	7.68
2008-09	79.66	669.19	8.40	4.00	31.70	7.93
2009-10	86.56	589.70	6.81	4.00	31.70	7.93
Average	393.12	2632.19	6.70	19.80	154.10	7.78

Source: DES, MoA, Govt. of India

I. NBPGR REGIONAL STATION UMIAM, MEGHALAYA

The National Bureau of Plant Genetic Resources (NBPGR) established in August 1976 under the auspices of Indian Council of Agricultural Research (ICAR) has the mandate to act as nodal institute at national level for acquisition and management of indigenous and exotic plant genetic resources (PGR) for food and agriculture, and to carry out supportive research and capacity building through human resource development. The bureau has its main campus at New Delhi with 10 regional stations located in different agro-ecological/ phyto-geographical regions of the country.

The regional station – Shillong, established in1978, represents the entire North - Eastern region of the country for the purpose of crop germplasm collection. The collection jurisdiction encompasses eight states such as Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura which lays within the geographical boundary of 21°3' N to 29°3' N latitude and 87°5' and 97°3' E longitude.

Activities:

- Collection of local crop diversities, including their wild relatives from North Eastern states through explorations.
- Maintenance and characterization of mandated crops (Field crops: paddy, maize, mustard; Horticultural crops: chilli, zinger, turmeric, *Citrus*, banana, yam, taro and passion fruit; Under-utilized crops: *Perilla*, *Coix*, buck wheat, rice bean).
- Conservation of germplasm at regional level in seed gene bank (under MTS) and maintenance of vegetatively propagated crop germplasm in field gene bank.
- Introduction and utilization of exotic materials.
- Undertaking various AICRP trials.
- Need based supply of germplasm for research purpose.

Salient achievements

Exploration:

A total of 23989 accessions of various agri-horticultural crops collected from 138 exploration trips. Among these 5897 accessions were collected during 1978 - 1986. The statewise collections are given in fig 1.

Evaluation

As many as 6640 accessions of field, under-utilized and horticultural crops were evaluated in last five years.

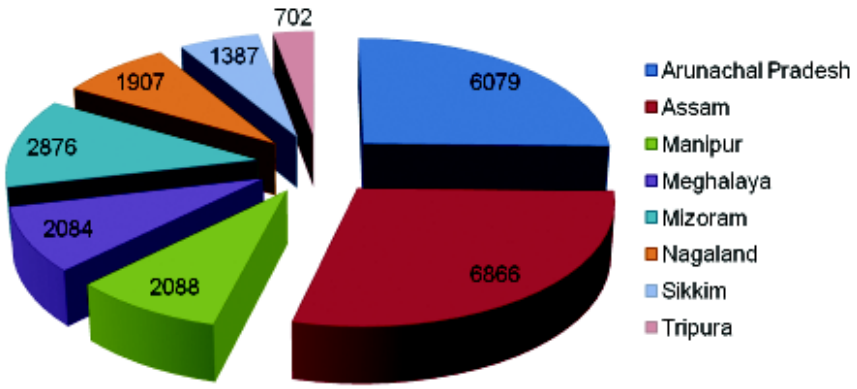


Fig- 1 Statewise germplasm collection by NBPGR Regional station, Umiam

Conservation

As many as 939 germplasm lines are in MTS and 381 are under FGB. After field evaluation, the accessions were sent to National Gene Bank for long term storage.

Table: Germplasm stored at MTS

Crop	Number
Paddy (total)	410
1.Upland	229
2.Low land	181
Maize	154
Chilli	64
Coix	54
Perilla	87
Rice bean	85
Buck wheat	85

Table: Status of FGB

Crop	Number
Citrus	27
Banana	60
Passion fruit	4
Ziziphus	1
Turmeric	144
Ginger	109
Medicinal and aromatic plants	36

J. REGIONAL RAINFED LOWLAND RICE RESEARCH STATION, GERUA, ASSAM

Flood is a recurrent problem in Assam and annually about 2 million ha of rice lands plunge under varying depths of flood water causing drastic reduction in production and productivity of rice in the state. Rice productivity under rainfed lowlands to deepwater conditions is only around 1 t ha^{-1} in spite of excellent soil and water resources available. In order is increase rice productivity by developing production technologies specially suited for flood-prone rainfed lowlands of Assam, Regional Rainfed Lowland Rice Research Station (RRLRRS) was established as a research station under Central Rice Research Institute (CRRI), Cuttack in 1997.

RESEARCH PROGRAMMES BEING UNDERTAKEN

I. Breeding for flood prone ecologies

1. Development of varieties for pre-flood (*ahu*), post-flood (*sali*) and flash flood situations.
2. Development of varieties for *boro* season.
3. Germplasm, seed maintenance and genotype evaluation through national and international trials.

II. Development of cropping systems for different rice ecologies

III. Integrated farming systems in different rice ecologies

IV. Enhancement of the resource use efficiencies

V. Quantitative and qualitative disease severity assessment

VI. Studies on components of IPM

PRODUCTION TECHNOLOGIES DEVELOPED

Some of the production technologies developed at RRLRRS, Gerua is enlisted below:

1.RRLRRS, Gerua is actively involved in collection, maintenance and evaluation of rice germplasm from North-Eastern region of India. Diverse rice genotypes available at RRLRRS, Gerua, have been given below:

Sl. No.	Category	No. of accessions
1	*Ahu*/*Aus* rice (Autumn rice) and upland rice	35
2	*Sali* rice (Winter rice)	265
3	*Boro* rice (Summer rice)	516
4	*Bao* rice (Deep water rice)	52
5	*Asra* (Semi-deep water rice)	112
6	*Bora/Biroin* (Glutinous/waxy rice) & *Chokuwa* (Semi-glutinous/soft rice)	36

7	*Joha* (Scented/aromatic rice)	63
8	Others (inclusive of breeding lines and improved cultivars)	291
	Total	**1370**

2. Variety 'Chandrama' was released in 2007 for cultivation in shallow lowland areas of Assam in *sali* and *boro* seasons and has cold tolerance in vegetative stage.
3. Variety 'Chandan' was released in 2008 for cultivation as irrigated *boro* rice.
4. Variety 'CR Dhan 601' was released in 2010 for cultivation as *boro* rice in Assam.
5. Rice varieties Anjali, Vandana and Nilagiri have been found suitable for growing as a pre-flood *ahu* crop in Assam.
6. The rice-rice-rice cropping sequence with 300% cropping intensity has been standardized. The technology is suitable for irrigated lowlands due to higher productivity of rice crop under high native soil productivity and controlled water management. The technology has a direct impact on food security and employment generation for small and marginal farmers.
7. Optimum crop configuration for SRI in *boro* rice has been standardized.
8. An integrated rice-fish-horti farming system model has been developed which can provide year round employment and income generation to farming household.
9. Evaluation of advance breeding lines (F_6 & F_7 generations) is underway in order to develop short duration varieties for pre-flood and post-flood situations. Advance breeding lines are also being evaluated to develop varieties for semi deepwater and deepwater conditions.
10. Integrated disease management strategy involving use of botanicals, biocontrol agents and fungicidal chemicals is being evaluated against blast and sheath blight diseases.

COLLABORATIVE EFFORTS

1. Local Institutions: The research station has close collaboration with the Department of Agriculture, Government of Assam and Krishi Vigyan Kendras under Assam Agricultural University for evaluation of varieties.

2. National Institutes and Agricultural Universities: Besides the CRRI, Cuttack and the Directorate of Rice Research, Hyderabad, the station collaborates with Assam Agricultural University, Jorhat, Assam, and ICAR Research Complex for NEH Region, Barapani, Meghalaya in conducting experiments.

3. International Institutes: The station is associated with the International Rice Research Institute, Manila, Philippines in evaluation and utilization of germplasm of INGER nurseries.

4. Extension and Development Agencies: The station maintains close cooperation with field functionaries of the Department of Agriculture, Government of Assam for dissemination of technology. Local farmers take benefits of the Agri-Clinic at this Station.

K. NBSS&LUP, REGIONAL CENTRE JORHAT

1) Assessment and mapping of important soil parameters including macro and micronutrients for the state of Tripura towards optimum land use planning

Soil reaction (pH): The soil pH ranges from 3.5-7.1. An area of 49.2 percent of the state belongs to strongly acidic (5.1-5.5) category followed by 24.46 percent of the state under very strongly acidic (4.5-5.0).

Soil Organic Carbon: Organic carbon content in the soils of Tripura ranges from 0.1 to 5.42 gm kg^{-1} and three categories *viz*., low (<0.75 gm kg^{-1}), medium (0.75 to 1.50 gmkg^{-1}) and high (>1.50 gm kg^{-1}) have been identified. 70.78 percent of the state belongs to medium category followed by 11.47 percent and 10.08 percent to low and high category, respectively.

Available Nitrogen: Available nitrogen content in the surface soils of Tripura ranges between 50.0 to 1206.0 kgha^{-1}. Soils of majority area (about 36 percent of the state) have medium status of available nitrogen (280-450 kg ha^{-1}) and about 32 percent have low (<280 kg ha^{-1}) available nitrogen content.

Available Phosphorus: Available phosphorus content ranges from 126.0-1059.0 kgha^{-1} in soils of Tripura. Soils of about 73.0 percent area are very low (<25 kg ha^{-1}) in available phosphorus content while about 10.29 percent area are found to be medium (25.0-45.0 kg ha^{-1}) in available P content.

Available Potassium: Available potassium content in soils of Tripura ranges from 3.85 to 1155.84 kg ha^{-1}. Most of the soils (about 51.0 percent of the state) have medium (150-340 kg ha^{-1}) and about 33.0 percent are low (below 150 kg ha^{-1}) in available potassium content.

Available Copper: The available copper status in surface soils of Tripura ranges between trace to 38.5 mg kg^{-1}. Soils of Tripura are sufficient in available copper. Only 33.0 percent area shows low (<1.0 mg kg^{-1}) available copper content.

Available Zinc: The available zinc ranges between trace to 62.0 mg kg^{-1}. Soils of about16.40 percent area are deficient (<0.5 mg kg^{-1}) in available Zinc.

Available Manganese: It ranges from 2.02 to 149.5 mg kg^{-1} in surface soils. All soils are sufficient in available Manganese content (>2.0 mg kg^{-1}).

Available Iron: Available iron content in surface soils ranges between 13.05 to 306.0 mg kg^{-1}. As per the critical limit of available iron (>4.5 mg kg^{-1}) soils of Tripura are sufficient in available iron content.

Soils of Tripura are acidic in nature ranging from slightly acidic (6.1 to 6.5) to extremely acidic (<4.5). An area of 49.20 percent of the state area belongs to strongly acidic category (5.1 to 5.5). The Organic Carbon content is moderate. Majority of soils (36.0 percent) have medium status (280 to 450 kg ha^{-1}). Soils (73.0 percent) are very low in available phosphorus content. Due to acidic nature P is fixed with Al and Fe. Most of the soils are rated as medium in potassium (150 to 340 kg ha^{-1}). Soils are sufficient in available Iron and Manganese

content. About 16.40 percent area of the state are deficient (<0.5 mg kg^{-1}) in available Zinc. Soils of Tripura (34.0 percent area) are deficient in available copper (<1.0 mg kg^{-1}).

2) Land resource inventory of east Lahing Gaon panchayat of East Jorhat Development Block, Jorhat District, Assam (Part of Land Resource Inventory for Farm Level Planning in different Agro-ecological Regions of India)

Eight land use-land cover features have been identified in different geomorphic units. The area have been mapped under five soil series, *viz*., Seojipam, Changmai, Janzi, Panitola and Churamoni with ten mapping units as phases of soil series. Soils have been categorized into different drainage, pH, CEC, surface texture, base saturation classes based on soil survey information. Suitability classification shows that the Seojipam and Changmai series are found highly suitable for Assam lemon and tea. Janzi and Panitola series are found moderately suitable for banana, cabbage and potato. Churamoni and Panitola series are found moderately suitable for rice.

3) Land resource inventory of Katonigaon Panchayat of Titabar block, Jorhat district (Part of Land Resource Inventory for farm planning in different agro-ecological regions of India)

The landforms identified in the study area are:

i) Gently sloping uplands with 3 to 8 per cent slope
ii) Very gently sloping uplands with 1 to 3 per cent slope
iii) Lowland
iv) Narrow valley land

During the course of survey 5 soil series with 11 soil mapping units as phases of soil series were identified. About 54.56 per cent of the study area is moderately eroded and 27.83 per cent of the area is severely eroded. Slightly eroded soil occurs only in 3.31 per cent of the area. The results show that soils of the study area are acidic in nature. 40.07 per cent of the study area is strongly acidic, 25.37 per cent is extremely acidic and 17.26 per cent is very strongly acidic.

4) Correlation of soil series of North-Eastern states (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura)

A total of 28 soil series from North Eastern region (6 series from Assam, 3 series from Arunachal Pradesh, 2 series from Meghalaya, 2 series from Mizoram, and 15 from Tripura) have so far been entered in the National Register.

5) Study of crop moisture availability of soils during post- *kharif* period in Sibsagar district of Assam

From water retention curve it is observed that the clay profile holds slightly more water on volumetric basis at any given tension and it behaves slightly different in release behavior of water. The variation in volumetric water content (m^3 m^{-3}) for different layers of a profile having the same texture at different tension values (1/3, 1, 5 and 15 bar) may be due to variation in clay, silt, fine sand and organic matter content.

6) Soil microbial biomass carbon and nitrogen in selected soil series of Northeastern region as affected by different land uses and varied agro- ecological conditions

Soil samples collected from Sibsagar and Jorhat district of Assam indicated that the vertical distribution of soil OC and soil MBC are very similar in the profiles showing a somewhat decreasing trend with depth. In the surface layer (0-20 cm) the content of soil OC and MBC ranges from 4.2 -10.4 g kg^{-1} and 74.06 -148.16 µg/g, respectively.

7) Assessment of heavy metal pollution and its mapping in soils of contaminated areas of Morigoan, Dibrugarh and Tinsukia districts of Assam

Among the metals, Fe had the highest mean concentration (7629.3 mg kg^{-1}), while the lowest value was for Cd (0.13 mg kg^{-1}). The mean concentrations of other metals were 952.9 mg kg^{-1} for Mn, 52.36 mg kg^{-1} for Cr, 32.77 mg kg^{-1} for Ni and 13.12 mg kg^{-1} for Pb.

8) Development of district level land use planning for Jorhat District, Assam under rain-fed ecosystem

Eight distinct Land Management Units (LMU) have been identified each of which represents unique features of soil, land use and production system. Each LMU has been evaluated for suitability of different crops in relation to the cropping pattern of Jorhat district. The LMUs have been evaluated for suitability for rice, mustard, potato, tea, citrus, pulses (black gram) and vegetables (chili, tomato and cabbage).

9) Land use planning of Diring-Thanglong micro-watershed of Karbi-anglong and Golaghat districts of Assam under hills & mountain ecosystem for integrated development

Preliminary base map of the study area has been prepared using Survey of India Topsheets (83 F/6, F/10) along with IRS P6 LISS-IV (5.8 m resolution) imageries of the concerned area. Tentative landform features were identified, *viz*., steep hills, moderately sloping hills, piedmonts, gently to very gently sloping uplands, inter-hill valleys and plains.

10) Assessment and mapping of some important soil parameters including macro and micro nutrients for 13 priority districts of Assam state towards optimum land use planning

A total of 26,342 soil samples (0-25 cm) were collected. Soil samples were processed for analysis of pH, organic carbon, available N, P&K, and DTPA extractable micronutrients for Goalpara, Bongaigaon, Kokrajhar, Bagsa, Chirang, Borpeta, Nalbari, Darrang and Sonitpur, Udalguri, Morigaon and Nagaon districts of Assam. Soil, administration and village maps were prepared for Goalpara, Bongaigaon, Kokrajhar, Bagsa, Chirang, Borpeta, Nalbari, Darrang and Sonitpur, Udalguri, Morigaon, Tinsukia and Nagaon districts. Soil variability maps for pH, organic carbon, available NPK and micronutrients (Cu, Zn, Mn & Fe) were prepared for Goalpara, Bongaigaon, Kokrajhar, Bagsa, Chirang, Borpeta and Sonitpur districts.

L. CIFRI REGIONAL STATION, GUWAHATI, ASSAM

1. Standardizing fish stock enhancement protocols in floodplain wetlands

The institute has been carrying out studies on various aspects of stock enhancement in Assam, which has over 50% of water-spread area covered by these wetlands in the country with a view to standardizing their stock enhancement protocols. As part of the study, field data were collected from twelve beels of Lower Brahmaputra Valley Sub-zone of Assam and six beels of Barak Valley Sub-zone during 2009-11.

The main criteria for selection of candidate species in the selected beels were growth performance (e.g., grass carp, catla), consumer preference and market price (e.g., chital> rohu>catla> kuhri>bata>mrigal>CC>GC>SB>BC>SC), availability of seed (e.g., kuhri and bata available in LBVZ/ CBVZ, silver barb available in Barak valley) and catchability (e.g., common carp and mrigal are less preferred in deep and perennial beels owing to low recapture rates). There were regional variations in selection of candidate species. Catla was the most preferred species for stocking the selected beels in all zones followed by rohu and grass carp, whereas common carp was preferred over mrigal in Barak valley (owing to higher demand and price). Minor carps, bighead carp and the clown knife-fin were stocked in Lower and Central Brahmaputra Valley Sub-zones while stocking of silver barb was observed only in the beels of Barak valley.

Stocking practice: Stocking in the selected beels was practiced during two seasons. In most beels located in lower and central Brahmaputra Valley Sub-zones carried-over carp fingerlings were stocked during the pre-monsoon months of February-March. In Damal beel, the length of carried over catla ranged from 14.2 to 18.0 cm, that of rohu from 9.6 to 16.2 cm, followed by mrigal (10.2 to 16.3 cm). These yearlings grew rapidly in the beels taking advantage of warm temperature regimes and abundant natural food produced during the pre-monsoon, monsoon and post-monsoon seasons

Species ratio: For shallow beels (post-monsoon season depth range 3-4 m) a tentative species ratio of 40 SF: 30 CF: 30 BF was suggested, whereas for deeper beels (depth >4 m), a tentative species ratio of 2 SF: 1 CF: 1 BF was suggested. However, species ratio followed in the selected beels varied widely. Mrigal was the dominant component of stocked fishes in Sibnarayan anoa (5m:2r:2c:1cc), Fulbari anoa (4m:2c:2r:2cc), Banskandi anoa (30m:20r:20c:30ec) and Sakaity beel (35m: 20r:10c:35ec). Catla and grass/common carp were the dominant stocking components in Baraknadi anoa (38c:21r:19m:22ec) and Korkoria beel (20gc:20cc:15r:15m:10c:10 mc). In Chiri anoa, rohu contributed 80% of the stocked seed with mrigal contributing the remaining 20%. In Puthimari beel a tentative species ratio (2:2 sc:2 gc:1 catla:1 cc) was followed. Similar species ratios favoring catla, grass carp, rohu and mrigal were followed in Motirkuthi beel.

Stocking density: Stocking density in the selected closed beels varied from 2190 no./ha (Barundanga beel) to 10000 no./ha (Lakhanabandha beel). In seasonally open beels stocking density ranged from 833 no./ha (Kapla beel) to 8750 no./ha (Dandua beel). Higher stocking density was practiced in closed beels than that in seasonally open ones.

Fish production: Fish production from both stocked and natural fish stocks in the selected closed beels ranged from 149.3 (Puthimari beel) to 1387.8 kg $ha^{-1}yr^{-1}$ (Damal beel). Contribution of stocked fishes to fish production in these beels varied from 134.3 to 832.7 kg $ha^{-1}yr^{-1}$. In seasonally open beels, total fish production varied from 41 (Kapla beel) to 528.8 kg $ha^{-1}yr^{-1}$ (46 Morakolong beel). The contribution of stocked fishes to fish production varied from 24.6 (Kapla beel) to 416 kg $ha^{-1}yr^{-1}$ (Bhoispuri beel). Both total fish production and contribution of stocked fishes to fish production was higher in closed beels than that in seasonally open ones.

Contribution of stocked and natural fish stocks: The contribution of stocked fishes to total fish production was 60% or more in all the closed beels indicating that culture-based fisheries was practiced in these beels. In seasonally open beels, the contribution of stocked fishes to total fish production was as low as 25% (Baraknadi anoa) to 30% (Singra and Charan beel), which were regularly flooded from the adjoining rivers. In the remaining seasonally open beels it ranged from 40% (Akra beel) to 80% (Dandua, Jaluguti, Bhoispuri, Chiri anoa). The contribution of stocked fishes to total fish production was 50% or more in 11 out of 17 seasonally open beels indicating that culture-based fisheries was practiced in these beels.

2. Demonstration of enclosure culture technology

First set of pen culture demonstration: A moderate-sized rectangular pen of 741 sq. m (46 m x 16.1 m) was constructed using net lined split-bamboo screens in Damal beel, Morigaon district, Assam. The pen was stocked with carried-over seed of Indian major and exotic carps @ 5 fingerlings per sq.m. during the last week of February, 2009 after manual clearance of aquatic macrophytes and removal of unwanted aquatic organisms through repeated netting with small-meshed net. The species ratio followed was 2 surface feeder (catla): 1 column feeder (rohu): 1 bottom feeder (mrigal). In addition, 5% grass carp and 1% silver carp was stocked to control submerged aquatic macrophytes and moderate phytoplankton bloom (of *Microcystis aeruginosa*) that started appearing at the time of pen installation.

Second set of pen culture demonstration: The second set of pen aquaculture demonstration was initiated in Damal beel during February, 2010. For this, the net-lined split-bamboo screens of the existing pen enclosure (414 m^2) were repaired. In addition, another new enclosure (200 m^2) using only mosquito netting was erected in order to further reduce the cost of pen construction. Both the enclosures were stocked with carp seed during the first week of March @ 6 no./ sq. m. A species ratio of 40% surface feeders (35% catla, 5%

silver carp), 30% column feeders (25% rohu, 5% grass carp) and 30% bottom feeders (15% mrigal, 15% common carp) was maintained in the pens. The species ratio was skewed in favour of the Indian major carps because of their higher preference and better acceptance. However, mrigal and common carp were stocked at equal proportions because of higher growth rate of common carp in the beels compared to that of mrigal.

Water quality: Water in the pens was characterized by favourable temperatures (26.7 to 27.1^{0}C), clear water (Secchi disc visibility in the range of 58-64 cm), moderately acidic pH (6.2-6.5), favourable dissolved oxygen (6.0-8.4 mg/l), free carbon dioxide (<2 mg/l) concentrations and medium total alkalinity (30-38 mg $CaCO_3$/l).

Feeding: The stocked fishes are being fed with rice polish and mustard oil cake mixture (1:1) fortified with vitamin-mineral mixture (1%) at the rate of 5% of body weight. The effect of feeding fish with this traditional mixture will be compared with an improvised feed formulation.

Third set of pen culture demonstration: Pen erected in Damal beel was stocked with carp seed in March, 2010. The stocked fishes in the pen enclosure were fed with a traditional mixture of rice bran and mustard oil cake.

Fish growth and water quality in the pen was monitored and the fishes were released into the beel proper. The specific growth rate (SGR) of *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*, *Ctenopharyngodon idella* and *Hypophthalmichthys molitrix* at the time of release was 1.60, 1.58, 1.86, 3.30 and 2.39, respectively. The range of water quality parameters observed during the experimental duration were: temperature (26.7-32.1^{0}C), Secchi disc visibility (58-69 cm), pH (6.2-6.7), dissolved oxygen (6.0-8.8 mg/l), free carbon dioxide (<2 mg/l) and total alkalinity (22-48 mg/l).

3. Refinement of cage culture

The institute carried out cage culture experiments at Charan beel, Morigaon district, Assam under a project with a view to refine the technology during 2010-11.

Determination of optimal stocking density: Data on fish production and related aspects was collected from seven beels of LBV sub-zone of Assam and also from six more beels of Central Brahmaputra valley zone of Assam and were analyzed for standardizing fish stocking density during the report period. Fish production from both stocked and natural fish stocks in the selected closed beels ranged from 149.3 to 1387.8 kg $ha^{-1}yr^{-1}$. Based on the field data, optimal stocking density was estimated at 3000 and 3600 fingerlings/ha for closed and seasonally open beels, respectively.

Optimization of stocking density in cage culture: The Centre conducted cage culture experiments at Charan beel, Morigaon, Assam with a view to standardizing the stocking density of *Labeo rohita* fry.

Incorporation of dried water hyacinth meal in *Labeo rohita* diet:The effect of water hyacinth (*Eichhornia crassipes*) meal-based feed on growth and biochemical

composition of *Labeo rohita* fry reared in net cages was also estimated in Charan beel, Morigaon district, Assam.

Digestibility studies using dried macrophyte meals in *Labeo rohita* diet: A series of experiments were conducted to evaluate dry matter and nutrient digestibilities of different macrophyte-based diets in *Labeo rohita* fingerlings.

Socio-economic evaluation

Property and water regime of selected wetlands: Socio-economic evaluation of five beels (46 Morakolong, Deorah, Lali, Sonduba) in Morigaon district and Shivasthan-potakolong beel in Nagaon district was done in 2009-10. The ownership of the beels was with the Assam Fisheries Development Corporation (AFDC). Three beels namely Morakolong, Shivasthan potakolong and Deorah were leased to primary fishermen cooperative society and the other beels were under individual management involving local fishermen. All the beels were ox-bow lakes except Shivasthan potakolong, which was a roughly circular depression. Weed infestation was seen in Shivasthan potakolong, Lali and Sonduba beels (25-40%).

Fisher & fisheries in selected wetlands: Different kind of management arrangement was reported in the selected beels. In Sonduba and Lali beel, lessees were working as managers and with the help of other fishermen control the management of fisheries. In Deorah and 46 Morakolong, secretary of the primary fishermen cooperative society worked as manager. In Shivasthan potakolong beel though the beel is leased to Puttakolong Meen U Krishi Unnayan Atmamelal help group, but *de-facto* management of the beel is under t one individual not belonging to fishermen community.

4. ICAR outreach activity on fish genetic stocks

As part of the activity led by the National Bureau of Fish Genetic Resources (ICAR), Lucknow the institute was entrusted the task of assessing genetic stocks of catla, rohu and mrigal occurring in Brahmaputra. As part of the activity, CIFRI Regional Centre, Guwahati collected data on length and weight and reproductive parameters for the targeted species mainly from Uzanbazar fish landing center of river Brahmaputra. Tissue samples of *Cirrhinus mrigala* (2 nos.) and *Labeo rohita* (3 nos.) were also collected from Dhubri landing centre of river Brahmaputra under the activity.

5. ICAR outreach activity on nutrient profiling of fish

As part of the activity led by CIFRI, Barrackpore, CIFRI Regional Centre, Guwahati collected samples of Hilsa and mola fishes from Uzanbazar, Kolongpar and Amingaon landing centres and their proximate composition was determined.

6. Contract research work initiated in the region

i) 'Investigation of minimum environmental flow required for the sustenance of ecology and biodiversity in Nyamjang Chhu river in Arunachal Pradesh' as part of a consultancy project sponsored by Bhilwara Energy Ltd.

ii) 'Investigation and suggestive measures in fish migration in river Kameng' in Arunachal Pradesh as part of a CP sponsored by GMR Londa Hydropower Private Ltd.

iii) 'Feasibility studies for designing fish pass and hatchery complex in the proposed dam in Lower Siang HE project' as part of a CP sponsored by Jayprakash Associates Ltd., Noida during Aug. 2010-July 2011.

7. Training programmes conducted

i) One on-campus training programme on "Floodplain Wetland Management" was organised for the benefit of faculty members and students of Cachar College, Silchar from December 17 -23, 2009. In this programme 2 faculty members and 6 students have participated and got benefited. One Training Manual entitled 'Floodplain Wetland Management' was also released on this occasion.

ii) The Centre conducted an interactive meet-cum-training programme on beel fisheries management for 120 fishermen, beel lessee and beel managers of Upper Assam Region organized by AFDC Ltd. at Bokakhat during December 28-30, 2010.

10. ROADMAP FOR POST HARVEST TECHNOLOGY & VALUE ADDITION IN NORTH-EAST REGION

INTRODUCTION

The northeastern region (NEH) of India comprises of eight states namely Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim. The region lies between 21°57' and 29°28' north latitude and 89°40' to 97°50' east longitude. Agro-climatically the region is known for its wide diversities, representing temperate, subtropical and tropical areas. Through erratic rainfall and similar fluctuations the region witnessed diversity in temperature, sunshine and relative humidity. This in turn facilitates cultivation of large variety of crops. Among the states, Assam has an area of 78,523 square kilometers and shares its boundaries with West Bengal, Bhutan, Arunachal Pradesh, Nagaland, Manipur; Mizoram, Tripura, Meghalaya and part of Bangladesh. The state lies between 89° 42'E and 96° 10'E longitudes and between 24° 8' N and 27° 9' N latitudes.

The whole of the region is pre-dominantly an agrarian region. In case of Assam, about 99 % total land mass is rural and almost 50 per cent of the total land area is used for cultivation. The net cultivated area of the State is 27.53 lakh hectares (2004-05) of which 23 per cent area is either flood or draught prone and the per capita availability of net sown area comes to around 0.1 hectare. The average operational holding is 1.15 hectare only and more than 83 per cent of the farmer family is small and marginal farmers. The contribution of the agriculture sector to the GSDP (at constant prices; 1999-2000 prices) was pegged at 22.85 per cent in 2007-08 (Quick estimate) after steady decline from 32.24 per cent in 1999-2000. However, this sector continues to support more than 75 per cent population of the state directly or indirectly providing employment to more than 53 per cent of the work force.

FIELD CROPS

Paddy is the most important field crop grown in the entire region. As of for oil seeds, except Assam and Nagaland, production in the other states are very negligible. It can be inferred that paddy, oil seed and pulses are the major crops grown in Assam. For the NEH region as a whole, other important crop is maize followed by pulses. The production of field crops in north eastern states is presented in Table 1.

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Table 1. Production of field crops in North Eastern States

Production statistics: (area in '000 hectare, production in '000 tones)

State	Crop	Area	Production
Arunachal Pradesh (2006-07)	Paddy	123.04	216.95
	Wheat	3.98	6.30
	Maize	46.28	63.52
	Pulses	7.84	8.30
	Millet	21.71	21.43
Assam 2006-07	Paddy	2189.00	2916.00
	Wheat	50.00	67.20
	Pulses	210.30	116.70
	Other cereals	7.50	4.00
	Oil seeds	277.30	140.30
	Maize	19.00	14.00
	Cotton	1.00	1.00
	Jute	58.00	559.00
	Mesta	5.00	25.00
Manipur:2008-09	Paddy	166.15	406.15
	Maize	2.96	8.44
	Oilseeds	2.08	—
Meghalaya:2006-07	Paddy	104.33	200.21
	Wheat	0.66	1.18
	Gram	0.64	0.33
	Tur(Arhar)	0.80	0.63
	Other Rabi pulses	2.17	1.71
	Oilseeds	10.11	6.80
	Maize	17.04	25.33
	Other Cereals & Small Millets	2.63	2.22
Mizoram:2005-06	Paddy	55.29	97.88
	Black gram	0.04	0.06
	Lentil	0.01	0.01
	Maize	11.74	22.73
	Sesame	2.22	1.67
Nagaland:2007-08	Paddy	167.50	311.30
	Maize	63.64	115.33
	Jowar	0.80	1.05
	Small millets	14.90	14.34
	Wheat	1.15	1.80
	Pulses	30.06	35.46
	Oilseeds	75.98	67.00
Tripura:2007-08	Paddy	250.98	620.50
	Wheat	0.98	1.83
	Maize	2.45	2.42
	Gram	0.94	0.62
	Pulses	8.08	5.29
	Oils seeds	3.02	0.68

**Economic Survey : Nedfi databank*

HORTICULTURAL AND PLANTATION CROPS

The region has a rich diversity in fruit crops. In citrus, there are as many as 17 species, 53 varieties and 7 probable hybrids. Wild and semi wild species of mango and temperate fruits particularly of the Rosaceae family occur in the state. In addition, quite a good number of underutilised fruits like leteku (*Baccaurea sapida*), poniol (*Flacourtia gangomos*), nagatenga (*Rhus semialata*), thereju (*Prunus jenkinsii*), kordoi (*Averrhoa carambola*), mirika tenga (*Parameria polyneura*), amora (*Spondias mangifera*), outenga (*Dillenia indica*), silikha (*Terminalia chebula*), bhomora (*Terminalia belerica*) etc. The region is also very rich in genetic resources of cucurbits, non-tuberiferous solanums, beans and tuber crops. Non-edible wild relatives of Luffa (*L. graveolens* and *L. echinata*) and Cucumis (*C. setosus, C. hystrix* and *C. trigonus*) grow abundantly in the state. A good number of wild species of *Trichsanthes* are also available. Some of the predominant wild and semi-wild relatives of *Solanum* are *S. khasianum, S. ferox, S. incanum, S. verbasifolium, S. xanthocarpum, S. torvum, S. gilo* etc. Among the indigenous legume *Dolichos purpureus, Canavalia ensiformis* and *Vigna umbellata* are common. NER can also be considered as a treasure house of germplasm particularly for ginger, turmeric and chillies.

Banana, pineapple, citrus are the major fruit crops grown in the region. Passion fruit has been extensively cultivated in Nagaland. Among the spices, ginger, turemeric, black pepper, large cardamoms are the dominant crops. However, due to poor post-harvest handling 35-50% of the crops are lost annually. Major horticultural and plantation crops of north eastern states are listed in Table 2.

Table 2. Major horticultural and plantation crops of the North Eastern states

Fruits	Apple, Citrus, Banana, Pear, Mango, Litchi, Kiwi, Passion Fruit, Peach, Pineapple, Strawberry, Guava etc.
Vegetables	Potato, Squash (Chowchow), Capsicum, Cabbage, Cauliflower, Tomato, Brinjal, Beans, other tubers and green vegetables.
Plantation Crops	Areca nut, Walnut, Coconut, Cashew nut
Bamboo	More than 25 species of bamboo
Flowers	Orchids, Anthurium, Carnations, Rose, Ilium, Gerbera, BOP, Marigold, Tube rose
Medicinal & Aromatic Plants	Safed Musli, Patchouli, Citronella, Geranium, Aloe vera, Amla, Coptis teeta, Texus etc.
Spices	Ginger, Turmeric, Large Cardamom, Black Pepper, Chilli.

MEDICINAL AND AROMATIC PLANTS

Nature has endowed the north east India with a huge resource of medicinal and aromatic plants (MAP). The geographical position of this region in the subtropical climatic belt coupled with undulating physiography have provided specific niches in its wide range of habitats both to the indigenous species and almost all the migratory and introduced plants.

Table 3. Statewise important horticultural and plantation crops

Arunachal Pradesh	Citrus, Pineapple, Apple, Kiwi, Walnut, Cabbage, Cauliflower, Broccoli, Tomato, Bean, Cucurbits Orchid, Carnation, Gerbera Ginger, Large cardamom, Black pepper, Chilli Patchouli, *Coptis teeta*, Taxus, Arecanut
Assam	Pineapple, Banana, Citrus, Guava, Passion fruit, Mango Tomato, Cabbage, Brinjal, Broccoli, Capsicum, Cucurbits Carnation, Gerbera, Marigold, Orchid, Tube rose, Lillies Ginger, Black pepper, Turmeric, Chilli Patchouli, Vanilla, Citronella, Lemon grass Cashew, Arecanut, Sugarcane
Manipur	Pineapple, Passion fruit, Banana, Citrus, Peach Cabbage, Tomato, Brinjal, Beans, Broccoli, Capsicum Anthurium, Gerbera, Carnation Ginger, Turmeric, Chilli
Meghalaya	Citrus, Passion fruit, Pineapple, Strawberry Tomato, Capsicum, Cabbage, Broccoli, Bean Anthurium, Rose, Carnation, BOP, Gerbera, Orchid, Lilium Ginger, Turmeric, Black pepper Arecanut, Cashew nut
Mizoram	Banana, Citrus, Passion fruit, Grape. Tomato, Brinjal, Capsicum, Chow-chow, Cabbage, Broccoli, Beans Anthurium, Carnation, Gerbera, Rose Ginger, Turmeric, Chilli Vanilla
Nagaland	Pineapple, Banana, Passion fruit, Citrus, Tomato, Cabbage, Brinjal, Broccoli, Pea, Beans Anthurium, Lilium, Carnation, Gerbera, Orchid, Rose Turmeric, Ginger, Chilli, Large cardamom, Black pepper *Aloe vera*, Patchouli, Citronella, Geranium Cashew
Sikkim	Citrus, Passion fruit, Sea- buck thorn Tomato, Capsicum, Chow-chow, Cauliflower, Broccoli, Beans Orchid, Gerbera, Carnations, BOP, Lilies Turmeric, Ginger, Large cardamom, Dale *Swartia chirata*
Tripura	Citrus, Pineapple, Banana, Litchi, Mango Tomato, Capsicum, Brinjal, Beans, Cucurbits Orchids, Anthurium, Carnation, Gerbera Turmeric, Ginger, Chilli, Black pepper, Coriander, Cinnamon Arecanut, Cashew

This region is experiencing the free migration of biodiversity between the Indian plateau and the Asiatic land mass which have geological history of origin in the northern and southern hemisphere, respectively.

But, this region is still far behind the commercialization of MAP, which is mostly due to poor land holding of the common and needy farmers coupled with lack of effective organized effort, presence of several cash crops in the hand of farmers for livelihood support, well developed rice and vegetable based mind-set, and insufficient technological support mainly for post harvest processing, storage and marketing.

Amongst the aromatic crops, agarwood is the pride of this region, particularly of Assam. Latest developments led some entrepreneurs and farmers to incline towards Sugandhmantri, Patchouli, Java-citronella and Lemongrass. Similarly Aswagandha, Sarpagandha, Tulshi, Ginger, Pipoli, Satavar, *Smilax*, etc. are some of the promising medicinal crops of this region. Despite high values of these crops, there is a little, or practically no remarkable improvement of economic condition of the farming community.

However, a section of farmers, more particularly some young entrepreneurs, are very optimistic in establishing MAP farming. A little technological support may be fruitful in encouraging their effort. In the present day context, some of the crops having market demand and potentiality are discussed below which require post harvest technology support for overall development of the MAP sector in Assam:

1. Storage of rhizome of ginger and Greater Galangal (*Alpinia galanga*), Aswagandha *(Withania somifera*) powder, Pipoli (*Piper longum*) spikes, etc. are very difficult in the Assam weather.
2. Quick removal of seeds from Amla (*Phyllanthus emblica*) fruits is a major hurdle in value addition processes of this crop.
3. Peeling of the skin from roots of Satavar (*Asperagus racemosus*) and Safed-mushli (*Chlorophytum borivilianum*) is very much expensive and hence is another major hurdle for a region like Assam where scarcity of agricultural labour is gradually becoming acute.
4. Patchouli oil extraction process is still time consuming; running of the oil distillation plant for 14 to 18 hours is very much fuel and labour consuming.
5. Agarwood oil extraction process is also very much time consuming - it requires nearly 15 days continuous burning of the burner.
6. Separation of infected agarwood from the non-infected stem tissues is done manually with very simple hand-made iron chisels, that demands huge mandays.
7. Absence of universal shell remover for variety of plants like Cocklebur (*Xanthium indicum*), Chalmogra (*Hydnocarpus kurzii*), Bonduc-nut (*Caesalpinia bonducella*), Velvet-bean (*Mucuna* spp.), etc. to obtain seeds. These seeds possess good market demand.

LIVESTOCK AND DAIRY

Status of meat industry in NE States

About 90% of the population of the north eastern region is non-vegetarian. People of all religious and social affiliations consume meat, fish, and eggs.

Though most of the people of NEH region are meat consumers, the region is far behind the rest of the country in terms of meat production. Even the domestic requirement of

fresh/ frozen meat and meat products is fulfilled by importing these items from other states. The production of meat in different states of NEH region is provided in Table 4.

Table: 4 State-wise meat production from organised sector ('000 tonnes)

States	2007					
	Cattle	Buffalo	Sheep	Goat	Pig	Poultry
Assam	4	0	0	7	12	4.866
Arunachal Pradesh	8	8	1	2	3	-
Manipur	7	4	0	0	8	5.358
Meghalaya	21	0	-	1	10	4.017
Mizoram	2	0	-	0	7	2
Nagaland	8	3	7	-	7	-
Tripura	-	-	-	2	6	5.629
Sikkim	-	-	-	-	-	-

Source: *Basic Animal Husbandry Statistics, 2006*

Meat industry in NEH region is still in its primitive state. Due to lack of basic infrastructure like modern slaughter hall, qualified workers, organised markets. The meat industry, despite its enormous potential, is in a dilapidated condition. At present, most of the meat animal is produced by the small scale or land less farmers with limited land holdings and it is hardly sufficient to satisfy the ever growing consumer demands. The per capita availability of meat in this part is less than the national level (14 g/ day), whereas the Indian Council of Medical Research (ICMR) recommends 34 g of animal protein per day per person.

Out of the eight states of NEH region, Nagaland has 7 Nos. of registered slaughtered houses followed by Arunachal Pradesh which possesses 2 Nos. of registered slaughter houses (Source: *Basic Statistics of NER, 2006*). In rest of the states, animals are slaughtered either in private slaughter yards or in some states in municipality licensed butcher's shops/ stalls. Most of the meat produced in this region is consumed as fresh meat and a small portion of it is sold in frozen condition in the urban areas. The animal food sector has high prospect for growth in this region and has the potential to improve the socio-economic scenario of the region.

Status of dairy industry in NEH region

The white revolution of 1970's has not made any inroads to this region, though livestock is an important occupation of the farm households in the North-Eastern States. A large percentage of animals in this part of the country are of non-descript type with poor productive and reproductive performances. These animals are reared as a backyard activity for the

purposes of milk, manure and meat. It provides subsidiary source of income to the farm families. The share of milk production by the states of NEH region is given below in Table 5.

Table 5. State-wise milk production in NEH region ('000 tonnes)

States	2007-08			
	Cattle		Buffalo	Goat
	Crossbred	Non-descript		
Assam	166	462	100	25
Arunachal Pradesh	27	23	-	-
Manipur	40	24	14	-
Meghalaya	46	28	2	-
Mizoram	13	3	1	
Nagaland	41	0	2	3
Tripura	31	56	2	3
Sikkim	-	-	-	-

Source: *Basic Animal Husbandry Statistics, 2006*

Post-harvest processing of milk into various products like ghee, cream, paneer, butter *etc.* is almost absent in this part of the country. This is mainly because of the fact that the present level of milk production in the region is not even sufficient to fulfil the domestic demand of fluid milk and in this impractical situation entrepreneurs would hardly think for production of value added milk products to fulfil the consumer demands. The per capita availability of fluid milk in the north-east region varies from about 70 g/day in Tripura to 232 g/day in Sikkim, as compared to the ICMR recommended level of per capita milk consumption of 250 g/day. Sikkim and Arunachal Pradesh witnessed an increase in per-capita availability of milk while in other states, it has either declined or stagnated. Assam which accounts for two-thirds of milk production of NER registered a significant and consistent decline in per capita availability of milk.

There are only two numbers of milk processing plants registered under Milk and Milk Products Order (MMPO), 1992 in the entire NEH region. Out of these, one plant is in the state of Sikkim having a handling capacity of 15,000 ltrs. of milk per day followed by another plant in the state of Tripura having a handling capacity of 10,000 ltrs. of milk per day. Besides this, there are 11 liquid milk processing plants in the entire region which are registered under the municipal act of concerned State Governments. These milk processing plants, despite having the potentiality to process a sizable quantity of milk, are generally operated below their capacity due to lack of inadequate raw material i.e. milk. A sizeable amount of milk and milk products are imported from other states of the country.

Status of poultry industry in NEH region

The North-eastern region is considered as one of the original areas in Asia for the development of modern poultry from the red jungle fowl, which is still found in the forest of North-East India. Apart from this, Miri, Doathirgir and Nakedneck frizzle fowl breeds are also reared as family poultry in the region under backyard system.

Although the region contributed towards the development of improved poultry breeds, it has lagged behind in terms of production and productivity partly because of the extensive system of rearing. With this production system, the region contributes only 1.5% and 4 %, respectively towards national broiler and egg production. State-wise share of egg production in NEH region is given below in Table 6.

Table: 6 State-wise egg production in NEH region (lakh nos.)

Year	States							
	Assam	Arunachal Pradesh	Meghalaya	Manipur	Mizoram	Nagaland	Tripura	Sikkim
2007-08	5350	73	978	836	348	868	1193	144

Source: *Basic Animal Husbandry Statistics, 2006*

Egg is considered as the most balanced source of animal protein and ICMR has recommended consumption of at least 180 eggs per person per year. But the present level of per capita availability of eggs in the region is about 17 no. in Assam to 41 no. in Mizoram.

As the production of poultry in this region is inadequate, a large part of the gap in demand and supply is being met by the supplies from neighbouring states. In order to meet the present demand, the region imports roughly about 200 million eggs from outside sources. Commercialization is yet to make a dent in the region. For developing the poultry as an industry in an organized way, availability of good quality DoCs and feed at the right price and at the right time are the two most important critical factors, (as these two inputs constitute about 90% of the total cost of production) apart from the assured marketing for the success of the activity.

Estimation of post harvest losses in North East region

A survey has been conducted by AICRP on Post Harvest Technology to assess the post harvest losses of major crops/ commodities in India including this agro-climatic region and to identify the technological gaps in the existing post harvest practices. Data were collected in different stages of post harvest handling starting from harvesting to retail marketing through enquiry as well as by actual observation. In this study information from Barpeta, Darrang, Kamrup, Lakhimpur, Nalbari, Naugaon and Tinsukia districts in the state

of Assam, and also from Bankura district of West Bengal, from this Eastern Himalyan Region (Agro- Climatic Zone 02). The results of analysis pertaining to different farm operations and storage channels for the selected crops/commodities of NE region are given in Table 7. While the percentage losses for individual unit operations may appear to be relatively lower as compared to the earlier estimates, the magnitude of cumulative losses are still very high.

Table 7. Quantitative post harvest losses in eastern Himalayan region

(Agro- Climatic Zone 02)

Coverage : Barpeta, Darrang, Kamrup, Lakhimpur, Nalbari, Naugaon and Tinsukia districts in Assam, and also from Bankura district of West Bengal

S. No	Crop / commodity	Harvesting	Collection	Threshing	Sorting / Grading	Winnowing / Cleaning	Drying of paddy / Staling of cane	Packaging	Transportation	Total Loss in Farm Operations	Farm Level Storage	God-own/ ware-house/ Cold Storage	Wholesaler Level Storage	Retailer/ Processing Unit Level Storage
1	Cabbage	0.35	0.46		2.88			0.37	0.99	**5.05**	0.98	0.63	2.58	1.83
2	Cauliflower	0.53	0.68		1.81			0.26	1.85	**5.13**	1.15	0.47	3.69	1.33
3	Citrus	4.42	0.18		0.69			0.02	0.13	**5.44**	0.96		0.57	2.58
4	Egg		1.65					1.06	0.96	**3.67**	0.54		0.41	1.90
5	Greenpea	1.21	0.51		1.81			0.11	0.40	**4.04**	0.62	0.30	1.64	1.64
6	Paddy	1.30	0.96	0.58		0.41	0.20	0.10	0.05	**3.60**			0.39	0.23
7	Papaya	2.68	0.32		1.16			0.23	1.96	**6.35**	0.58		2.48	1.36
8	Poultry meat	6.14								**6.14**			0.05	0.30
9	Sugarcane	4.82	0.08		1.73		2.86	0.51	1.56	**11.56**	0.83			
10	Tapioca	0.45	0.71		2.25			0.96	0.60	**4.97**	5.18			0.75

MAJOR CONSTRAINTS

Inadequate post-harvest management and marketing facilities

Due to highly inadequate post-harvest handling facilities and under-developed marketing system, NER is experiencing great problem in channeling the market surplus in fruits and vegetables. Although the region is having few processing units, the capacity utilization of these units is not satisfactory for many reasons. Moreover, due to lack of organized farming and poor supply of raw materials all the processing units have already suffered heavy losses. Lack of organized marketing systems, slow enactment of market legislation, low market density, lack of market information, poor transportation setup, presence of middlemen, absence of effective product delivery system equipped with pack-house & cold storage facilities and refrigerated carriers for highly perishable commodities have been identified as long standing problems. Due to lack of market regulation and control over midway margin makers, the middlemen's share as commission appears to be as high as 80-90 per cent of the

wholesale price of horticultural produce. Likewise, due to low availability of adequate network of roads/railways, the transportation cost accounts for 43 to 85 per cent of the total marketing cost.

Sub-optimum R&D support

The research and development functionaries of the region are not yet fully equipped in developing location specific and need-based PHM strategies. Administrative support and research thrust on export of horticultural commodities of the region are practically negligible.

Inadequate institutional credit

Prevalence of defective land ownership system, absence of legal rights and non-availability revenue documents create problems in forwarding bank loans to entrepreneurs. Cumbersome bank procedures often discourage the growers from approaching the bank for credit advance.

Lack of investment climate

Although under the liberalized agricultural policy, a vast frontage in horticulture has been kept open to the national and multinational companies, prevalence of discouraging situations like socio-political disturbances, insufficient power supply, poor network of roads and communication and delay in government clearance is still restricting the growth of investment in the state.

Status of R&D technologies for fruits and vegetables in NEH

Process technology has been standardized by OUAT Bhubaneswar of AICRP on PHT for preparation of different value added products such as ready-to-serve (RTS) beverage, squash, jam, toffee and tidbits from fruits such as cashew apple and pineapple. The centre has also recently developed a pineapple peeler-corer-slicer device with which 15 no. of pineapples can be processed by a skilled worker in one hour.

An excellent and profitable process has been developed for osmo-dehydrated pineapple slices, wherein pineapples are cleaned, sliced into 6-8 circular pieces with peel and core removed, followed by keeping the rings in sugar syrup of 59 ^{0}B for 8 h. The pieces are then dried at 60 ^{0}C for 24 h in a tray dryer. Centre for Community Development (an NGO), Mandalsahi, Paralakhemundi, Gajapati district, Orissa has started an Agro Processing Centre with this technology which is being managed by the tribal people of the location. Also, a Self Help Group of tribal women from Nagaland, after receiving training from Bhubaneswar centre, have successfully started an enterprise with the help of Nagaland state government and are now marketing the product under their own brand name (NAGA).

Process and protocol have been standardized by UAS Bangalore centre for several value added products from jackfruit, such as halwa, chips, candy, RTC beverage, squash, fruit leather, papad, pickles, bulb flour, seed flour from jackfruit bulbs and seeds. Processing of jackfruit into value added products would enhance income of jackfruit growers by 2.5 to 6 times as compared to fresh jackfruit.

Corrugated fibre board (CFB) boxes have been standardized by AAU Jorhat centre for packaging of (1) Pineapples and (2) Khasi mandarin for transportation.

Washing of vegetables helps in substantial removal of contaminants such as adhering soil/dirt, surface pesticide and microbial load. When carried out after harvesting, it also removes the field heat, thereby enhancing its shelf life. A stainless steel portable mechanical vegetable washing machine (power 1 hp, cost Rs 25000-50,000 for 100-600 kg/h capacity) has been developed and commercialized by PAU Ludhiana centre, suitable for a wide range of fruits and vegetables (carrot, potato, radish, turnip, ginger, okra, tomato, spinach, kinnow and pears). This machine could also be successfully used for polishing turmeric (dry) and peeling potatoes and ginger (wet operation). The versatility of this equipment has been enhanced with minor modification to for use as a blancher for vegetables. Technology is already commercialized to M/s Paradise Engineering Corp., Ludhiana and 10 pieces have been sold by the manufacturer.

Vegetable seed processing can be a very lucrative agro-business owing to high value addition and economic returns. However, extraction of seed from vegetables is time consuming and arduous to labour. Under AICRP on PHT, appropriate equipment have been developed to extract seeds from brinjal, tomato and chilli. PDKV Akola centre developed a chilli seed extractor machine and modified to improve further (present capacity 100 kg chilli fruit per hour). The technology has been commercialized with one manufacturer, *viz*., Y.M.B. Agro Machineries, Akola and already 12 units have been sold at a cost of Rs. 43,000/- per unit. Tomato seed extractor machine developed by TNAU, Coimbatore centre has 180 kg/h capacity, unit cost Rs.30,000/- and the operational cost of seed extraction is Rs.10/- per kg compared to Rs.100 per kg by the conventional method.

Process parameters for preserving milky mushrooms up to 18 months by canning in brine (3%) and tomato pulp (4^{o} Brix) were standardized by TNAU, Coimbatore centre. The technology has been transferred to M/s Blue Hills Agrotech, Coimbatore who have submitted canned samples for quality clearance to export the product to Japan.

A fluidized bed dryer for the oyster and milky mushroom has been developed by TNAU Coimbatore centre consisting of a 3 hp motorized centrifugal blower, holding bin, 4 x 500 W heating coils and thermostat control. Hot air of 50 to 90ºC temperature at a flow rate of 9 to 32 m^3 / minute can be obtained in this dryer. It has an output capacity of 6 kg/batch and costs Rs.40,000/- per unit. The technology has been licensed to 4 entrepreneurs.

Agro-processing centres for milling of food grains

AAU Jorhat centre under AICRP on PHT has established 3 APCs *viz*., (1) Seuj Krishi Samabai Samiti, Allengmora, Jorhat, Assam (2) Rohdoiya Self Help Group Agro Processing Centre, P.O. Roha - 782103, Dist. Nagaon, Assam and (3) Bihaguri Seuji Krishok Samitti, Pithakhowa, Bihaguri - 784153, Dist: Sonitpur, Assam which are owned and managed by farmer-cum-processors belonging to Self Help Groups. The net annual profit of this APC at Allengmora was Rs 58,643 and Rs 75,883 during the years 2009 and 2010, respectively. APC at Allengmora Jorhat centre has also established one more Agro Processing Centre at

the college campus itself for hands-on-training and demonstration for the benefit of would be entrepreneurs. These APCs have proved to be quite effective in post harvest loss reduction, income augmentation and rural employment generation.

Conclusions and recommendations

The scope for promoting processing and value addition in the north eastern states is enormous. However, setting up of small capacity processing units for value addition of local produce will be a good option. The huge potential of NEH regions in respect of horticultural crops / animal husbandry is in contrast with the low level of productivity and entrepreneurship. The time has come to fill the yield gaps and to capitalize on the opportunities offered by the region. In the context of globalization and opening up of the domestic agriculture and livestock sector to competition from outside, the highest priority must be accorded to exploiting available potential in the country and enhancing competitiveness. In this context the NEH regions provide possibly the widest and most lucrative prospects. Some pertinent recommendations for R&D and Transfer of technology are as follows:

1. Storage of rhizome of ginger and Greater Galangal (*Alpinia galanga*), Aswagandha (*Withania somifera*) powder, Pipoli (*Piper longum*) spikes, etc. are very difficult in the NE climate.
2. Quick removal of seeds from Amla (*Phyllanthus emblica*) fruits is a major hurdle in value addition processes of this crop.
3. Peeling of the skin from roots of Satavar (*Asperagus racemosus*) and Safed-mushli (*Chlorophytum borivilianum*) is very much labour expensive and hence is another major hurdle for a region like Assam where scarcity of agricultural labour is gradually becoming acute.
4. Patchouli oil extraction process is still time consuming; running of the oil distillation plant for 14 to 18 hours is very much fuel and labour consuming.
5. Absence of universal shell remover for variety of plants like Cocklebur (*Xanthium indicum*), Chalmogra (*Hydnocarpus kurzii*), Bonduc-nut (*Caesalpinia bonducella*), Velvet-bean (*Mukuna* spp.), etc. to obtain seeds. These seeds possess good market demand.
6. Post harvest processing of meat into various value added meat products.
7. Development of processing technologies for cashew nut and passion fruit.
8. Model processing facilities required for
    - Pineapple, Orange and Passion fruit processing for juice
    - Banana processing for chips
    - Rice milling
    - Pulse milling
    - Spices processing
    - Ginger and Turmeric processing

A model DPR for a multi-commodity Agro-Processing Unit for North-East states (proposed for initially setting up in Arunachal Pradesh) is given below.

MODEL DPR FOR AGRO-PROCESSING CENTRE FORNORTH EASTERN REGION

1. Introduction

Agro processing could be defined as set of techno-economic activities carried out for conservation and handling of agricultural produce and to make it usable as food, feed, fibre, fuel or industrial raw material. Hence, the scope of the agro-processing industry encompasses all operations from the stage of harvest till the material reaches the end users in the desired form, packaging, quantity, quality and price. Inadequate attention to the agro-processing sector in the past put both the producer and the consumer at a disadvantage and it also hurts the economy of the country. Agro-processing is now regarded as the sunrise sector of the Indian economy in view of its large potential for growth and likely socio economic impact especially on employment and income generation. Some estimates suggest that in developed countries, upto 14 per cent of the total work force is engaged in agro-processing sector directly or indirectly. However, in India, only about 3 per cent of the work force finds employment in this sector revealing its under developed state and vast untapped potential for employment.

2. Status of field crops, fruits and spices production in North East states

The northeastern region of India comprises of eight states namely Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim. Agro-climatically the region is known for its wide diversities, representing temperate, subtropical and tropical areas. The whole of the region is pre-dominantly an agrarian region. Paddy is the most important field crop grown in the entire region. The other significant field crops are maize, oilseeds (rapeseed/mustard, sesame) and pulses (gram, blackgram, greengram, lentil and pigeonpea). The total production of paddy, maize, oilseeds and pulses was approximately 4767, 252, 216 and 168 thousand metric tonnes, respectively in northeastern states. Assam contributes around 60, 70 and 65 % of paddy, pulses and oilseeds produced in north eastern region, whereas maize is mostly produced in Nagaland and Arunachal Pradesh.

3. Fruits and spices of North East

The north eastern region has a rich diversity in fruit crops. The major horticultural crops which have scope for processing and value addition are banana, pineapple, citrus, orange, passion fruit, potato etc. Among the spices, ginger, turmeric, black pepper, large cardamom are the dominant crops. Production of selected horticultural crops and spices is presented in Table 8 and 9.

The north eastern states having potential for processing of banana, citrus/ orange, pineapple and ginger are presented in Table 10

Table 8. Production ('000 tonnes) of selected horticultural crops in north eastern states (2008-09)

State	Banana	Citrus	Pineapple	Potato
Assam	610.00	163.0	161.0	354.00
Arunachal Pradesh	16.00	37.8	33.0	N.A
Manipur	120.00	33.6	72.4	29.30
Meghalaya	67.80	N.A	85.3	141.60
Mizoram	151.50	41.56	N.A	1.15
Nagaland	59.00	28.0	10.0	35.85
Tripura	80.16	19.4	116.0	80.85

(Source: Collated from various sources); N.A-not available

Table 9. State wise production of important spices of North East (in MT)

States	Black Pepper	Turmeric	Ginger	Large cardamom	Chilli
Assam	5680.0	10423.00	166776.00	-	13394
Arunachal Pradesh	-	2119.00	37908.00	727.00	3557
Meghalaya	366.0	8752.00	47137.00	-	-
Manipur	-	4092.00	12524.00	-	29296
Nagaland	360.0	3050.00	4230.00	500.00	1435
Tripura	123.6	6594.00	9363.00	-	12198
Sikkim	-	2.07	35.98	2.74	-
Mizoram	-	83500.00	57010.00	-	200

Table 10. North Eastern states having potential for processing of banana, citrus, pineapple, ginger, turmeric and chillies

Crops	States
Banana	Arunachal Pradesh, Assam, Sikkim and Tripura
Pineapple	Assam, Manipur and Meghalaya
Citrus/Orange	Sikkim, Arunachal Pradesh, Nagaland, Mizoram, Assam, Tripura, Meghalaya
Ginger	Assam, Meghalaya, Mizoram and Nagaland
Turmeric	Assam, Mizoram, Meghalaya
Chilli	Assam, Manipur, Tripura, Nagaland

4. Components of Model Agro Processing Centre for North East

A model agro-processing centre comprising of following units is proposed for North Eastern states. These units can be taken up either individually as remunerative processing units or in combination of two or more units. The selection will depend on the availability of the crops and the capacity of the entrepreneur to invest in land, equipment and raw materials.

i) Rice Milling
ii) Pulse Milling
iii) Processing of Spices
iv) Oil Milling
v) Processing and value addition of fruits and vegetables
vi) Cotton ginning

The technical details of these processing units are described below:

4.1 Rice Milling

Paddy in its raw form cannot be consumed by human beings. It needs to be suitably processed for obtaining rice. Rice milling is the process which helps in removal of husk and bran from paddy grains to produce polished rice. Rice forms the basic primary processed product obtained from paddy and this can further be processed for obtaining various secondary and tertiary products.

The basic rice milling process consists of pre-cleaning which involves removing all impurities and unfilled grains from paddy. De-stoning is the next unit operation for separation of small stones from paddy. Parboiling is the optional processing in improving the nutritional quality by gelatinization of starch inside the rice grain. It improves the milling recovery per cent during shelling and polishing / whitening operation. De-husking operation is carried out for removing husk from paddy. This husk needs to be separated from brown rice by paddy aspirator. Then paddy separator separates the un-husked paddy from brown rice. The next unit operation is the whitening which involves the removing all or part of the bran layer and germ from brown rice. Polishing of rice is then carried out to improve the appearance of milled rice by removing the remaining bran particles. The last operation involves the weighing and bagging for preparing the milled rice for transport to the customer.

4.2 Pulse Milling

Pulse milling is an important agro-based industry in India next only to rice and wheat milling. Unlike wheat or rice milling, processing of pulses to produce dhal is unique and indigenous to India. Pulses are de-hulled particularly to improve their appearance, texture, cooking quality, palatability and digestibility. The split pulses are less susceptible for insect pests attack during storage than whole grains. Milling of pulses means removal of the outer husk and splitting the grain into two equal halves. The kernel of some pulses tightly holds the husk. Therefore, de-husking of these pulses poses a problem. To loosen the husk, pre-treatment with oil and conditioning of grains by alternate drying / wetting is done. It facilitates de-husking and splitting of pulses. A large amount of abrasive force is applied to the conditioned pulses for de-husking of the grains. It results in high losses in the form of broken and powder. Consequently, the yield of split pulses in traditional mills is only 65 to 70 per cent in comparison to 82 to 85 per cent potential yield.

There is no common processing method for all types of pulses. However, some general operations of dry milling method such as cleaning and grading, rolling or pitting, oiling, moistening, drying and milling have been described in subsequent paragraphs.

a) **Cleaning and grading:** Pulses are cleaned from dust, chaff, grits, etc., and graded according to size by a reel type or rotating sieve type cleaner.
b) **Pitting:** The cleaned pulses are passed through an emery roller machine. In this unit, husk is cracked and scratched. This is to facilitate the subsequent oil penetration process for the loosening of husk. The clearance between the emery roller and cage (housing) gradually narrows from inlet to outlet. As the material is passed through the narrowing clearance, mainly cracking and scratching of husk takes place by friction between pulses and emery. Some of the pulses are de-husked and split during this operation, which are then separated by sieving.
c) **Pre-treatment with oil:** The scratched or pitted pulses are passed through a screw conveyor and mixed with some edible oil like linseed oil (1.5 to 2.5 kg / tonne of pulses). Then they are kept on the floor for about 12 hours for diffusion of the oil.
d) **Conditioning:** Conditioning of the pulses is done by alternate wetting and drying. After sun drying 3-5 per cent moisture is added to the pulses and tempered for about eight hours and again dried in the sun. Addition of moisture to the pulses can be accomplished by allowing water to drop from an overhead tank on the pulses being passed through a screw conveyor. The whole process of alternate wetting and drying is continued for two to four days until all pulses are sufficiently conditioned. Pulses are finally dried to about 10 to 12 per cent moisture content.
e) **Dehusking and splitting:** Emery rollers, known as Gota machines, are used for the dehusking of conditioned pulses. About 50 per cent pulses are dehusked in a single operation (in one pass). Dehusked pulses are split into two parts also. The husk is aspirated off and dehusked, split pulses are separated by sieving. The unhusked pulses and unsplit dehusked pulses are again conditioned and milled as above. The whole process is repeated two to three times until the remaining pulses are dehusked and split.
f) **Polishing:** Polish is given to the dehusked and split pulses by treating them with a small quantity of oil and/or water.

4. 3 Processing of Spices

The brief description of the processes used for processing of some of the important spices is given below:

4.3.1 Turmeric

India is the largest producer, consumer and exporter of turmeric, which covers about 6 % of total area under spices. The flow chart for processing of turmeric rhizomes is shown below:

REMOVAL OF FINGERS (FROM MOTHER RHIZOZOMES)
↓
CLEANING
↓
CURING
↓
COLOURING
↓
PACKAGING
↓
STORAGE

The fingers are removed from the mother rhizomes, which is used as seed materials. These rhizomes are then collected, cleaned and cured before packing**.** Curing involves boiling (which is done in copper vessels till froth starts coming out) then drying (till metallic sound of breaking) after which cleaning and polishing is performed. The colour of turmeric always attracts the buyers hence colouring is done. Pouring the emulsion, which has the following composition, performs colouring:

For 100 kg of half polished turmeric

Alum	=	0.04 kg
Turmeric powder	=	2.00 kg
Castor seed	=	0.14 kg
Sodium bisulphate	=	30 gm
Conc. hydrochloric acid	=	30 ml

Packaging is done in double burlap new gunny bags, which are properly fumigated.

In case of ground turmeric care should be taken regarding the size of the ground particles. Following flow chart depicts the production methodology used to obtain ground turmeric powder.

CLEANING
↓
CURING
↓
COLOURING
↓
GRINDING
↓
PACKAGING

Turmeric should be ground to such a size that it should pass through a 300 micron sieve and for coarse grinding it should pass through a 500 micron sieve.

4.3.2 Black Pepper

Black pepper is also known as “king of spices”. It has the highest position in the international market. Usually whole pepper is marketed. The method employed to get the marketable whole pepper is as follows

DRYING
↓
CLEANING
↓
GRADING
↓
QUALITY
↓
PACKAGING
↓
STORAGE
↓
MARKETING

In small scale industries, winnowing or use of blowers is used for cleaning whereas in large-scale industries multiple sieves cum air classifier type are used. The grading is according to Compulsory Grading Scheme, for exports in India. The pungent principle alkaloid piperine having a melting point (129-130 ^{0}C) is approximately 4 -10 % in pepper. It is responsible for its biting taste. The adulteration comprises of dust, dirt, stem, chaff, and papaya seeds. Pepper with moisture content of 10-11% (w.b.) is packaged in high-density polyethylene (H.D.P.E.) pouches of 200 gauge. The method of preparation of ground pepper is illustrated below:

DRYING
↓
CLEANING & FRACTIONATING
↓
GRINDING
↓
SIEVING
↓
PACKAGING
↓
STORAGE
↓
MARKETING

For grinding roller mills/hammer mills should be used and product should pass through 500 micron sieve.

4.3.4 Chillies

Primary processing of chillies essentially consists of drying and spiking. Better retention of colour and higher yield of finished product, avoiding breakage of pods and loss of seeds are achieved by adopting improved technologies. The flow chart for processing of chillies into whole dried chillies is illustrated below:

CHILLIES FOR PROCESSING
(100 kg)
↓
WASHING
↓
INSPECTING
↓
BLANCHING
↓
PRICKING
↓
DRYING (PRIMARY)
↓
DRYING (SECONDARY)
↓
DRIED CHILLIES
(20 kg)
↓
INSPECTING
↓
PACKAGING

Artificial drying has advantages over traditional sun drying in that the product is more consistent and of a better quality, the time taken is less and crop losses are also minimised. The dried chillies are ground and packed into retail containers.

4.3.5 Processing of Ginger for powder

Traditionally the fresh rhizomes are dried to obtain a product called *Saunth*. However the method described here is suitable for obtaining dried ginger powder, which is not commercially available in market. This process for production of ginger powder (developed at CIPHET) is suitable for region. The process for preparing dried ginger powder is described below.

The mature ginger rhizomes are procured. The rotten or spoiled rhizomes are manually sorted. The rhizomes are washed with water to remove soil and dirt. After washing the rhizomes are sliced mechanically or manually into 3 mm thick slices. Slicing is done to hasten the drying process and yield better product. The slices are sun dried in thin layers. The sun dried ginger slices are then dried to a moisture content of around 6-8 per cent in a tray dryer. If sun drying is not possible due to weather conditions, we can dry the slices in the drier. The dried slices are powdered in a pulveriser and packed in plastic bags.

4.4 Oil milling

Traditional oil extraction equipment of India is bullock drawn *Ghani* which leaves 10-15 % oil with cake. Mechanical power *ghanis* are now being used which leave 8-12% oil with cake. However, most of the commercial oil extraction by mechanical means is done by expellers. Mechanical expellers leave 6-7% oil with cake under good management.

Mustard oil is expressed mechanically in commercially available oil expellers. The seed is expressed thrice in mechanical expeller to extract maximum amount of oil. The moisture content of the seeds should be 7-8% (wb) and no cooking is required before oil expression. The expressed oil is filtered in a filter press, in which the filtration of oil is done through a cotton canvass cloth. The filtered oil is filled into containers, which are subsequently sealed & labelled, for marketing. On an average 33 to 35 per cent of oil is obtained from the seeds (on weight basis). The recovery of oil from the seed is dependent on the quality of the seeds. The cake obtained is used as cattle feed and also fetches remunerative price. The oil expeller and the filter press need regular maintenance for successful operation of the machinery. The project does not create any pollution as the main product (oil) and the by-product (oil cake) is consumed by humans and cattle.

4.5 Processing and value addition of fruits and vegetables

The processing of the pineapple and oranges into processed products such as RTS beverage, squash, jam and preseves which have ready demand in the market is suggested. Fruits are popular amongst all age groups. But fresh fruits are available only during specific season and that too for 2-3 months every year. Hence, downstream products made from fresh fruits have become popular especially in urban and semi-urban areas. But off-late demand from rural areas is also going up. Apart from households, they are sold at many places like restaurants, clubs, railway stations and bus-stops, cold drink houses, picnic or tourist spots and many such places. With growing disposable incomes and changing lifestyles, such products have witnessed increase in demand.

The fruit squash must contain at least 25 per cent fruit juice or pulp and 40 to 50 per cent total soluble solids. It also contains about 1.0 per cent acid and 350 ppm sulphur dioxide or 600 ppm sodium benzoate. It is diluted before serving. The RTS beverage prepared from fruits must contain at least 10 per cent fruit juice and 10 per cent total soluble solids besides about 0.3 per cent acid. It is not diluted before serving, hence it is known as ready-to-serve (RTS).

4.5.1 Banana processing for chips

Bananas are important fruit crop in the north-eastern India. Processing of banana into chips is suggested. The chips are the most popular variety of snacks and they are consumed round the year by people of all age groups from all income segments. Although, potato chips are more popular than banana chips, but banana chips have a special category of consumers and they are preferred by many. Competition is not as fierce as in case of potato chips. There are some national as well as regional established brands for potato chips but they are not in banana chips as the market is small. The market for banana chips is expected to grow with the establishment of manufacturing units.

Banana chips are made from unripe bananas. Chips or wafers are crispy, salty or spicy and consumers prefer fresh quality. They have high nutritious values as well. The product needs to be packed in transparent or specially designed HDPE bags. Raw mature bananas with low sugar content must be used for making banana chips. Peel and slice the bananas (2 mm thick slice) with stainless steel knives. Dip the peeled fruit slices in a solution of 0.1 % citric acid for 15 minutes to avoid browning. Remove the slices from the solution. Wash them in cold water, drain and spread on flat trays (2.5-5 kg/m^2 of tray surface). Trays made of wooden or bamboo strips are suitable. Transfer the trays to a sulphuring box and expose them for an hour to fumes of sulphur dioxide. Burn about 3 g of sulpher for a batch of ten trays. Dry the sulphured slices either in the sun or in a drier at 60-63 ^{0}C temperature. Stop drying when the slices become brittle. The dried slices are fried in edible oil to yield banana chips. Fried chips are treated with salt and spices and cooled at room temperature before packing. The chips are packed in high density polyethylene bags or in suitable packing materials and stored in airtight containers.

5. Suggested capacity of the processing units

The processing capacities for various processing units and other assumptions are listed as under:

- Monthly repair and maintenance charges: 1 % of the cost of machines
- Depreciation on machines and equipment: 10 % p.a.
- Depreciation on furniture and tools: 20 % p.a.
- Depreciation on building: 4 % p.a. (Assuming life span of building to be 25 years and nil salvage value)
- Rate of interest: 11% p.a.
- Capacity utilization: 1st yr 50%; 2nd yr 60%; 3rd yr 70%; 4th yr 80 %; 5th yr onwards 90%
- No. of working days in a month: 25
- Working hours per day: 8

5.1 Horticultural crop processing

The oranges will be available from November to March and hence will be processed in 5 months period and Pineapple will be available from August to October and December to February and will be processed in 6 months.

5.1.1 Orange and pineapple processing

- The project capacity would be 50 tonnes of oranges and 200 tonnes of pineapples per annum.
- Building with total built up area of about 150 sq.m will be adequate. About 75 sq.m would constitute production area whereas balance space can be utilised for packing and storage.

5.1.2 Banana processing

- The project capacity would be of 250 tonnes of raw banana per annum with production of 25 tonnes of banana chips.
- Total built up area of 150 sq.m will be adequate with around 75 sq.m will be production hall and balance area can be utilised for storage and packaging.

5.2 Food grain processing

5.2.1 Rice Milling

- The project capacity would be of 0.5 tonnes per day and 125 tonnes per annum
- Built up area of 100 sq.m would be required. This will involve area for rice mill, storage of raw paddy and milled rice and its byproducts
- Per cent head rice recovery (on weight basis) is 65 %
- Per cent brocken rice (on weight basis) is 3 %
- Per cent husk (on weight basis) is 25 %
- Per cent impurities, germ 2 %

5.2.2 Pulse Milling

- Built up area of 25 sq.m would be required.
- Capacity of dal mill unit: 24 tonnes per annum
- Recovery: 70 %
- Total number of working days in year: 250

5.3 Spices Processing

- Built up area of 75 sq.m would be required
- Average capacity of unit: 20 tonnes per annum
- Ginger 15 tonnes per annum and Turmeric 5 tonnes per month
- Recovery: 15% for ginger powder.
- Recovery: 90 % for dried and polished turmeric
- Total number of working days in year: 250

5.4 Oil Milling

- Average capacity of oil expeller/filtration unit: 30 kg/h (75 % of the rated capacity)
- Recovery: 32 % oil and 66 % cake
- Total no. of working days in year: 300

6. Equipment required

The suggested equipment for various processing units is listed in Table 11.

Table 11. List of equipments for setting up proposed agro-processing model

Sl. No	Name of the equipment	Quantity (No.)
Processing of Fruits / Vegetables		
1.	Fruit washing machine	1
2.	Non IBR boiler	1
3.	Working table	3
4.	Stainless steel trays	10
5.	Twin Pulper (with coarse and fine sieves 1extra set)	2
6.	Pineapple slicer	1
7.	Fruit Mill (1 hp approx. 500 kg/h)	2
8.	Screw type of juice extracting machine	2
9.	Cap sealing machine	2
10.	Vaccum filling machine (40-50 bottles per min.)	2
11.	Portable stirrer	2
12.	Sterilization tank	2
13.	Steam jacketed kettle	2
14.	Banana slicer	2
15.	Frying pan	2
16.	Juice homogeniser	1
17.	Heat sealing machine	2
18.	Stainless steel utensils	-
19.	Weighing scale	1
20.	Precision weighing balance	1
21.	Deep Freezer 500 litre capacity	2
Rice Milling Equipment		
22.	Paddy cleaner	1
23.	Rice polisher	1
24.	Paddy cleaning sieves	1
25.	Brocken rice separator	1
26.	Paddy separator	1
Pulse Milling Equipment		
27.	Dal mill, sieves, cleaners, elevators etc.	1 set
Oil Milling Equipment		
28.	Oil Expeller	
29.	Filter Press	
Equipment for processing of spices		
30.	Tray dryer (including 48 trays and trolley)	1
31.	Slicer (Cap10 kg / h, heavy duty with ½ HP motor)	1
32.	Hammer mill (5 HP)	1
33.	Heat sealing machine	1
34.	Turmeric boiler	1
35.	Turmeric polisher	1
Ginning of Cotton		
36.	Cotton ginning machine	1
Common Facilities		
37.	Furniture	LS
38.	DG Set (for all processing plants 25-40 KVA)	1
39.	Water tank, Purification and supply system (for all processing plants)	1

7. Funds required

The estimated requirement of funds for a model agro processing centre comprising of rice milling, pulse milling, oil milling, processing of spices, processing of fruits and vegetables and ginning of cotton will be as under:

Agro-Processing Unit	Cost of building (Rs. in lakhs)	Cost of Equipment (Rs. in lakhs)	Working Capital (Rs. in lakhs)	Total cost (Rs. in lakhs)
Rice milling	5.00	7.50	2.50	15.00
Milling of pulses	5.00	4.00	2.00	11.00
Milling of spices	2.50	4.50	2.00	10.00
Oil milling	2.50	3.00	1.50	7.00
Processing of fruits and vegetables	10.00	20.00	6.00	36.00
Ginning of cotton	1.00	1.00	Nil (custom hiring)	2.00

8. Conclusion

The agro-processing activities have been selected on the basis of availability of raw materials and requirement of processed products. The primary and secondary processing has been covered in all units except fruits. Marketing of end products is more difficult in comparison to intermediate products which are commonly used in each and every household. The marketing of fruit products should be explored before setting up the unit. All these units are financially viable at the suggested levels of operation. The specific cost benefit analysis for the agro-processing model can be worked out at the time of actual commissioning on the basis of location, capacity and availability of raw materials and market of processed products.

9. Suggested models of agro-processing centres for KVKs

The list of KVKs located in north east states is as under:

Sr. No.	Name and Address of KVK	Suggested units for agro-processing activity
1.	KVK West Siang ICAR Research Complex for NEH Region Basar, Dist. West Siang, Arunachal Pradesh	Paddy, Millets, Ginger, Fruits (Banana/ pineapple)
2.	KVK Karbi Anglong, AAU Karbi Anglong, Assam – 782460	Oilseeds, Paddy, Pulses, Cotton Ginning, Ginger
3.	KVK East Sikkim ICAR Research Complex for NEH Region Ranipool, East Sikkim	Cardamom, Ginger
4.	KVK Bishnupur, BPO Utlou, P.O. Nambool, Dist. Bishnupur, Manipur	Paddy, Maize, Pulses, Chilli
5.	KVK Ribhoi ICAR Research Complex for NEH Region, Umiam Meghalaya	Ginger, Pineapple, Paddy, Pulses
6.	KVK Lanwgtlai, Lawngtlai, Mizoram	Paddy, Black pepper, Turmeric, Ginger
7.	KVK, Dimapur ICAR Research Complex for NEH Region Medziphema, Nagaland Centre, Nagaland	Pulses, Maize, Passion Fruit, Paddy, Chilli
8.	KVK, West Tripura P.O. Chebri, Khowai, Dist. West Tripura	Paddy, Oil Milling, Chilli, Black Pepper

The KVKs would have to be involved in selecting the need based units for establishing agro-processing centres.

Annexure-I

LIST OF PARTICIPANTS
20TH MEETING OF THE ICAR REGIONAL COMMITTEE NO. III
From 5-7 MAY 2011

Sl. No	Name	Designation
	Indian Council of Agricultural Research	
1	Dr. S. Ayyappan	Secretary, DARE, Govt. of India & Director General, ICAR
2	Dr. Arvind Kumar	DDG (Edn)
3	Dr. H.P. Singh	DDG (Hort)
4	Dr. K.D. Kokate	DDG (Agril Extn)
5	Dr. K.M. L. Pathak	DDG (Animal Science)
6	Dr. B. Meena Kumari	DDG (Fishery)
7	Dr. M.M. Pandey	DDG (Engg)
8	Dr. A.K. Singh	DDG (NRM)
9	Dr. Bangali Baboo	National Director (NAIP)
10	Dr. S.V. Ngachan	Director, ICAR Research Complex for NEH Region
11	Dr. K.C. Bansal	Director, NBPGR, New Delhi
12	Dr. V. Venkatasubramaniam	ADG (Extn)
13	Dr. A.K. Vasisht	ADG (PIM)
14	Dr. S. Mauria	ADG (IP & TM)
15	Dr. Ravindra Kumar	ADG (Coordination)
16	Shri Sudhi Bhargava	Member, Governing Body
17	Dr. T.P. Rajendran	ADG (PP)
18	Dr. T.P. Trivedi	Project Director, DIPA
19	Dr. K.A. Singh	Director, IGFRI, Jhansi
20	Dr. Anubrata Das	Director, NRC (Pig), Guwahati
21	Dr. A.K. Gogoi	ZPD, Zone III, Umiam
22	Dr. Chandan Rajkhowa	Director, NRC (Mithun), Nagaland
23	Dr. B.C. Jha	Head, RWFD, CIFRI, Barrackpore
24	Dr. R. Bhagawati	Jt. Director, AP Centre, ICAR Research Complex
25	Dr. K.A. Pathak	Jt. Director, Mizoram Centre, ICAR Research Complex
26	Dr. M. Datta	Jt. Director, Tripura Centre, ICAR Research Complex
27	Dr. P. Singh	I/C, Animal Nutrition, ICAR Research Complex, Umiam
28	Dr. Satish Chandra	Head, Plant Pathology, ICAR Research Complex, Umiam
29	Dr. R.K. Bardoloi	Head, Animal Production, ICAR Research Complex, Umiam
30	Dr. D.J. Rajkhowa	Head, Water Management, ICAR Research Complex, Umiam
31	Dr. B.C.Deka	Head, Horticulture, ICAR Research Complex, Umiam
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52	Dr. S.N. Puri	VC, CAU, Imphal
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58	Dr. L.K. Hazarika	Dean (Agriculture), AAU, Jorhat
59	Dr. Apurba Chakravarty	Director Research (Vety), AAU, Khanapara
60	Dr. B.C. Bhowmick	Director (Extn), AAU
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Sl. No	Name	Designation
65	Dr. Pranab Nath	Director, Fisheries, Arunachal Pradesh
66	Shri Abhijit Deb	Irrigation Department, Assam
67	Shri N.K. Das	Irrigation Department, Assam
68	Dr. N. Dhananjoy Singh	Jt. Director, AH & Vety, Manipur
69	Dr. Th. Jeevan Singh	Director, AH & Vety, Manipur
70	Shri S. Karam	Director, Fisheries, Manipur
71	Dr. O. Nobo Singh	Jt. Director, Agriculture, Manipur
72	Shri W.M. Moilanroe Law	S.E (Water Resources), Meghalaya
73	Er. K.D. Phawa	S.E. (Water resource), Meghalaya
74	Shri K.M. Brahma	Jt. Director, Horticulture, Meghalaya
75	Shri Samuel Rosanglura	Director, Horticulture, Mizoram
76	Shri C. Lalzaeliana	Director, Agriculture, Mizoram
77	Dr. O.P. Singh	Director, Agriculture (RNE), Fisheries, Mizoram
78	Dr. Saingura Sailo	Jt. Director, AH & Vety, Mizoram
79	Dr. Dipak Chetri	Jt. Director, Agriculture, Nagaland
80	Shri Pawan Kumar	Dy Director, Hort, Nagaland
81	Shri. N. Tekatushi Ao	Jt. Director, Agriculture, SARS, Nagaland
82	Dr. L.S. Moses	Director, AH & Vety, Nagaland
83	Shri A.Y. Ovung	Director, Agriculture, Nagaland
84	Shri R.D. Bhutia	Addl Chief Engineer (Irri & FC), Sikkim
85	Shri K.S. Bhutia	JE (Irrigation & FC), Sikkim
86	Shri Tochen Lepcha	Director, Agriculture, Sikkim
87	Dr. S.N. Sen	Director, Agriculture, Tripura
		Others
88	Dr. V.V. Sadamate	Agricultural advisor, Planning Commission
89	Shri Hansraj Nayak	CPC, Doordarshan, New Delhi
90	Dr. Manoj Srivastava	Registrar, PPVFRA, New Delhi

Annexure –II

LIST OF PARTICIPANTS
KVK Interface meeting during 20th Regional Committee Meeting-Region III
From 5-7 MAY 2011

Sl. No.	Participants
1.	Dr. S. Ayyappan, Director General, ICAR & Secretary, DARE. GOI, New Delhi
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8.	Dr. A. K. Singh, DDG (NRM), ICAR, New Delhi
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10.	Dr. T. P. Trivedi, Director, DIPA, ICAR, New Delhi
11.	Dr. Bangali Babu, ND (NAIP), ICAR, New Delhi
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13.	Dr. T. P Rajendran, ADG (Plant Protection), ICAR, New Delhi
14.	Sh. Sudhir Bhargava, GB Member (ICAR), New Delhi
15.	Dr. S. V. Ngachan, Director (ICAR NEH), Umiam
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17.	Dr. Anubrata Das, Director, NRC on Pig, Rani, Guwahati
18.	Dr. Kishore Baruah, Director, NRC on Yak, Dirang
19.	Dr. Chandan Rajkhowa, Director, NRC on Mithun, Jharnapani, Nagaland
20.	Dr. B. C. Bhowmick, Director (Extn), AAU, Jorhat
21.	Dr. K. C. Bansal, Director, NBPGR, New Delhi
22.	Dr. M. Premjit Singh, Director (Extn), CAU, Imphal
23.	Dr. S. N. Sen, Director (Agri), Govt. of Tripura
24.	Dr. O. P. Singh, Director (Agri), Govt. of Mizoram
25.	Dr. J. S. Lyngdoh, Director (Agri), Govt. of Meghalaya
26.	Sh. Tochen Lepcha, Director (Agri), Govt. of Sikkim
27.	Dr. Anupam Mishra, Joint Director I/c, ICAR Complex, Nagaland Centre
28.	Dr. Narendra Prakash, Joint Director, ICAR Complex, Manipur Centre
29.	Dr. Rupankar Bhagawati, Joint Director, ICAR Complex, Arunachal Pradesh Centre
30.	Dr. M. Dutta, Joint Director, ICAR Complex, Tripura Centre
31.	Dr. S. K. Verma, Incharge, Regional Centre, NBPGR, Umiam
32.	Dr. V T Raju, Dean, PG College, CAU, Umiam
33.	Dr. Utpal Baruah, Head, NBSSLUP, Jorhat Centre

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38.	Dr. Kameswar Das, PC, KVK, Cachar
39.	Dr. Sunil Kr Paul, PC, KVK, Bongaigaon
40.	Dr. T. P. Saikia, PC, KVK, Darang
41.	Dr. M. K. Chauhan, SMS, KVK, Dhemaji
42.	Dr. P. P. Neog, PC I/c, KVK, Dhemaji
43.	Dr. Sarat Saikia, PC, KVK, Dhubri
44.	Dr. Aradhana Baruah, SMS, KVK, Dibrugarh
45.	Dr. Uttam Kumar Baruah, PC, KVK, Dudhnoi
46.	Dr. Samiran Dutta, SMS, KVK, Khumtai
47.	Dr. Rupam Borgohain, PC, KVK, Jorhat
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49.	Dr. Akhil Kr. Deka, PC, KVK, Karbi Along
50.	Mr. Mohan Kumar Sarma, PC, KVK, Karimganj
51.	Dr. Yogendra Prasad, PC, KVK, Kokrajhar
52.	Dr Niranjan Deka, PC, KVK, Lakhimpur
53.	Dr. T. P. Saikia, PC, KVK, Shillongaoni
54.	Dr. Manoranjan Neog, PC, KVK, Nalbari
55.	Dr. Phuleswar Nath, I/c PC, KVK, Sivasagar
56.	Dr. Pramod C Deka, PC, KVK, Sonitpur
57.	Dr. Amal Chandra Sarmah, PC, KVK, Tinsukia
58.	Dr. Shamsher Singh, PC, KVK, Hailakandi
59.	Dr. Sanjoy Borthakur, PC, KVK, East Kameng
60.	Dr. M. Pathak, PC, KVK, East Siang
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62.	Dr. T. J. Ramesha, PC, KVK, Lower Dibang Valley
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69.	Dr. Anjana Nand Tripathi, PC, KVK, Upper Subansiri
70.	Dr. R. Bhagawati, PC, KVK, West Siang
71.	Dr. R.K. Imotomba Singh, PC, KVK, Bishnupur
72.	Mr. G. P. Kabui, PC, KVK, Chandel
73.	Dr. W. Rajen Singh, PC, KVK, Churachandpur
74.	Dr. T. Medhabati Devi, PC, KVK Leitanpekpham

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80.	Dr. R. Bordoloi, PC, KVK, Ri-bhoi
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83.	Mr. N. S. Nongbri, PC, KVK, West Khasi Hills
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85.	Dr. K. P. Chaudhary, PC, KVK, Aizawl
86.	Dr. O.P Singh, PC I/c, KVK, Champhai
87.	C. Lalthlamuana, PC, KVK, Kolasib
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89.	Vanlalhruaia Hnamte, PC, KVK, Lawngtlai
90.	R. K. Nithanga, PC, KVK, Mamit
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103.	Mrs. Sherab L. Dorjee, PC, KVK, South Sikkim
104.	Mr. N.T. Bhutia, PC, KVK, West Sikkim
105.	Dr. Arvind Kumar Singh, PC, KVK, South Tripura
106.	Dr. Pranab Dutta, PC, KVK, West Tripura
107.	Dr. Sentu Acharya, PC, KVK, North Tripura
108.	Dr. Anjan Debnath, PC, KVK, Dhalai