



Vision 2050



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शरद पवार
SHARAD PAWAR



कृषि एवं खाद्य प्रसंस्करण उद्योग मंत्री
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**MINISTER OF AGRICULTURE &
FOOD PROCESSING INDUSTRIES
GOVERNMENT OF INDIA**

Dated the 13th June, 2013

MESSAGE

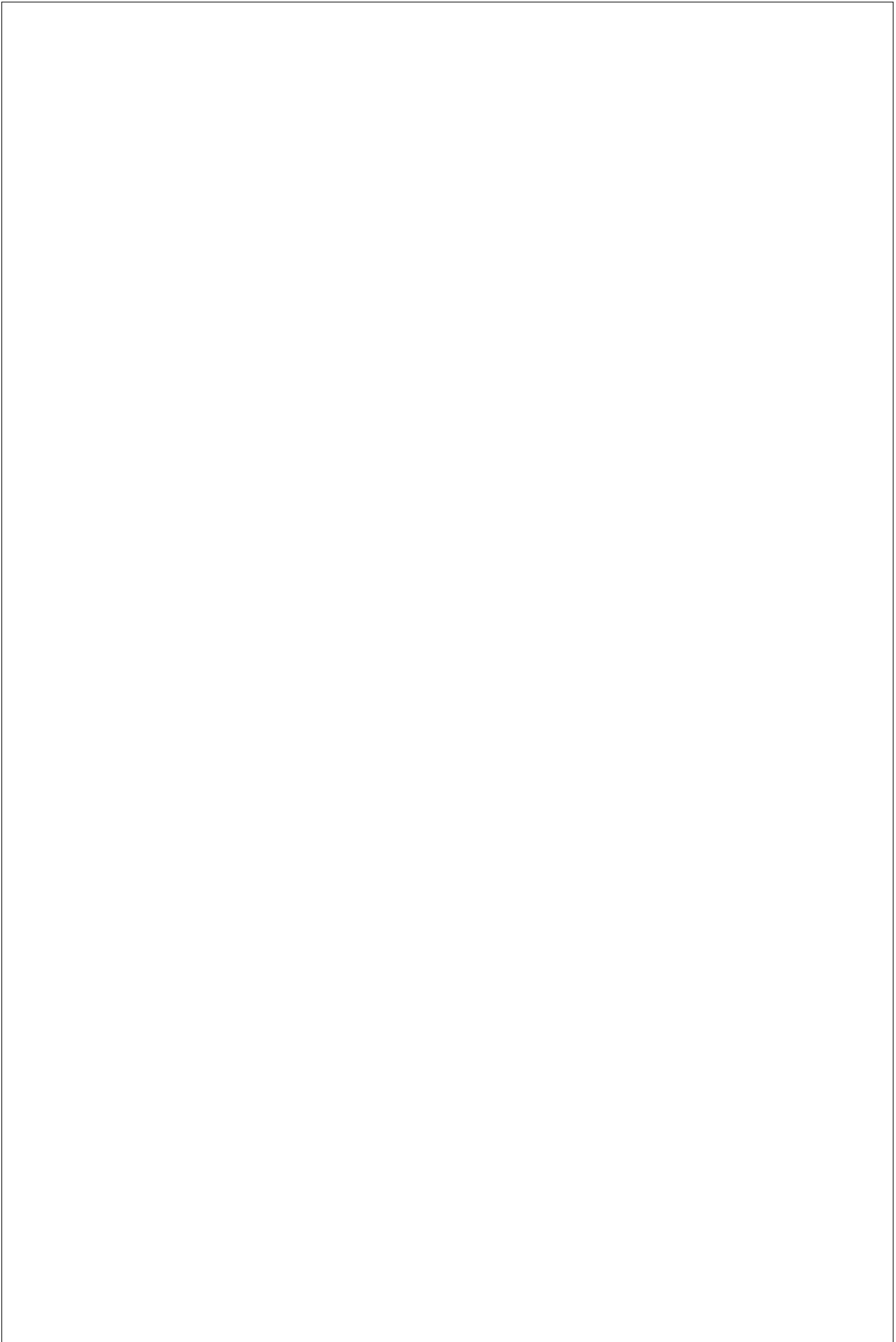
The scientific and technological inputs have been major drivers of growth and development in agriculture and allied sectors that have enabled us to achieve self reliant food security with a reasonable degree of resilience even in times of natural calamities, in recent years. In the present times, agricultural development is faced with several challenges relating to state of natural resources, climate change, fragmentation and diversion of agricultural land to non-agricultural uses, factor productivity, global trade and IPR regime. Some of these developments are taking place at much faster pace than ever before. In order to address these changes impacting agriculture and to remain globally competent, it is essential that our R&D institutions are able to foresee the challenges and formulate prioritised research programmes so that our agriculture is not constrained for want of technological interventions.

It is a pleasure to see that ICAR Research Complex for NEH Region (ICARNEH), Meghalaya, a constituent institution of the Indian Council of Agricultural Research (ICAR) has prepared Vision-2050 document. The document embodies a pragmatic assessment of the agricultural production and food demand scenario by the year 2050. Taking due cognizance of the rapidly evolving national and international agriculture, the institute has drawn up its Strategic Framework, clearly identifying Goals and Approach.

I wish ICARNEH all success in realization of the Vision-2050.


(SHARAD PAWAR)

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Foreword

The Indian Council of Agricultural Research, since inception in the year 1929, is spearheading science and technology led development in agriculture in the country. This is being accomplished through agricultural research, higher education and frontline extension undertaken by a network of research institutes, agriculture universities and Krishi Vigyan Kendras. Besides developing and disseminating new technologies, ICAR has also been developing competent human resources to address the present and future requirements of agriculture in the country. Committed and dedicated efforts of ICAR have led to appreciable enhancement in productivity and production of different crops and commodities, which has enabled the country to raise food production at a faster rate than the growth in demand. This has enabled the country to become self-sufficient in food and emerge as a net food exporter. However, agriculture is now facing several challenges that are expected to become even more diverse and stiffer. Natural resources (both physical and biological) are deteriorating and getting depleted; risk associated with climate change are rising, new forms of biotic and abiotic stress are emerging, production is becoming more energy intensive, and biosafety concerns are growing. Intellectual property rights and trade regulations impacting technology acquisition and transfer, declining preference for farm work, shrinking farm size and changes in dietary preferences are formidable challenges.

These challenges call for a paradigm shift in our research approach to harness the potential of modern science, innovations in technology generation and delivery, and enabling policy and investment support. Some of the critical areas as genomics, molecular breeding, diagnostics and

vaccines, nanotechnology, secondary agriculture, farm mechanization, energy efficiency, agri-incubators and technology dissemination need to be given priority. Multi-disciplinary and multi-institutional research will be of paramount importance, given the fact that technology generation is increasingly getting knowledge and capital intensive.

It is an opportune time that the formulation of 'Vision – 2050' by ICAR institutions coincides with the launch of the national 12th Five Year Plan. In this Plan period, the ICAR has proposed to take several new initiatives in research, education and frontline extension. These include creation of consortia research platforms in key areas, wherein besides the ICAR institutions, other science and development organizations would be participating; short term and focused research project through scheme of extramural grants; Agri-Innovation fund; Agri-incubation fund and Agri-tech Foresight Centres (ATFC) for research and technology generation. The innovative programme of the Council, 'Farmer FIRST' (Farmer's farm, Innovations, Resources, Science and Technology) will focus on enriching knowledge and integrating technologies in the farmer's conditions through enhanced farmer-scientist interface. The 'Student READY' (Rural Entrepreneurship and Awareness Development Yojana) and 'ARYA' (Attracting and Retaining Youth in Agriculture) are aimed to make agricultural education comprehensive for enhanced entrepreneurial skills of the agricultural graduates.

I am happy to note that the Vision-2050 document of **ICAR Research Complex for NEH Region (ICAR-RCNEH), Umiam, Meghalaya** has been prepared, based on the assessment of present situation, trend in various factors and changes in operating environment around agriculture to visualize the agricultural scenario about 40 years hence and chalk out a demand-driven research agenda for science-led development of agriculture for food, nutrition, livelihood and environmental security, with a human touch.

I am sure that the '**Vision-2050**' would be valuable in guiding our efforts in agricultural R & D to provide food and nutritional security to the billion plus population of the country for all times to come.

Dated the 10th June, 2013
New Delhi


(S. Ayyappan)

Preface

Caring for mother earth will give a share to each of us. It will lead to sustainable development and improvement in quality of life. Experiences from the past revealed many emerging issues, challenges and opportunities for north eastern hill farming. It was unequivocally realized that conservation of natural resources such as soil (nutrients), water, energy and bio-inhabitants (human, animal and plant) and their efficient management are vital to sustainable agriculture. Hence, the natural resources within the carrying capacity of the supporting ecosystems and their continuous improvement through research, training, application of new tools and technologies will ensure requirements of the present and future generations. During the XI plan period, food grain production and productivity increased and deficiency in meat, fish, eggs and milk reduced. However, the overall food and nutritional security is yet to be achieved. Marginal and small farmers having less than 1 ha land holding size in this region have many limitations in large scale adoption of technologies for increasing output. It is further aggravated by climate change and market complexities. Hence, the first attempt to sustainable growth in food production is to venture into farmers' first policy with a new vision for agriculture in entrepreneurship programmes, secondary agriculture, youth ready, women friendly agriculture and to instill confidence among rural farm families.

Integrated farming system, changes in cropping pattern, increasing cropping intensity, enhancement of soil and water productivity, biodiversity utilization, carbon management and trading, control of soil erosion, conservation agriculture, strengthening of traditional knowledge (ITKs), organic farming and diversification through agroforestry shall be the strategies to sustain agricultural production system. Twelfth plan envisages flagship programmes on *Jhum improvement*, *Temperate horticulture* and *Trans-boundary diseases*. Emphasis will also be on up-scaling natural resources, farm mechanization, attracting rural youth to agriculture and better linkages with other stake holders. The eastern Himalayan region including Darjeeling and NE states is a transition zone

between the Peninsular to the Indo-Malayan and Indo-Chinese ranges having diverse tribes and communities. The zone is rich in genetic resources, aquatic organisms, animals, plants, insects including honey bee and silk worm, flowers and orchid resources. The region has sufficient capacity to generate low volume-high value products of unique identity through primary and secondary agriculture.

ICAR Research Complex for NEH Region has earned distinction in serving the north east hill agriculture. Our research capabilities and core competency in hill farming will take us forward in establishing the institute as a centre of advanced learning and an institute *par excellent* in the field of natural resource management in South- East Asia. I wish our proactive planning, quality research and extension supported by favourable state policy would help us in securing sustainable agriculture for the future generations. I owe a great deal to the farmers of the north-eastern hill region whose untiring efforts in agricultural fields and feedback helped us to bring out this document.



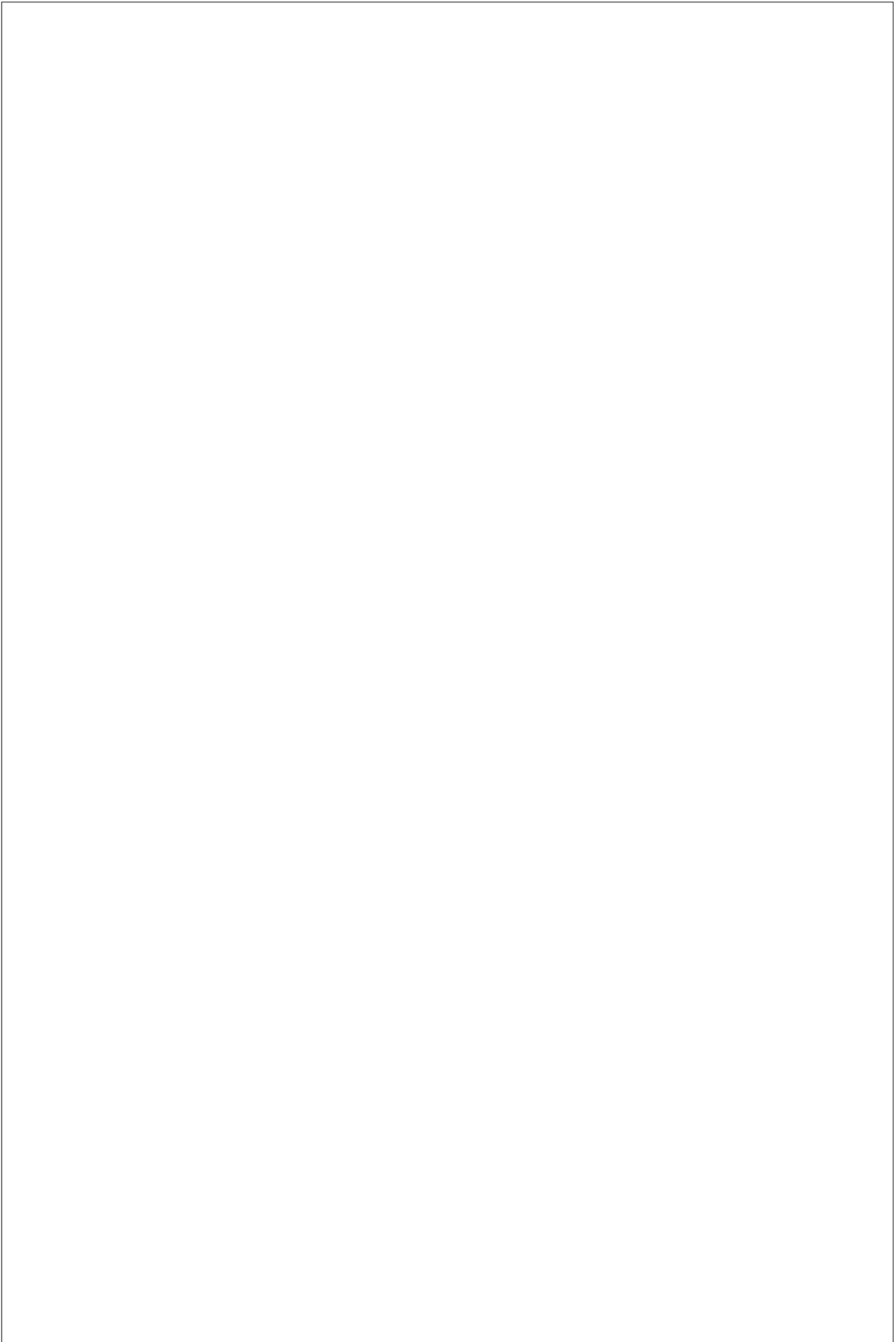
(S.V. Ngachan)

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Context

To the hungry man, God comes in the form of bread

~ Mahatma Gandhi

Father of the nation, Mohandas Karamchand Gandhi, had a strong belief that “freedom is not mere freedom from the colonial rules but freedom from poverty, hunger and malnutrition”. This noble thought is more relevant to the context of the north-eastern hill (NEH) region of India which has multipronged challenges to overcome in terms of food and nutritional security, sustainable agricultural growth, degradation of rich natural resources, equitable access and distribution of resources, and social, political and economic mainstreaming. The NEH Region includes the states of Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. The region, being a repository of rich biodiversity, is recognized as a climate marker. Different cultural backgrounds of the inhabitants coupled with variable food habits and climatic situations resulted in cultivation of diverse and mixed crops of cereals, pulses, oilseeds, vegetables, fruits, spices and flowers. Agroforestry, animal husbandry and fisheries are the integral parts of their farming systems. Rural population is around 82% and the society is primarily agrarian and depends on agriculture and allied sectors for its livelihood.

Potential of rich resource base from the peninsula to the peaks of the eastern Himalayas in developing agriculture in the eastern India was realized long back by Dr M.S. Swaminathan, father of Indian Green Revolution. His visionary zeal led to establishment of the ICAR Research Complex for NEH Region with its headquarters at Shillong in 1975. The institute progressed over time and scaled many heights under the leadership of its visionary founder director, Dr. D. N. Borthakur, who pioneered hill farming research in the north-east and gave new dimension to farming system research in India.

After going through a series of modifications to meet the requirements of changing times, the institute currently has been operating with the following mandates:

- To develop and improve sustainable farming systems for different agro-climatic and socio-economic conditions of the region.
- To improve crops, livestock and fisheries, and to impart training for development of local competence for management of resources to enhance agricultural productivity.
- To maintain, analyze and project database of resources for perspective planning.
- To collaborate with State Departments of the region for testing and promotion of improved farming technologies.
- Research on organic agriculture.
- To develop local human resources through post graduate teaching and research.
- To act as a repository of information on different farming systems of the region.
- To collaborate with national and international agencies in achieving the above objectives.
- To provide consultancy.

The institute carries out its mandated research, extension, training and teaching through its headquarters in Meghalaya, six regional research centres and 14 KVKs spread over different states of the north-east including Sikkim.

There has been significant growth in agriculture since 1970s. Food grain production in the north-eastern region has increased from nearly 3.5 million tonnes in 1981 to about 8.14 million tonnes in 2012. During the past ten years rice production of the region (including Assam) increased by 21.28%. Among the NE states, Tripura achieved highest productivity of food grains (2.62 tonnes/ha) and highest cropping intensity (184%). Though there is manifold growth in agriculture during the past decades, the region still has large deficits in pulses, oilseeds, meat, milk and eggs. By the year 2050 the total food grain demand would go up to 13.28 million tonnes, further widening the demand and supply gap (Table 1). Therefore, production should increase almost two-folds from the same or less land resources.

Table 1 Projected food grain production and requirement (in '000' tonnes)

States	CGR	Production			Requirement		
		2011	2030	2050	2011	2030	2050
Arunachal Pradesh	1.54	333.70	431.42	534.29	242.30	320.57	402.95
Assam	0.37	4876.50	5219.09	5579.71	5462.41	7226.77	9084.00
Manipur	0.77	592.70	679.59	771.05	476.99	631.05	793.23
Meghalaya	0.35	239.00	254.88	271.59	519.44	687.22	863.83
Mizoram	2.77	66.80	101.96	138.96	191.20	252.96	317.97
Nagaland	1.60	568.30	741.33	923.46	347.10	459.21	577.23
Sikkim	0.61	110.30	123.00	136.37	106.50	140.90	177.11
Tripura	0.98	712.40	844.63	983.81	643.35	851.15	1069.89
NER	0.53	7499.70	8250.06	9039.91	7989.29	10569.84	13286.20

Given the resourcefulness of the region, it is needed to relook into the region; start reinventing and reinvesting to bring in changes in the lives of people. Productivity has already reached a plateau in the traditional Green Revolution belt in the western plains. To sustain an economic growth of 10 %, agriculture has to grow at 4 %. Therefore, the government is now looking towards the east to trigger a second Green Revolution to feed the nation. But, there has been a significant change in approach to the present day agriculture. The change is from need-based to demand-driven agricultural production; nutrient intensive to nutrient balanced system. In the present global economic scenario, there is very limited restriction on trans-boundary trade of agricultural commodities. Demand for organic food is picking up and standards for food quality are becoming more stringent. It is therefore necessary to produce enough food with highest quality at the most competitive cost to thrive in the national and international markets. The agro-based and artisan-based industries such as spices, fruits, vegetables, silk, honey, bamboo, canes, medicinal and aromatic plants, and other agroforestry products would find easy market across the border because of similarity in cultural heritage and food habits. This geopolitical situation will have significant impact on cross border trade, trans-boundary pest and diseases and gene flow across international

boundaries influencing crop, animal, dairy, poultry and fish production in the region.

Today's science is in the era of functional genomics, gene tagging, reverse genetics, transgenics, stem cell research, remote sensing etc. that is helping to develop robust processes and technologies. Concerted efforts are being made all over the world on bio-fortification of crops with novel genes for nutritional security and development of generic drugs from novel bio-molecules for health security of the society. North-east, which is sitting on a vast mine of biological diversity, can be a good source of such novel genes and bio-molecules. Phosphorus-starvation tolerance 1 (PSTOL1) gene in the traditional rice variety of the north-east is a good example. Besides many new initiatives, pork revolution, ITKs in fisheries and fish production systems will need strong technology backstopping such as breed development, cheap nutrition and health care and service delivery systems at the farmers' doorstep.

In the absence of major industries and service sectors in the north-eastern hill region, agriculture is going to be the major avenue to provide livelihood to people of the region. However, this will be successful only if agriculture is devoid of drudgery and economic penury. In order to be economically attractive and less risk prone, north-east agriculture needs specialty/complementary/smart agriculture rather than subsistence and need-based agricultural production system.

As the future agriculture is going to be knowledge-based and skill-oriented, the local human resources need to be developed in agricultural research, education and extension. The institute therefore, envisions for local competence (hilly tribals, weaker sections of society, marginal and small farmers) in productive, sustainable and profitable agriculture in the north east. The government of India, on its "look east" policy, not only emphasizes diplomacy with neighboring countries but also offers greater opportunities for development of north-eastern states in agriculture and its products. The under-privileged tribal farmers with diverse communities, languages and religions are still known for their conservation values, ITKs (indigenous technical knowledge) and their cultural heritage. The conservation of bio-resources (thousands of rice and maize cultivars' selections), natural resource management (e.g., paddy cum fish culture at Apatani in Arunachal

Pradesh, *Zabo* system in Phek district of Nagaland, alder-based farming systems in Nagaland) are still vibrant among the tribal population.

It is also committed to develop professional and requisite skills imparting vocational trainings and prepare farm women, local youths to a profitable venture of agriculture. The institute has also ventured **farmer's first** policy in handling flagship programmes on *jhum* improvement, temperate horticulture and trans-boundary diseases. The consortia platforms in 11 out of 18 programmes will be under taken in the 12th Five Year Plan. Hence, the institute is committed to be the centre of excellence in agricultural sciences, knowledge, research in hill agriculture and a spark for intellectual innovations in the remote and frontier areas. The educated youths aspiring to take up leadership in agricultural marketing, post-harvest, mechanization, skills and expertise will be facilitated at the institute through training, exposure programmes and technology support adding values to **student ready** policy. The institute is striving to understand the realities of socio-economic problems and promote self reliance, employment growth, food security and livelihood. It endeavors to gauge the country's demand and to master the challenges on frontier issues. Therefore, the future agriculture has to operate in an environment with many new challenges and delivers location-specific options providing not only food and nutritional security but also the basic human issues of peace and harmony, culture and governance.

Challenges

1. Retaining and holding interests of farmers in agriculture and allied sectors.
2. Sustaining food grain productivity and production to meet the requirement of the growing population in the changing climatic conditions and increased competition for land, labour, water and energy for other economic uses.
3. Productivity enhancement in *jhum* and soil acidity affected areas while improving soil health.
4. Efficient rain water harvesting and soil moisture conservation for increasing cropping intensity.
5. Developing efficient and cost effective seed and planting material supply chain to augment productivity of agriculture and allied sectors.
6. Reducing post-harvest losses and adding spatial, temporal and quality values to the produce – expansion of secondary agriculture, peri-urban agriculture, improvement of storage, packaging and transport, etc.
7. Production technologies for organic farming, intelligent marketing of truthfully labeled produce to fetch better price.
8. Cost-effective and eco-friendly plant health management.
9. Low-cost balanced feed and health management options for animal husbandry, poultry and fishery sectors.
10. Development of a networked monitoring and response system to improve market intelligence and accessibility, preparedness for biotic and abiotic stresses.
11. Capacity building of all stake holders, especially youths, to attract them towards agriculture. Human-resource development to meet the future requirement of technical manpower in agriculture.
12. Improving technology adoption and reducing technology fatigues.
13. Integration of research-extension- market
14. In NE, many youth stray to insurgency because of poverty, desperation and lack of opportunity. The greatest challenge is to attract and engage them in agriculture and other convergence programmes to enable them to improve their quality of life.

Operating Environment

Agriculture has been the mainstay of the North-East economy from ancient times, and the situation has not changed much until recently. However, the region has seen considerable improvements in food production. In 2012, 8.14 million tonnes of food grain was produced within the region that made it self-sufficient. Rice and maize, which are the main food crops, showed dramatic improvements. In the pulses and oilseeds sector, however, the growth was somewhat slow. Although the food grain scenario is currently not alarming, by 2050, the deficit may reach up to 32%. Therefore, increasing food grain production is critically important for improving food security, especially because the population is growing by about 2%.

Agriculture and allied activities are the main sources of livelihood in North Eastern region where the small and marginal farmers outnumber progressive / large farmers by a huge margin. As agriculture throughout the region is mostly rainfed, area and production of crops in *kharif* is much higher than those in *rabi* both in agriculture and horticulture sector. Production in animal husbandry, poultry and fishery sectors is much below the requirement. However, meat (decadal growth 72.48%) and poultry (decadal growth 21.61%) sectors are growing at a faster rate than the dairy sector.

It is indicated that roughly 84% of the soil in the region is acidic and nearly 1.3 million ha suffers from serious soil erosion problems. Soils are low in available phosphorous and zinc but high to medium in available nitrogen and potash. *Jhum* (slash and burn) cultivation, although traditional to the region, is showing a sharp decline trend, and it has reduced from 1.6 million ha to 0.8 million ha in one decade. The region receives abundant rainfall (2400 mm/year) which is mainly concentrated in the monsoon season. Surface water is still the main source of irrigation; therefore, water-use efficiency is less than 7%. Rice is the main crop in *kharif*. In the *rabi* season nearly 95% of the rice area in the hills remains fallow because of lack of irrigation. It is estimated that by 2050 per capita availability of water would be about 290 m³/year. Producing more from less water would

become very complex in the hills where water retention capacity of soil is very low and rainfall is highly seasonal. Although ICAR has demonstrated the benefits of micro-rain water harvesting, *in-situ* moisture conservation, land configuration, zero tillage practices, etc., their adoption rates are slow. The states of the North East Hill Region are also responding to the soil and water conservation interventions. The state of Mizoram has come out with a new land use policy. Meghalaya through its soil conservation department has taken initiatives to demonstrate research derived conservation measures (RDCM).

Service delivery, especially in the seed and animal husbandry sector is still developing. Supply of good-quality seed and planting material is inadequate. Similarly, availability of animal feed and cost of feed are the two major hurdles to the development of animal husbandry, poultry and fishery sector. There are some organized seed production programmes in Assam. The hill states are, however, dependent entirely on ICAR, agricultural universities and private seed agencies for their seed requirement. National Seed Corporation has a branch in Assam, but their supply is restricted to varieties available in the national chain.

Agriculture in the region is organic, mostly by default. In the low-productivity upland condition, resorting to organic mode of food production and their planned marketing can bring in extra cash returns to the farmers. The Sikkim state has decided to be completely organic in agriculture by 2015. It will be an interesting model to study the researchable and policy issues emerging in this process of transformation. On the other hand, about 54% cultivable areas under valley and wetland ecology are suitable for high input agriculture. The region is rich in the biodiversity of agri-horti crops and medicinal plants. Biodiversity is the backbone of the agricultural sustainability in the region. The national agencies are active in collection and characterization. However, *in situ* conservation, trait-based classification and database development, and utilizations are still in its infancy. The potential of the huge diversity in ornamental fish is untapped as yet and is attracting bio-smugglers.

Sustainability of the fragile rainfed agriculture throughout the region is further threatened by the changing climatic conditions. The region experiences both floods and droughts. Although district-wise contingency plans are available, mode of their implementation is not clearly defined. In addition, the changing climatic conditions increased the risk of incursion

of trans-boundary diseases through the long international boundary in the region. In the absence of an IT-enabled networked response system, threats of such biotic and abiotic stresses always loom large.

The region is currently surplus in horticultural produce, but post-harvest losses in this sector are very high. Secondary agriculture based on location-specific advantages, storage, packaging and transportation maintaining a cold chain to reduce post-harvest loss is yet to set off. Energy and economic efficiency of agricultural practices throughout the NE region are far from satisfactory. More than 80% of the operations are manual and farm mechanization is limited to certain pockets only. Recently, some private initiatives in the manufacture of farm tools and machineries have been observed. A small part of the agricultural waste is used either as pig feed or for composting. The remainder, which could generate an estimated 400 MW power, is wasted through burning. Recently, ICAR through its activities in NICRA has initiated some bio-energy activities.

Growth in production must come from an increase in productivity as the opportunity for expanding area is limited due to increasing competition for land from other economic and social activities. Improved technologies, therefore, need to be developed, validated and widely disseminated to farmers. Such technologies not only must raise productivity per unit area, but also make more efficient use of energy and water for which competition for other usages is increasing with economic growth. To ensure this, the agricultural universities are training students who can handle the problems unique to the region.

Opportunities

The north-eastern part of India is a land of extremes and one of the most picturesque parts of our country. Physiographically, the region can be categorised into Eastern Himalayas, Northeast Hills (Patkai-Naga Hills and Lushai Hills) and the Brahmaputra and Barak Valley Plains. It has rocks of diverse geological ages from the Archaean to the Quaternary. The region shares its boundary with China (South Tibet) in the north, Myanmar in the east, Nepal in the west of Sikkim, Bangladesh in the southwest, and Bhutan to the northwest. Although pace of agricultural development was not as fast as it was in the north and north western parts of India, the potential is very high because of its rich resource base. Some of the opportunities are described below:

- 1. Mega biological diversity:** NEH region is one of the mega centers of diversity having many endemic species. It is part of both Himalayas and Indo-Burma biodiversity hot spots supporting 50% of the total plant diversity in India. The region exhibits rich diversity in orchids, zingibers, yams, rhododendrons, bamboos, canes, medicinal plants and has wild relatives of many cultivated plants. Around 6000 rice lines, designated as ARC series, are used in major rice improvement programmes of the world; about 50 % of the bamboo species of the country are available in the region. About 14 species of banana, 17 species of citrus, 600 orchids out of which 175 are rare and many medicinal and aromatic plants belong to this region. Wild relatives of 132 economically important species like rice, banana, citrus, mango and pulses have primary or secondary centres of origin in the region. This diversity can be a source of many valuable products, genes of desirable traits, strains of micro-organism having strong industrial significance and insects of economic value. Examples include: phosphorus-starvation tolerance 1 (PSTOL1) gene in the traditional rice variety of the north-east, medicinal rice, rice with high lysine, methionine, calcium and iron content, maize with higher tryptophan content, King chilli having high capsicin content, turmeric with very high curcumin content, ginger with high oleoresin content, spices such as star anise, large cardamom, fruits like jackfruit, pineapple,

Phyllanthus, Garcinia, Malus, Fragaria etc., medicinal plants such as *Taxus wallichiana*, *Aconitum*, *Panax pseudoginseng*, *Cordicep sinensis*, *Podophyllum hexandrum* and trees like agar wood, bay leaf, dalchini and grasses like broom grass, many edible insects, silk worm insect, many species of biocontrol agents like *Trichoderma* etc. The region is also rich in ornamental fishes harboring about 274 species.

- 2. Water Resources:** Rainwater forms major source. Natural lakes, ponds, springs, watershed ponds, silt retention ponds, waste land ponds and ground water are the other sources of water. Since the hills have the sources or catchment areas of the streams and the rivers, they have a comparatively higher rainfall, and the plains are endowed with much water resources for irrigation. According to the Central Ground Water Board, the total ground water recharge of the Brahmaputra valley is 9,418 million cubic meter while the same for Barak valley is 901 million cubic meter. North east hill region receives average annual rainfall of 2400 mm with considerable surface water discharge. Mawsynram or Cherapunjee receives more than 11000 mm annual precipitation; Karbi Anglong and N.C. Hills of Assam, entire territories of Arunachal Pradesh, Nagaland and Meghalaya with per humid to humid climate receive 3,528 mm rainfall annually. The water resources potential of the region is the largest in the entire country (42 million ha m) but most part (93 %) of it is wasted and drains to the oceans. Most of the rain is received during the monsoon and the winter months are very dry limiting the scope of *rabi* crops. There is also scope to develop and optimize structural measures (mechanical, vegetative measures), water harvesting and recycling, cropping system and crop geometry for *in situ* moisture conservation and enhancement of water productivity.
- 3. Fresh water aquaculture:** The region has huge potential for fish culture. Total river length in the north east region is about 19150 km; 1,43,790 ha Beels out of which approximately 43,790 ha are in the hill states only; the region has 14,600 ha area under reservoirs also. There is ample opportunity for cold water fisheries as Sikkim and Arunachal Pradesh have about 2900 km river length, a significant proportion of which is in the cooler region.

- 4. Market for meat and meat products:** Majority of the population in the north-east has non-vegetarian food habit and the demand for meat and meat products is very high. There is an opportunity to enhance production of meat, eggs and fish which will be less affected by remoteness and transportation cost.
- 5. Off season vegetables:** The region is endowed with wide climatic variability and has tropical to alpine zones. Off-season vegetables with suitable package of practices can earn good revenue. The temperate regions can be a good place for seed production for crops which do not get congenial climatic conditions for the same in the plains.
- 6. Organic cultivation:** The north-eastern states are moving towards adopting the policy of organic food production systems. Fertilizer application is very low in this region (as low as 2 kg per ha in Arunachal Pradesh) implying that the region is suitable for organic farming. Sikkim is already an organic state and many are moving in that direction. These policies provide new avenues of research.
- 7. Floriculture:** Many localities of the region are suitable for floriculture that has very high export potential. The region is home to 600 species of orchids out of which 175 are rare species. *Anthurium* and *Lilium* have already become popular for cultivation in Mizoram. There is opportunity to strengthen the R&D on package of practices of important flowers, better breed development and value addition, packaging and marketing.
- 8. Spices and Condiments:** By virtue of its niche climates throughout the region, it harbors some of the best spices of the world e.g., Turmeric species with anti-cancerous properties and very high curcumin content (> 7%), ginger with high oleo resin, King chilli with highest pungency, star anise etc.
- 9. Secondary Agriculture:** Post-harvest loss is very high in the north-eastern hill states. In the horticultural sector, the NEH region has surplus production of both fruits and vegetables, which occupy the second place next to rice. Not only the area allocation is high, the proportion of households growing vegetables is also high. But perishable nature of the commodity, lack of market availability within reasonable distance from the production site and poor road

network, storage and transportation infrastructure further adds to the problem. Except few crops such as tea, jute, sugarcane, pineapple, orange, citronella etc, the potentialities for agro-based or bio-based industries have not been realized due to infrastructural deficiencies. Recently, agro-industrial potentialities of crops such as rubber in Tripura, bamboo and canes in Arunachal Pradesh etc. have been recognized. Spices such as ginger, turmeric, cinnamon, large cardamom are important cash crops of the region. Tuber crops such as tapioca, arrowroots, yams, sweet potato, groundnut, soybean, mustards and rapeseeds etc., can be used as source of carbohydrate, starch and protein. Besides, oil from bay leaf contains 70-80 % eugenol, sericulture, mushrooms, floriculture opens great scope for agro-based enterprises. Fiber crops such as jute, banana, pineapple, ramie, coconut fiber etc are important. Agro-waste such as paddy husk, rice bran, rice straw, coco peats, sugarcane bagasse, press mud, vermicompost can be good materials that require consideration and development. There is ample opportunity in developing secondary agriculture, primary processing, value addition and increasing shelf-life of farm produce.

- 10. Climatic analogues:** Wide variability in altitudinal range (50 to 5000 m above msl) provides a number of climatic analogues in terms of temperature and rainfall. This can be used for climate change studies to develop adaptation and mitigation strategies.
- 11. Vertical expansion of agriculture:** In the present scenario, horizontal expansion is not possible due to population pressure and rapid urbanization. But, there are suitable climatic conditions (adequate rainfall and solar radiation) for vertical expansion of agriculture. Agroforestry and integrated farming system hold promise in this regard.
- 12. Medicinal plant resources:** The region is very rich in medicinal plants with rich traditional knowledge of utilizing them for cure of many plant, animal and human diseases. There is a scope for drug discovery and validation for human welfare.
- 13. Temperate horticulture:** The high hills of Arunachal Pradesh, Sikkim and parts of Manipur and Nagaland are suitable for cultivation of temperate fruits such as apple, kiwi, cherry, walnut,

hazelnut etc. They can generate substantial amount of revenue from the hills which are otherwise lying unproductive.

- 14. High biomass and forest of the region:** The region has maximum area under forest vegetation with close canopy. Apart from non-tangible benefits, through the application of science and technology, there is potential to derive tangible economic benefits from this biomass through the route of carbon sequestration and carbon credits/trading.
- 15. Humid climatic conditions:** Although excessive humidity is not good for crop production with respect to pest and diseases, the climatic conditions can be utilized to screen germplasm of many crops, livestock and poultry for resistance against major insects, pests and diseases.
- 16. Bamboo and cane resources:** Bamboo is the future timber of the 21st century. The region contains more than 50 bamboo species (50 % of the country) which have multiple functions. Bamboo shoots are extensively used as a food item. It has good export potential across the border especially to Myanmar, Bhutan, Bangladesh and China.

Goals and Targets

1. Making the region self-sufficient in food production.
2. Placing the region in organic food production map of the world.
3. Reduction of area under *jhum* and ensuring livelihood security of the *Jhumias*.
4. Inventorization and development of utility mechanism of biological diversity.
5. Establishing climate-ready agriculture in changing climate scenario.
6. Creating a robust agricultural information network system to narrow down the distance between farmers, researchers, policy makers, business houses and entrepreneurs through effective IT interfaces.
7. Establishment of surveillance, detection and management of plant and animal diseases including the trans-boundary pest and diseases.
8. Agricultural technology for conservation of natural resources.
9. Enhancement of technology adoption for agricultural growth.
10. Establishment of strong institutional linkages with line departments, national and international organizations, NGOs and other stake holders.

Way Forward

The approach to achieve the goals of Vision 2050 would be a holistic strategy in convergence with various national, international and regional programmes. Achieving food security in a sustainable manner with adequate emphasis on environment would be the major thrust of the Institute. The major action points envisioned to achieve the set goals are indicated below-

1. Making the region self-sufficient in food production:

- a. **Food grain:** For self-sufficiency, food grain productivity has to increase by two times from the present level of 1.9 t/ha and cropping intensity from 135 % to 240%. To meet this target, every component of the crop production system such as seed, nutrient and disease management etc will be addressed.
 - i. Location specific crop varieties will be developed through breeding programs supported by biotechnological tools such as allele mining for biotic and abiotic stress, gene tagging, functional genomics, RNAi technology and transgenic research.
 - ii. In most of the areas only a single crop is taken in a year. Cropping intensity will be increased by popularizing the available cropping systems and developing new cropping systems to fit in the agro-ecosystem of the north east. Double cropping of rice with special emphasis on *boro* rice cultivation and inclusion of pulses (pea/lentil) in rice fallow would be followed for enhancing cropping intensity.
 - iii. Maize production in upland will be focused with improved varieties and package of practices to enhance the productivity by at least 50% from the present level (1.5 t/ha).
 - iv. Slow release fertilizers, nano-particles, bio-control agents shall be developed to improve efficiency and efficacy of fertilizers, insecticides and pesticides.
 - v. Establishment of model seed villages for major food crops in each regional station for enhancing availability of quality

seeds and demonstration to the state government officials for large scale replication.

b. Meat, Milk and Eggs:

- i. For meat sector, piggery and poultry would be the focal species. Improvement of the local breeds and development of cross breed pigs to suit the local conditions and preferences will be continued. AI in pig has been standardized and has been quite successful in farmers' field. AI will be popularized in larger scale. Studies will be carried out on reproductive biology including IVM, IVF, OPU and cryopreservation of gametes, embryo and stem cell research in farm animals. Back yard poultry is the mainstay of NE farmers. In addition to the available popular poultry breeds Vanaraja and Gramapriya, new varieties suitable for the region will be developed for enhancing meat and egg production.
- ii. High feed cost of pig, dairy cattle and poultry has been a major problem. Cost minimization through locally available feed materials will have major emphasis. Screening of tuber crops, development of nutritive grasses, screening fodder trees will be some of the future areas of research. Massive tree improvement programme will be taken up to develop high yielding fodder tree species to meet the demand of lean season fodder requirement. Probiotics would be developed for enhancing nutritional quality of feed.
- iii. Higher productivity is very closely linked with less mortality and lower loss of yield through better health management. In the disease management strategy, it will be attempted to develop new generation vaccines and adjuvants, edible vaccines, DIVA vaccines and companion diagnostic tests for major livestock diseases. Research focus will be on recombinant antigens (diagnostic reagents) for disease pathogens which have either been eradicated like Rinderpest or for exotic diseases like BIV, BVDV etc.

2. **Reduction of area under *jhum* and ensuring livelihood security of the *Jhumias*:** Productivity of *jhum* land is very low and the *jhum* farmers are economically less privileged. Efforts will

be undertaken to develop and introduce improved package of practices for *jhum* agriculture with appropriate integration of technological interventions. Tree crop interaction of highly remunerative cash crops such as bay leaf, dalchini, agarwood, tree beans, Khashi Mandarin, som, sohiong, edible bamboo, king chilli, bird's eye chilli, turmeric, ginger, star anise, medicinal plants etc. in the agroforestry systems will help to establish appropriate tree-crop combination for returns maximization and resource conservation. Higher economic returns will certainly act as an incentive to permanent settled agriculture.

3. **Placing the region in organic food production map of the world:** The region has the unique opportunity for organic food production considering its strategic advantage in low agro-chemical use, favorable climatic condition, rich flora of niche crops and good availability of organic manure including biomass. Organic package of practices will be developed for major crops/ varieties of the region. Accordingly organic farming will be promoted in identified pockets with selected crops and commodities on a farming system mode to boost the economy of farmers.
4. **Inventorization and utilization of biological diversity:** The institute has contributed significantly to collection and characterization of rice, ginger, turmeric, chilli, chow-chow germplasm of the north-east. These efforts will be expanded to other agriculturally important crops in collaboration with NBPGR. Special emphasis will be laid on medicinal plants for discovery of new bio molecules, generic drugs etc. A comprehensive programme involving expertise in all the fields of science related to medicinal plants will be taken up. It would involve identification of medicinal plants, its chemo-profiling, drug/formulation development, bioassay, and its evaluation on plants, animals at field scale, development of appropriate varieties/genotypes of plants and their best cultivation practices. It will be a multi-disciplinary and multi-institutional approach involving experts in the field of organic chemistry, genetics, veterinary science, forestry, taxonomy, agronomy, entomology, pathology, marketing and post-harvest engineering.

5. Establishing climate ready agriculture in future scenario:

Assessment of carbon stock, its quality (fractions) and nutrient dynamics under different cropping systems and land use practices in climate change scenario (elevated CO₂ and temperature) and evaluation of alternate cropping systems along with identification/development of climate ready varieties to suit the climate change scenario will be focused. Carbon sequestration potential of different agroforestry systems and their up linking with Clean Development Mechanism (Carbon trading) and promoting non-conventional energy sources in agricultural operations will be taken up. Physiological adaptability and morphological characterization of pigs and poultry and development of feeding strategies for enhancement of productivity, reduction in emission of greenhouse gases will be given emphasis. New tools like crop modeling/simulation studies to evaluate the effect of climate change on cropping/farming systems will be conducted. Need based integrated agro-advisory services will be given for contingency planning by the farming community. Evaluation, validation and refinement of ITKs would be focused for climate resilience. Special emphasis would be given on generating technologies including identification of varieties and breeds for abiotic stresses such as soil acidity, floods and drought condition. Crop diversification with emphasis on pulses, oilseeds, vegetables, medicinal plants would be also focused for sustainable hill agriculture.

6. Creating a robust agricultural information network system by narrowing down distance between farmers, researchers, policy makers, business houses and entrepreneurs through effective IT interfaces: The strategy and actionable issues to achieve this objective are as below:

- KIRAN will be expanded and made a web based interface for multiple functionality.
- Create data bank for exotic disease situations.
- Development of agricultural databank and estimation of parameters of importance in NEH Region.
- Field level to regional scale ET estimation, extrapolation, validation and development of spatial map.

- Resource mapping and decision support system with the help of GIS and remote sensing tools.

7. Establishment of surveillance, detection and management of plant and animal diseases including the trans-boundary pest and diseases, the activities include:

- Disease surveillance and monitoring, repository building and reporting systems.
- ELISA, micro array and Tagman based diagnostic protocols for transboundary diseases.
- Research on emergence and prevalence of hitherto unknown/emerging diseases of trans-boundary importance.
- Act as a platform for ensuring constant research on diseases affecting the animal-human continuum and building up an information repository/database for such diseases.

8. Agricultural technology for conservation of natural resources:

- Development of suitable resource conservation technology (RCT) options for higher productivity.
- Study of bio-resource flow pattern in different farming systems.
- Economic evaluation of tangible and non-tangible benefits in different farming systems.
- Development of organic package of practices for important field crops, vegetables and fruit crops.
- *In-situ* moisture conservation, rain water harvesting and recycling through efficient irrigation practices (micro irrigation).

9. Extension, training and transfer of technology for enhancing percolation of technologies at field level and improve technology adoption:

- Establishment of V-type nursery for mass production of horticultural planting materials.
- Establishment of Technology Park for demonstration of the technologies to all the stake holders.
- Enhancing availability of seeds through public private partnership, seed village etc.

- Small tools and implements will be licensed to entrepreneurs to make them readily available to the farmers at competitive cost. For costlier machineries, custom hiring centres will be established at each regional center and the KVKs. For pig and poultry, mega seed programmes will be undertaken.
- Training local youth in hybrid seed production, apiculture, manufacture of small tools and implements etc.

10. Collaboration/Linkages for multidiscipline research: The institute being a research complex has wide mandate cutting across many disciplines. Therefore, effective linkages would be strengthened with different national and international institutes.

Some of them are as below:

- Farming system/Shifting cultivation: PDFSR, CTCRI
- Phenomix: CAU, IARI
- Seed programme: DSR, IARI, NGOs, CAU, DRR, DMR
- Conservation Agriculture: PDFSR, IARI, CSWCRTI, CRIDA
- Watershed: CSWCRTI, CRIDA, NAARM, DWM
- NICRA: CRIDA, IARI, IVRI, NDRI, IIHR, CIFE
- FASAL: IMD, Pune
- Temperate Horticulture: CITH, J&K
- GHG inventory management: CRIDA, IARI, CRRI
- Germplasm exchange for stress tolerance- IIHR, CRRI, DRR, DMR, IIPR, VPKAS, IGRI, NRCAF, NBPGR
- GIS/RS/Simulation & Modeling- NRSA, CSWCRTI, NAARM, CRIDA, NESAC

Platform projects

- Medicinal Plants: DMAPR, Viswavarti, NEHU, AAU, Assam University
- Conservation agriculture: PDFSR, CSWCRTI, CIAE
- Scaling up water productivity: DWMR, CSWCRTI

Abbreviations

AAU	Assam Agricultural University
CAU	Central Agricultural University
CGR	Compounded Growth Rate
CIAE	Central Institute of Agricultural Engineering
CIFE	Central Institute of Fisheries Education
CITH	Central Institute of Temperate Horticulture
CRIDA	Central Research Institute for Dryland Agriculture
CRRl	Central Rice Research Institute
CSWCRTI	Central Soil and Water Conservation Research and Training Institute
CTCRI	Central Tuber Crops Research Institute
DMAPR	Directorate of Medicinal and Aromatic Plant Research
DMR	Directorate of Maize Research
DRR	Directorate of Rice Research
DSR	Directorate of Seeds Research
DWMR	Directorate of Water Management Research
FASAL	Forecasting Agricultural output using Space Agro-meteorology and Land based observations
GHG	Green House Gas
GIS	Geographic Information System
IARI	Indian Agricultural Research Institute
IGFRI	Indian Grassland and Fodder Research Institute
IIHR	Indian Institute of Horticultural Research
IIPR	Indian Institute of Pulse Research
IMD	Indian Meteorological Department
ITK	Indigenous Technical Knowledge
IVRI	Indian Veterinary Research Institute
KIRAN	Knowledge Innovation Repository in Agriculture for North East
KVK	Krishi Vigyan Kendra
NAARM	National Academy of Agricultural Research Management
NDRI	National Dairy Research Institute

NEH	North Eastern Hill
NEHU	North Eastern Hill University
NER	North Eastern Region
NICRA	National Initiative on Climate Resilient Agriculture
NRCFAF	National Research Center for Agroforestry
NRSA	National Remote Sensing Agency
PDFSR	Project Directorate for Farming Systems Research
RS	Remote Sensing
VPKAS	Vivekananda Parvatiya Krishi Anusandhan Sansthan

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