REGIONAL MEETING IN NORTH-EAST ON AGRICULTURE AND ANIMAL HUSBANDRY IN INTEGRATED FARMING SYSTEM

PROCEEDINGS

5-6 October 2006

Central Agricultural University, Imphal 795 004 (Manipur)

PROCEEDINGS OF REGIONAL MEETING IN NORTH-EAST ON AGRICULTURE AND ANIMAL HUSBANDRY IN INTEGRATED FARMING SYSTEM

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CENTRAL AGRICULTURAL UNIVERSITY
IMPHAL 795 004 (MANIPUR)

H.E. Dr S.S. Sidhu releasing the publications of CAU, Imphal;
seen Dr S.N. Puri and Dr S.P. Tiwari

H.E. Dr S.S. Sindhu welcomed at the inauguration of
VCs regional meeting at CAU, Imphal

Dr S.S. Sindhu, Governor of Manipur, being received by host VC,
Dr S.N. Puri, and Dr M.P. Yadav President, IAUA

H.E. Dr S.S. Sidhu lighting the lamp, seeing
Dr S.P. Tiwari, Dr S.N. Puri, Dr. M.P. Yadav and Dr R.P. Singh

SESSION I

TECHNICAL PROGRAMME ON THE REGIONAL MEETING IN NORTH-EAST ON AGRICULTURE AND ANIMAL HUSBANDRY IN INTEGRATED FARMING SYSTEM AT CENTRAL AGRICULTURAL UNIVERSITY, IMPHAL

(5-6 October 2006)

SUB-THEME: CONCEPT, PRINCIPLE AND IMPORTANCE OF INTEGRATED FARMING SYSTEM

Session I: Sub-theme: **Concept, principle and importance of integrated farming system**
Time: **12.00-13.30, 5 October 2006**
Chairman: Dr M. P. Yadav
Co- Chairman: Dr D. P. Singh
Rapporteurs: Dr Gajaraj Singh

Topic/Speaker:

(i) North-East agriculture: issue and perspective: Dr Bujarbaruah, Director, ICAR Research Complex for North-Eastern Hills Region, Shillong

(ii) Important components of agriculture and livestock in integrated farming systems for North-Eastern Hills region: Dr S. S. Baghel, Vice-Chancellor, AAU, Jorhat

(iii) Socio-economic compulsions, problems and impacts of agriculture and livestock in integrated farming system in North-East: Dr C. R. Hazra, Vice-Chancellor, IGKV, Raipur

NORTH-EAST AGRICULTURE: ISSUES AND PERSPECTIVES

K. M. Bujarbaruah

Director
ICAR Research Complex for North-Eastern Hills Region

Some Basic Information About North - East

- Geographical area : 27 million ha
- Net sown area : 4 million ha
- Total population : 3.9 million ha (3.81% of India)
- Growth during 1981 2001
- Area : 13.65 %
- Production : 34.0 %
- Productivity : 25.89 %

Table: Projected foodgrain production and requirement in North-East states

State	Production (`000 tonnes)				Requirement (`000 tonnes)	
	CGR	2005	2015	2025	2005	2015	2025
Arunachal Pradesh	1.3	217	246	280	220	276	348
Assam	2.58	4,733	6,105	7,876	5,234	6,214	7,377
Manipur	1.96	416	505	613	486	630	817
Meghalaya	1.19	215	243	273	469	608	787
Mizoram	10.37						
Nagaland	6.57	381	720	1,360	443	720	1,169
Tripura	2.25	584	730	911	620	717	829
All		6,546	8,549	11,315	7,473	9,165	11,326

Agriculture

Area (million ha)	Production (million t)	Yield (kg/ha)	Requirement (million t)	Deficit (%)
3.90	6.54	1509	7.47	13

Horticulture

Sector	Area (million ha)	Production (million t)	Yield (kg/ha)	Requirement (million t)
Fruits	2.70	2.33	8.65	11.01
Vegetables	3.68	4.05	11.98	15.16
Spices	0.69	0.44		
Plantation crops	1.15	0.10		

Animal husbandry and fisheries

Sector	Production (million t)	Requirement (million t)	Deficit (%)
Meat	0.22	0.439	49.70
Milk	1.06	2.14	50.50
Eggs (million)	902.09	7,027.21	87.20
Fish	0.21	0.38	55.26

Why Such a Situation?

1. Environmental constraints
   - Acidic soil
   - High rainfall and relative humidity
   - Shifting (*jhum*)cultivation
   - Land-tenure system

2. Technical constraints
   - Seed and planting material
   - Disease and pest management
   - Farm mechanization
   - CDR type of agriculture

3. Physical constraints
   - Infrastructure
   - Undulating topography

4. Economic constraints
   - Lack of commercialization

- Limited credit flow
- Market constraints

SWOT Analysis

Strength

1. One of the 18 mega bio-diversity hot-spot areas
2. Abundant natural resources (in lakh ha)
    1. Forest : 171.08
    2. Agricultural land : 39.08
    3. Water bodies
        a. River : 20,150 km
        b. Reservoirs : 0.45
        c. Tanks/lakes/beels : 1.43
        d. Ponds : 0.41
        e. Paddy-cum-fish culture : 0.08

Livestock and poultry (in million)

1. Cattle : 13.14
2. Buffalo : 0.91
3. Sheep : 0.17
4. Goat : 4.15
5. Pig (28.22%) : 3.09
6. Yak (24.61%) : 0.021
7. Mithun (100%) : 0.153
8. Horse and pony : 0.005

Total : 21.639

9. Poultry : 36.46

- Indigenous crop germplasm : 4,500 (approx.)
- Orchids : 600 (175 rare spp.)
- Medicinal and aromatic plants : 1,700 spp. (119 identified)
- Bamboo resources : 50% of the country
- Fish germplasm : 347 species including ornamental species
- Water resources : 42.50 million ha-m

Agro-ecological zones

- Alpine zone (>3,500 m)
- Temperate and sub-alpine zone (1,500-3,500 m)
- Sub-tropical hills zone (1,000-1,500 m)
- Sub-tropical plains zone (400-1,000 m)
- Mild-tropical hill zone (200-800 m)
- Mild-tropical plains zone (<200 m)

Weaknesses

- Inaccessibility, marginality and fragility
- Overexploitation of forest for fuel, timber and fodder
- Improper land-use practices
- Shifting cultivation on hill slopes
- Poor infrastructural development

- Inadequate agricultural mechanization
- Absence of storage and agro-processing activities
- Limited availability of quality seeds
- Lack of policy framework for channelization of production-processing-marketing components
- Lack of commercialization and value addition

Opportunities

1. Development of farming system, specific for agro-ecological zones
2. Uncommon opportunities to increase agricultural production by 3-4 times
3. Opportunity for extensive organic farming under upland ecosystem
4. Mechanization of hill agriculture for increasing production and reducing drudgery
5. Rain-water conservation and management
6. Agro-forestry intervention, particularly in classified waste lands/marshy lands and permanent fallows
7. Opportunity for generating meat revolution in the country
8. Conservation and utilization of bio-resources through conventional and bio-technological interventions
9. Tremendous opportunities for development of horticulture sector, including apiculture and floriculture
10. Tapping of Post-harvest processing, value addition and export or domestic market
11. Ornamental fish farming
12. ITKs for validation and utilization
13. Opportunities to develop region-specific farming systems for poverty reduction and natural-resource conservation

Threats

1. Danger of extinction of valuable bio-resources
2. Larger areas being barren or degraded due to shifting cultivation
3. Gradual replacement of ecosystem by people ecological refugees
4. Danger of losing bio-diversity due to germplasm piracy on account of international boundaries

N.E. farmers

- Farmers in the region can be classified as :
- Small and multiple job holders, who work as agricultural labourers and also do some farming on leased land
- Small to medium starter farmers, who cultivate in own and leased lands with little off-farm income (cafeteria approach)
- Medium-to large-scale farmers with high level of farm production, income and expenditure

Their need

A. Technical

- New varieties or breeds to suit location-specific needs
- Production and distribution of seed or planting material
- Vaccines and sero-diagnostics for animal diseases
- Technologies for watershed development, water conservation and management
- Soil or plant-health care programme
- Organic farming package
- Knowledge management

B. Package of service

- Capacity building of farmers
- Rural connectivity and infrastructure
- Credit supply and insurance
- Storage and marketing facilities
- Self-employment facilitation centres
- Production planning and market management

C. Package of public policies

- Involvement of Panchayati Raj institutions
- Establishment of regional marketing network
- Recognition and rewards for primary conservers
- Public and private investments
- Farmer's life-saving support rather than small subsidy
- Pro-poor, pro-woman, pro-livelihood and pro-environment projects
- Hand-holding and monitoring role by NGOs and SHs

What Should be Done by R & D?

Amelioration of constraints

- To categorize soil on the basis of pH values and development of amelioration measures
- To issue soil-health card to at least 10% farmers from each district in a collaborative mode
- To neutralize acid soil @ 33% of net- sown area per year
- To monitor climate and establish its linkage with pest and disease problem
- To enhance institutional capacity to handle HRD and service-delivery issues
- To improve productivity in shifting-cultivation areas through varietal development and dissemination of soil and water-conservation technologies already developed

Making the Region Self - Sufficient in Food

Agriculture Sector

Bridging Gap of Foodgrain Deficiency by:

- Developing rice variety with average yield of 2.2 t/ha, from the present yield of 1.8 t/ha, i.e. a gain of 1.4 million tonness from 3.5 million ha of rice area.
- Introducing double cropping in 25-30% valley land area of 1.5 million ha to gain 1.12 million tonnes.
- To promote irrigation facility in association with state department through Bharat Nirman Programme to get additional 1 million tonne production.
- Development of rice varieties for SC areas to achieve yield of 1.2 t/ha from the present level of 0.7 t/ha to record a gain of 0.8 million tonnes from 16 lakh ha SC area.
- If this gain (4.32 million tonnes) + existing food grain (5.8 million tonnes), i.e. 10.12 million tonnes, is achieved, it would contribute to surplus of 1.51 million tonnes by 2015, when the projected requirement is 8.61 million tonnes
- Similarly, facilitation of additional production of 0.67 lakh tonnes maize, by increasing its productivity from 1.5 t/ha to 2.2 t/ha from 0.96 lakh ha maize area.

Crop Diversification:

- To encourage diversification, technology for wheat production (which is not a traditional crop) needs to be generated by tapping surface- and ground water- irrigation potential under GoI schemes.
- Technology backstopping for diversification into pulses and oilseed sector.
- Economic options for diversification into fisheries in marshy lands and floriculture under protected cultivation.

Organic Agriculture:

- Delivery of organic food production package to utilize 50% of *jhum* area, i.e. 8.0 lakh ha, @ 10% of the area per year for a period of 10 years.
- Another 25% of 1.5 million ha mid-altitude areas to be supported for organic agriculture.
- Information generation for ecosystem-specific crops to be grown organically.
- Validation of ITKs for pest and disease control.
- Support for processing, packaging, marketing and certification.

- Development of referral laboratory for organic farming.

Bio-resource Inventorization and Utilization:

- Collection, screening, genetic cataloguing, conservation and use of important bio-resources through conventional and molecular means.
- Protection of IPR issues and finding out gene-flow pattern in highly endangered species.
- Development of database for information sharing and establishment of regional gene bank.

Addressing the Constraints of Deliverables:

- Development of cold or heat resistant or tolerant varieties, weather-based disease and pest-forecasting models, and molecular disease-diagnostic systems for both crops and animals.
- Improved farm tools and machineries for production optimization and drudgery reduction.
- Seed production in a participatory mode.
- Refinement and propagation of rain water-harvesting models like JALKUND.
- Technology for managing global-warming issue.

Harnessing the Benefit of Plant, Animal and Fish Biotechnology:

- Application of biotechnology in the development of high-yielding varieties of crops and animals with assured quality parameters, and enhanced tolerance to biotic and abiotic stresses.
- Identification of vaccine candidates for the production of biotechnologically effective vaccines for animals against some of the specific diseases of concern.
-

Horticulture sector

Development of Fruit Sector:

- Development of agro-techniques and varieties to increase productivity per ha at least to All-India level.
- Gradual expansion of area under high-yielding varieties using cultivable waste land.
- Production of sufficient disease-free planting material.
- Propagation of orchard-management practices.

Development of Vegetable Sector:

- Ensuring availability of high-yielding varieties and their seed.
- Utilization of at least of 50% of current fallow lands for increasing vegetable production.

Development of Spices Sector:

- Increase productivity and area under turmeric, ginger and chilli.
- Facilitating private-public partnership for processing, value addition and marketing.
- Facilitating local production of inputs.

Development of Plantation Crops:

- Production of quality planting material and development of processing technologies for coconut.
- Development of dwarf hybrids of arecanut.
- Development of superior clones, high-intensity planting technique and technologies for processing of cashew.

Animal science Sector

Production Aspects: Pig and Poultry:

- CB pig variety produced by the institute is to be multiplied at state department farms for quality germplasm with simultaneous research attempt to develop three-breed crosses.
- Conducting research on different aspects of poultry production, establishing nucleus farm at the institute with grandparent stock of tested backyard poultry breeds.
- AI technology in pig and poultry developed at the institute to be propagated through the veterinary

department after training.

- Development of pregnancy-diagnosis kit for pig.
- Evolving economic feed formula for the industrial houses and carrying out research on enriching feed quality through chemical, mechanical and biological means.
- Development of complete feed blocks for disaster management and lean-season feeding.

Health Aspects:

- Intensification of research on molecular diagnosis of animal diseases and parasites including zoonotic diseases.
- Development of weather-based animal disease-forecasting models.
- Software and kit support to line departments for important diseases and parasites.
- Exploring the possibility of developing referral laboratory in the region for animal- disease diagnosis.

Fisheries sector

Riverine Fisheries:

- Replenishment of stock through appropriate ranching.
- Earmarking suitable stretches for running-water fish culture.
- Creating facilities for fish-seed production at least at district level.

Reservoir Fisheries:

- Augmenting yield by increasing stocking density and adopting scientific production packages.
- Intensive pen and cage culture in reservoirs built for hydroelectric projects.
- Promoting culture of masheer for conservation and increasing production.
- Exploring untapped reservoir areas.

Beel Fisheries:

- Registration of beels for organized production and harvesting.
- Regular stocking and harvesting to increase production.
- Adoption of pen culture to improve yield.

Pond Aquaculture:

- On-farm demonstration and training on carp culture.
- Facilitate establishment of eco-hatcheries at district level.
- Information and service delivery centres through farmers or producer co-operatives.
- Harnessing benefits of water-harvesting structures developed under watershed projects.

Rice-Fish Culture:

- Horizontal expansion of area in a partnership mode.
- Popularization of raised and sunken bed technology.
- Identification of suitable species.

Common Issues

- Intensive integrated farming system.
- Precision farming.
- Post-harvest handling of produce.
- Research on sanitary and phytosanitary measures.
- Strengthening the knowledge base of women involved in agriculture.
- Dissemination of evolved technologies for enhancing production.
- Using information technology in agriculture.
- Establishment of agri-business centres or agri-clinics.

- Programme of skill upgradation for all stakeholders.
- Public-private partnership or contract farming for a shift from household level to commercial production.

Conclusion

- N.E. India has large untapped production reservoir.
- Progress of agricultural productivity and the economic and ecological well-being of farm families is inextricably linked.
- Resources are necessary but no panacea for tackling poverty, disparities and backwardness. The determining factor is the institutional capacity to formulate viable, need-based schemes or projects with efficient delivery systems to utilize optimally the available resources.

  Establishment of regional consultative and monitoring bodies that would help speed up the process.

IMPORTANT COMPONENTS OF AGRICULTURE AND LIVESTOCK IN INTEGRATED FARMING SYSTEM FOR NORTH-EAST REGION

S. S. BAGHEL

Vice-Chancellor
Assam Agricultural University, Jorhat, Assam

Agriculture in North-East India

- Predominantly rainfed
- Risk-prone, having diverse crop environments
- Growth in industry and service sectors is very slow in the region, resulting in high pressure on agriculture for livelihood
- Poor farmers, having small and fragmented holdings with topographical problems
- Traditional subsistence agriculture with adoption of mixed farming

Table 1: Projected foodgrain production and requirement in North-East states

States	CGR (Prod)	Production (`000 tonnes)					Requirements (`000 tonnes)				
		2005	2010	2015	2020	2025	2005	2010	2015	2020	2025
Arunachal Pradesh	1.30	217	231	246	263	280	220	246	276	310	348
Assam	2.58	4,733	5,375	6,105	6,934	7,876	5,234	5,703	6,214	6,770	7,377
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Mizoram	10.37										
Nagaland	6.57	381	524	720	990	1,360	443	565	720	917	1,169
Tripura	2.25	584	653	730	816	911	620	667	717	771	829
NE states		6,546	7,471	8,549	9,817	11,315	7,473	8,269	9,165	10,178	11,326

Farm system

Each individual farm has its own specific characteristics, arising from variations in resource endowments and family circumstances. The household, its resources, and the resource flows and interactions at this individual farm level are together referred to as a 'farm system'.

The bio-physical, socio-economic and human elements of a farm are interdependent, and thus farms can be analysed as systems from various points of view. A farm system includes the variety of natural resources available to farm families. These resources normally include different types of land, various water sources and access to common property resources, including ponds, grazing areas and forest. To these basic natural resources may be added climate and bio-diversity, as well as human, social and financial capital.

Farming system

A farming system is defined as a population of individual farm systems that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints, and for which similar development strategies and interventions would be appropriate. Depending on the scale of the analysis, a farming system can encompass a few dozen or many millions of households.

Over the past 30 years, the original approach to analysing the farming systems has evolved markedly

Fig. 1: Evolution of farming-systems approach

Characteristics	1970s	1980s	1990s	2000s
System level				
Farm				
Household				
Groups/Community				
District/Zones/Catchment or Sector				
Livelihood focus				
Crops				
Crop-livestock				
Multiple household livelihoods				
Functional focus				
Research sectoral, including I				
Research and extension				
Research, extension and support services				
Multi-sectoral, including infrastructure				
Stakeholder focus				
Public				
Public and civil society				
Public, civil society and private				
Other foci				
Gender				
Household food security				
Productivity and resource management				

Important components of a farming system

- Crop component, usually taken up in the main crop fields ;
- Animal component, usually taken up within the homestead; and
- Homestead farming, which includes other allied activities taken up within the homestead.

The experience of the farmer and his ancestors over years enable them to select the activities under each system. In fact the farmer had been experimenting with the crops and crop varieties or species and the animal types or breeds

knowingly or unknowingly over generations before finally incorporating these in the farm plan.

It is very important for the researchers and development workers to remember the fact that any farming system adopted by the farmers has evolved over a very long period of time through a painstaking learning process. Due care must therefore be taken while recommending interventions for improvement of any farming system.

Farming systems in North-East India

- The physiographic and agro-climatic conditions vary in North-East India very widely.
- The climate ranges from alpine to subalpine in the region of high altitude, mild sub-tropical in Assam plains, and mild tropical in Tripura, though the region is climatically classified as sub-tropical humid in general.
- Rainfall varies widely according to season, place and altitude.
- Similarly, soil also shows wide variation in the physico-chemical and biological properties.
- Again, the region is home of more than hundred different ethno-cultural groups, differing in religious belief and heritage, adding to the diversity of 'agri-culture' of the region.
- The wide variation in the agro-ecological, socio-economic and ethno-cultural conditions has given rise to widely different types of farming systems in the region.

A survey (Bhowmic *et al.*, 1999) conducted in Assam involving farmers from farms of different size groups across different agro-climatic zones of the state identified as many as 43 combinations of various enterprises with crops, out of which four or five were noted as major ones.

Another survey (Saikia, 2004) conducted in different districts of the region including Assam, Nagaland, Manipur and Arunachal Pradesh identified a number of farming systems, indicating large variation in the farming systems in the region.

Some of the major farming systems being practised in different agro-climatic zones of Assam are given below

- CROP + DAIRY COW + GOATTERY + PIGEON + DUCK
  (LBV, CBV, NBPZ)
- CROP + DAIRY COW + POULTRY
  (CBV, LBV, NBPZ AND CHAR AREAS)
- CROP + DAIRY COW + POULTRY + PIGGERY
  (HILLS ZONE)
- CROP + DAIRY COW + PIGEON + FISHERY + PIGGERY
  (UBVZ)
- CROP + DAIRY COW + POULTRY + FISHERY
  (NBPZ, BVZ)
- CROP + DAIRY COW + FISHERY
  (NBPZ, BVZ)
- CROP + DAIRY COW + GOATTERY + POULTRY + DUCKERY
  (UBVZ)
- CROP + DAIRY COW + GOATTERY + DUCKERY
  (LBVZ)
- CROP + DAIRY COW + GOATTERY + SHEEP + POULTRY
  (CHAR AREAS)
- CROP + DAIRY COW + POULTRY + DUCKERY + FISHERY + PIGEON
  (BVZ)

Table 2: Major livestock-crop production systems identified in different agro-climatic zones

NARP zone or District	Production systems identified
Darrang, NBPZ	Rice-local cow-goat Rice-local cow-crossbred cow Rice-oilseeds-vegetables-potato-local cow-goat Rice-oilseeds-local cow-goat Rice-potato-local cow- goat
Jorhat, UBVZ	Rice-vegetables-local cow-buffalo-goat Rice-vegetables-local cow-buffalo-pig Rice-vegetables-local cow-goat Rice-vegetables-bullock-local cow Rice-oilseeds-vegetables-local cow-buffalo-goat
Nagaon, CBVZ	Rice-jute-local cow Rice-local cow-goat Rice-jute-local cow- goat Rice-local cow
Kamrup, LBVZ	Rice-vegetables-local cow- crossbred cow Rice-vegetables-local cow- crossbred cow-goat Rice-oilseeds-local cow
Cachar, BVZ	Rice-buffalo-goat Rice-local cow- crossbred cow-buffalo-sheep Rice-vegetables-local cow-buffalo-goat Rice-local cow- crossbred cow
Karbi Anglong, HZ	Rice-bullock-local cow Rice-bullock-local cow- goat-pig Rice-bullock-local cow- crossbred cow-goat Rice-vegetables-mustard-bullock-local cow
Subansiri (PU pumpare), Alpine Zone NEH 1 Temperate Sub-Alpine Zone NEH 2 West	Rice-millet-local cow-bullock-mithun-goat Rice-millet-maize-mithun-goat Rice-millet-mithun-goat Rice-maize-potato-local cow- crossbred cow-pig-mithun-goat Maize-potato-local cow- mithun-goat Rice-maize-local cow- mithun-goat Maize-potato-local cow Potato-vegetables-local cow-pig Maize-potato-vegetables-local cow-goat-pig Rice-maize-local cow-pig Rice-maize-potato-local cow-goat-mithun Maize-local cow-goat-pig Maize-potato-local cow Maize-vegetables-local cow Maize-potato-vegetables-local cow-goat-pig Maize-vegetables-local cow-pig
East Khasi Hills, Sub-tropical Hills Zone NEH3 Imphal, Subtropical Plain Zone	Vegetables-local cow Vegetables-potato-local cow-bullock Rice-local cow- crossbred cow Rice-pulse-local cow
NEH 4	Rice-maize-pulse-local cow Rice-potato-local cow- crossbred cow Rice-pulse-local cow-pig

Mild Tropical Hills Zone, NEH 5 Kohima	Rice-pulse-maize-vegetables-spice-local cow- crossbred Cow-bullock Rice-pulse-maize-vegetables-local cow- crossbred cow Rice-maize-local cow Rice-local cow-pig Rice-pulse-vegetables-local cow- crossbred cow
Mild Tropical Plains Zone, NEH 6 West Tripura	Rice-local cow- crossbred cow Rice-local cow-goat Rice-vegetables -local cow- crossbred cow Rice-vegetables -local cow- crossbred cow-goat

Table 3: Relative share of various components in human labour employment in major farming systems in North Bank Plains Zone of Assam

Component	Human labour (mandays)									
	Small			Medium			Large			
	FS 1	FS 11	FS 12	FS 1	FS 4	FS 12	FS 1	FS 9	FS 12	FS 22
Field crops*	187	167	167	280	270	287	454	462	452	413
	77.59	*62.31*	*74.22*	*71.25*	*73.57*	*77.36*	*74.67*	*75.37*	*78.20*	*73.62*
Animals	36	68	42	59	62	41	78	71	56	81
	14.94	*25.37*	*18.67*	*15.01*	*16.89*	*11.05*	*12.83*	*11.58*	*9.69*	*14.44*
Homestead	18	33	16	34	35	43	76	80	70	67
	7.47	*12.31*	*7.11*	*13.74*	*9.54*	*11.59*	*12.50*	*13.05*	*12.11*	*11.94*
Systems total	241	268	225	393	367	371	608	613	578	561
	100	100	100	100	100	100	100	100	100	100

Figures in italics indicate percentage of total
****Excluding summer and rabi vegetables and potato, which are included under homestead***

Table 4: Relative share of various components in net return in the major farming systems in North Bank Plains Zone of Assam

Component	Net return (Rs)									
	Small			Medium			Large			
	FS 1	FS 11	FS 12	FS 1	FS 4	FS 12	FS 1	FS 9	FS 12	FS 22
Field crops*	8,852	6,009	7,156	11,180	10,699	12,234	16,557	14,211	19,435	14,226
	67.17	*54.77*	*62.89*	*56.83*	*64.49*	*68.98*	*56.30*	*59.83*	*68.31*	*64.39*
Animals	2,415	3,260	2,614	4,010	2,772	2,280	5,190	3,240	2,653	3,006
	18.32	*29.71*	*22.97*	*20.39*	*16.71*	*12.86*	*17.65*	*13.64*	*9.32*	*13.60*
Homestead	1,912	1,703	1,609	4,481	3,120	3,222	7,664	6,301	6,365	4,863
	14.51	*15.52*	*14.14*	*22.78*	*18.81*	*18.17*	*26.06*	*26.53*	*22.37*	*22.01*
Systems total	13,179	10,972	11,379	19,671	16,591	17,736	29,411	23,752	28,453	22,095
	100	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*

Relative share of different components in net returns, labour employment and working capital investment on an average farming system

COMPONENT	Net return (Rs)	Human labour employment (mandays)	Working capital investment (Rs)
FIELD CROPS	12,196 (58.77)	307 (74.34)	6,901 (55.83)
ANIMALS	3,871 (18.65)	57 (13.80)	1,696 (13.72)
HOMESTEAD	4,685 (22.58)	49 (11.86)	3,765 (30.45)
SYSTEM TOTAL	20,752 (100)	413 (100)	12,362 (100)

Fig. 2: Average annual income by sources

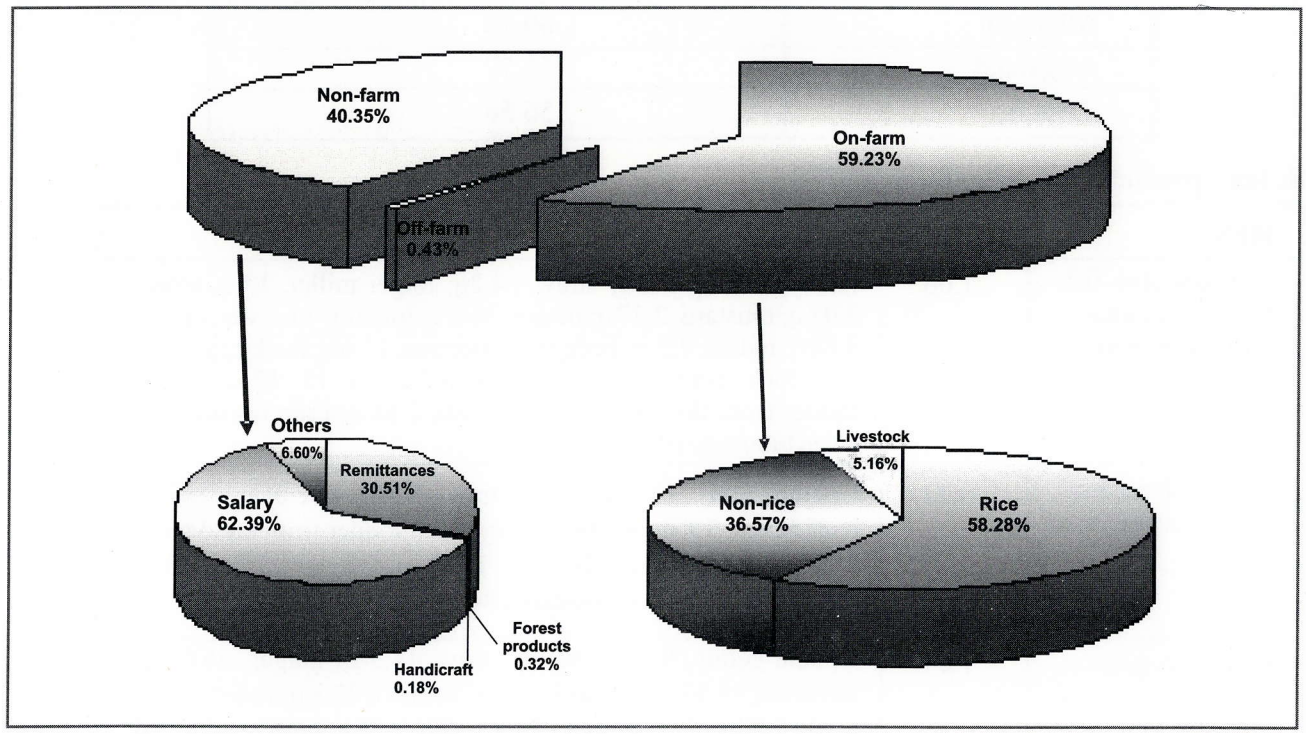

Table 6: Shifting cultivation in NE region

State	Annual area* under shifting cultivation (km^2)	Fallow period	No. of families practising shifting cultivation
Arunachal Pradesh	700	3-10	54,000
Assam	696	2-10	58,000
Manipur	900	4-7	70,000
Meghalaya	530	5-7	52,290
Mizoram	630	3-4	50,000
Nagaland	190	5-8	116,046
Tripura	223	5-9	43,000
Total	3,869		4,43,336

Research on Integrated Farming Systems

There has been far less research on integrated technologies for diversifying the livelihoods of small farmers in relatively less developed regions and increasing the sustainability of land use. Despite these weaknesses, the research agenda is gradually moving from a focus on individual crop performance to a growing acceptance of the importance of increased system productivity. This is viewed largely in terms of better-managed interactions among diversified farm enterprises, sustainable resource management, and improved targeting of technologies towards women farmers and poorer households.

Table 7: Integrated rice farming: share of rice in agriculture of NE region

State	Rice area (% to gross cropped area)
Arunachal Pradesh	49.38
Assam	62.34
Manipur	71.82
Meghalaya	62.95
Mizoram	60.18
Nagaland	55.77
Tripura	56.58

Table 8: Total productivity under different IIFS

IIFS	Area (ha)	Productivity / year *
Chicken-crop-fish-duck-horticulture along with hedge row on contour bunds	1.06	Paddy, 25.9 q; paddy straw, 34.2q; finger millet, 1.6q; straw, 8.07 q; mustard, 2.27 q; potato, 36.5 q; tomato, 4.6q; knol-khol, 3.64 q; radish, 9.2 q; hedge row biomass, 11.6 q; duck egg, 3410 no.; duck meat, 1.21 q *; dressed-chicken, 15 .12 q; Green fodder from the bunds, 35.2 q; Fish, 2.53 q; crop residue and weed biomass, 104.2 q.
Crop-fish-poultry-multi-purpose trees	0.97	Upland paddy, 13.6 q; paddy straw, 21.4 q; rice bean, 0.43 q; buckwheat, 3.8 q; potato, 28.5 q; green fodder from bund grass 25.0 q; egg, 5320 no.; Dressed, chicken, 0.82 q*; fish, 1.80 q; crop residue and weed biomass, 84.2 q.
Crop-fish-goat-multipurpose trees	1.04	Upland paddy, 9.04 q; paddy straw, 14.3 q; ginger, 36.06 q; turmeric, 30.92 q; mustard, 2.27 q; tomato, 22.8 q; radish 11.5 q green fodder, 23.8 q; meat, 0.35 q; fish, 1.06 q; crop residue and weed biomass, 91 q.
Crop-fish-pig-vermicompost - bamboo-multipurpose trees-hedge row-broom	1.05	Upland paddy, 8.85 q; paddy straw, 12.5 q; colocasia, 17.0 q; maize, 9.4 q; brinjal, 3.9 q; radish, 5.7 q; potato, 34.2 q; buckwheat, 1.1 q; meat, 1.95 q; fish, 1.68 q; hedgerow biomass, 3.6 q; green fodder from bunds, 12.8 q; vermicompost, 11.6 q; broom, 0.94 q and broom fodder, 1.79 q; crop residue and weed biomass, 98 q.
Crop- fish-dairy-mushroom-vermicompost-horticulture-hedge row	1.17	Upland paddy, 18.07 q; paddy straw, 28.5 q; green fodder from bunds, 52.5 q; fodder from jobs' tear millet, 5.6 q; liquid manure, 1629 litres; FYM, 90.60 q; mushroom,12.5 q; vermicompost, 5.4 q; milk, 3132 litres; hedgerow biomass, 14.8 q; green fodder fron bunds, 63.75 q; fish, 2.43 q; crop residue and weed biomass, 74 c
Crop-fish without integration (control)	0.95	Upland paddy, 9.6 q; paddy straw, 15.2 q; maize, 7.5 q; french bean, 21.4 q; fish, 0.7 q; green fodder from bund grass, 30.0 q; crop residue and weed biomass, 34.2 q

Commonly adopted farming systems in North-East

- Rice-fish integration
- Rice-poultry-duck integration
- Rice-fish-cattle integration
- Rice-goat-pig-fish integration
- Integrated fish-livestock farming

Research findings on the systems are available from AAU and ICAR Complex for North-East Hills Region, Barapani.

Table 9: Economics of integrated poultry-pig-fish farming

Commodity	Price rate (Rs/kg)	Under integrated system		Under non-integrated system	
		Quantity produced	Sale price (Rs)	Quantity produced	Sale price (Rs)
Pig	40/kg	228.4 kg	9,136	233.2 kg	9,332
Poultry meat	40/kg	27.6 kg	1,104	28 kg	1,120
Egg	1.5/egg	3,462 no.	5,193	3,325 no.	4,957
Fish	35/kg	318 kg	11,130	215.7 kg	7,549
Total return (Rs)		26,563		22,989	
Net return (Rs)		12,364		3,040	
Return to variable cost (%)		87		15.2	

Pond area/unit (no.) = 0.05 ha; pig/unit (no.) = 2 + 2 no.; poultry/unit (no.) = 20 no.

Table 10: Annual energy input or output pattern (MJ/year) in IIFS

IIFS	Total input	Total output	Output: input ratio
Chicken-crop-fish-duck -horticulture- hedge row	1,35,461	2,47,916	1.83
Crop-fish-poultry-MPTs	98,131	1,76,448	1.80
Crop- fish-goat -bamboo-MPTs	97,131	1,45,214	1.50
Crop-fish-pig-hedge row-MPTs-Verrmiculture	87,692	1,387,08	1.58
Crop-fish-dairy-mushroom-liquid manure-broom- horticulture- vermiculture	1,97,155	2,72,443	1.83
Crop and fishery (without integration)	70,983	87,352	1.23

Table 11: Monetary output or input patterns (Rs/year) of IIFS

IIFS	Total input	Total output	Output: input ratio (including labour component	Output: input ratio (excluding labour component)
Chicken-crop-fish-duck-horticulture-Hedge row	1,05,722	1,6,7331	1.58	2.24
Crop-fish-poultry-MPTs	60,137	90,625	1.51	2.12
Crop-fish-goat-bamboo-MPTs	59,442	91,880	1.55	2,40
Crop-fish-pig-Hedge row MPTs - vermiculture	77,243	1,09,887	1.42	1.86
Crop- fish-dairy –mushroom-liquid manure-broom-horticulture-vermiculture	1,70,120	29,8735	1.76	2.48
Crop and fishery (without integration)	31,773	34,894	1.09	1.50

Note: Input includes cost of labour, seed or planting material, concentrate feed, fish fingerlings, livestock or birds, farmyard manure, pond preparation, shed for livestock or birds and electricity charges. Output includes income from egg, meat, milk, dung, fish, farmyard manure, liquid manure, crops, crop by-product and green fodder.

Conclusion

- The task ahead is: To make the existing systems productive commensurate with increased demands for food, fodder, feed, meat, milk, fish etc. and to provide livelihood to increased numbers; and
- To suggest conservation measures and optimal use of natural resources available with the farming community for sustainable livelihood.

SOCIO-ECONOMIC COMPULSIONS, PROBLEMS AND IMPACT OF AGRICULTURE AND LIVESTOCK IN INTEGRATED FARMING SYSTEM IN NE

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The following considerations are important in determining the socio-economic compulsions and problems as well as the impact of agriculture and livestock under integrated farming system in the NE region.

1. The region receives high rainfall but the benefits from such high rains are not reflected in the overall cropping pattern. A greater part in most of the states is under monocropping, mostly rice. Rain-water conservation for its better utilization in non-rainy or draught period will help in increased cropping sequence, and cropping during winter (*rabi*) season.
2. Soil and water conservation, especially terrace cultivation on the hill slopes, is the most important scientific practice for realizing higher yields of crops with reduced soil and water loss.
3. The region is blessed with high rainfall with shallow water-table, which would prove a boon in valley areas, table-land etc., making available irrigation water for the second crop in *Rabi* and more than one vegetable crops during *rabi* or summer season.
4. Appropriate land-use planning to get the best from available land resources.
5. Since food security is uppermost in our mind, considering the need of foodgrains commensurate with population rise, sustainable efforts should be made for increasing the productivity of rice and other crops.
6. For improving the livelihood of the farmers and their farm income on year-round basis, crop diversification and integration of crops with livestock and fishes as a complementary activity is considered to be the most sustainable practice. Separate models could be developed considering the need of the farmers and the resources available with him, including socio-economic considerations.
7. The North-East region in general and shifting (*jhum)* cultivation in the area in particular should be targeted for promoting organic agriculture. Technology transfer and extension activities are important for promotion of agriculture.
8. Availability of quality inputs especially seed and fertilizer is the key to the success of increased productivity of agricultural crops. Availability of quality seeds in almost all crops including rice is the vital problem area in all the states of NE region. Adequate measures and sincere efforts have to be made for improving the seed sector in all the states.
9. Capacity building of the extension agents (official and non-official) is the great need of the region.
10. Improvement of marketing and storage infrastructure is important for giving a boost to the agricultural development and farmers' income.
11. Primary processing, processing for value addition and food processing are the key areas of development.
12. Scale of production through organized production.
13. Self-employment, agri-clinics and agri-business should be promoted through policy and financial support.
14. Credit supply and crop insurance for small farmers should be given utmost attention.

15. As per the need of the farmers` families, cattle, goat, pigs, yak, mithun, poultry, ducks, fishes etc. Should be promoted as per their requirement.
16. Forages and feed are the key to the success and for getting economic output. Cultivation and promotional activities should be supported with production of grasses, fodder crops and feed crops.
17. Human-resource development is essential for promoting integrated crop-livestock farming system.
18. Subsidiary and allied activities like apiculture, sericulture, lac-culture, mushroom cultivation, agro-based handicrafts, family-based minor food processing etc. along with agriculture will help in improving the livelihood of poor and small farmers.
19. Promotion of some of the crops like maize, soybean, ricebean, forage and feed crops in the context of crop-livestock integration will be quite useful in the overall improvement of farm productivity.

SESSION I: RECOMMENDATIONS

CONCEPT, PRINCIPLE AND IMPORTANCE OF INTEGRATED FARMING SYSTEM

At the end of Technical Session I, the following recommendations emerged through brain-storming discussion among the participants.

1. To address the issue of technology delivery in the present-day context, capacities of existing ICAR institutes and universities located in NE Region should be enhanced in terms of equipments and manpower.
2. Regional referral laboratory needs to be established in ICAR NEH Region to promote organic agriculture or animal husbandry
3. A regional consultative group needs to be established under the chairmanship of seniormost VC in the region, to frame education and development agenda in a partnership mode, to facilitate addressing of the farmers' issues and propagation of intensive integrated farming system models developed for the region by ICAR Research Complex.
4. North East Region imports large quantities of animal products from outside the region. Besides several other factors, higher cost of availability of feed is the main limiting factor. The region is agro-climatically ideally suited to produce maize and soybean–the two important components of animal feed. It is recommended that cultivation of these crops should be popularized in a mission mode with forward and backward linkages.
5. To improve the productivity and profitability of various components of farming systems like crop, animal, fishery etc., the availability of quality seed, planting material, fish seed, chicks etc. should be ensured. The region lacks the basic infrastructure to meet the requirement. It is recommended that systematic planned programmes should be undertaken and necessary infrastructure should be created.
6. For development of human resources, creation of awareness and development of technical skills in various aspects of production and rearing of various components of farming systems is a pre-requiresite to improve the productivity of the system. The scientists of KVKs should be given required training to serve as master trainers.
7. Research infrastructure in the region is extremely poor. It should be suitably strengthened.
8. The region receives high rainfall but the benefits from such high rains are not reflected in the overall cropping patterns. Greater part in most of the states is under monocropping, mostly rice. Rain *14*water conservation for its better utilization in non-rainy or drought period will help in increased cropping sequence and cropping during winter (*rabi)* season.
9. Soil and water conservation, especially terrace cultivation on the hill slopes, is the most important scientific practice for realizing higher yields of crops with reduced soil and water loss.
10. The region is blessed with high rainfall but the water-table depth is shallow. Shallow-water tube-wells will be extremely useful in valley areas, table-lands etc., making available irrigation water for the second crop in *rabi* and more than one vegetables crops during *rabi* or summer season.
11. For improving the livelihood of the farmers and their farm income on year-round basis, crop diversification and integration of crops with livestock and fishes as complementary activity should be considered as the

most sustainable practice. Separate models could be developed considering the need of the farmers and the resources available with him, including socio-economic considerations.

12. The North-East region in general and *jhum* cultivation area in particular should be targeted for promoting organic agriculture. Technology transfer and extension activities are important in this respect.
13. Subsidiary and allied activities like apiculture, sericulture, lac-culture, mushroom cultivation, agro-based handicrafts, family-based minor food processing etc. along with agriculture will help in improved livelihood of poor and small farmers.
14. Promotion of some of the crops like maize, soybean, rice-bean, forage and feed crops in the context of crop-livestock integration will be quite useful in the overall improvement of farm productivity.

SESSION II

SUB-THEME: MANAGEMENT OF NATURAL RESOURCES IN N.E. REGION THROUGH INTEGRATED FARMING SYSTEM OF AGRICULTURE AND LIVESTOCK

Chairman: Dr S. S. Baghel
Co- Chairman: Dr Dilip Kumar
Rapporteurs: Dr K. K. Jindal

Topic/Speaker:

(i) Watershed management for improved integrated farming: experience from central India Dr D.P. Singh, Vice-Chancellor, JNKV, Jabalpur

(ii) Conservation of crop bio-diversity in North-East India Dr S.K. Sharma and Dr M.K. Rana, NBPGR, New Delhi

(iii) Conservation of animal bio-diversity Dr S.P.S. Ahlawat, Director, National Bureau of Animal Genetic Resources, Karnal

(iv) Problems of feed-fodder and integrated plant nutrient management in North -East: Dr R.P.S. Ahlawat, Vice-Chancellor, Navasari Agricultural University, Navasari, South Gujarat

(v) Role of fisheries in overall development in N.E. Dr Dilip Kumar, Director, CIFE, Mumbai

WATERSHED MANAGEMENT FOR IMPROVED INTEGRATED FARMING IN N.E.: EXPERIENCES FROM CENTRAL INDIA

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The N.E. Region is characterized by high rainfall (2,000 mm) and suffers from soil erosion (1.3 million ha) with annual loss of top soil litter 46 tonnes / annum compared with the national average. It is also characterized by poor water-harvesting measures (0.88 million 42.5 top million), low irrigation intensity (20.74%), low cropping intensity (114%), predominantly rice based (except in Sikkim where maize is the dominating crop), non-cropping with very low fertilizer consumption (11 kg/ha). It has greater bio-diversity with highest forest cover (77% of the total area) with hilly, slopy and plain lands in the valley. It is also deficient in foodgrains, milk, meat, egg and fish. The following recommendations emerged based on this presentation.

1. There is need to follow soil and water conservation rigorously for sustainable progress in agriculture on watershed basis by adopting integrated farming systems approach. The upstream catchments should be kept under natural vegetation, followed by ponds in series to catch the water from up-streams in middle reaches with earthen embankments and also ponds in series in lower terrains to conserve maximum amount of water by utilizing the available resources in the locality. There is a need to put shallow wells open to irrigation in winter (*rabi*) season. Such successful experiments have been implemented in central India through peoples' participation with technologies back up from scientific community and NGOs.
2. The steep slopes may be utilized for silvi-pasturse and agro-horticulture system, whereas lower terrains may be utilized for rice-fish culture in rice fields and ponds. The livestock should be an integrated part of the system with the addition of small enterprises like mushroom, lac cultivation, backyard poultry, honey-bee and sericulture, depending on the choice of the family or location.
3. There is a great scope to diversify the area in horticulture, medicinal plants, vegetables, pulses (lentil), groundnut, soyabean etc. The *utera* cultivation (seeding in standing crops of paddy) of field pea, berseem etc. has been practised in central India, which may be tested in this region to increase the cropping intensity. *Brassica* niger is another crop requiring low water input, which may be tried in the area for honey-bee enterprise.
4. The under crops of turmeric and ginger with main crops of fruits have proved very remunerative in central

India, which may also be tested in this region.

5. There is a need to form SHG's or farmers' clubs with women empowerment and with full back-up in terms of training for post-harvest processing, value addition and marketing. Thus paradigm shift is needed in watershed-based integrated farming-system approach for sustainable progress in agriculture by following the steps in holistic manner.

CONSERVATION OF CROP BIO-DIVERSITY IN NORTH-EAST INDIA

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National Bureau of Plant Genetic Resources, New Delhi 110 012

North-Eastern India: basic facts

States	:	7
Districts	:	71
Villages	:	9945
Population	:	31.4 million
Geographical area	:	25.5 million ha
No. of tribes	:	120
Area in context of Indian subcontinent	:	6.06%
Population in context of Indian subcontinent	:	1.23%

Cultivation practices for self-dependence and food security

- Mixed farming
- Mixed cropping
- Maintaining highly adapted genetic and varietal diversity
- Growing such plant species in shifting cultivation *(jhums)* that are food sources for human and domestic animals
- Deriving nutrition from a large number of wild plants from their natural habitats

North-Eastern region
Its characteristic unique features are:

- A primary centre of diversity for rice, several minor millets particularly *Coix lachryma-jobi*, several cucurbits, tree cotton, banana and plantain, large cardamom and several medicinal plants.
- A secondary centre of diversity for maize, chow-chow, chillies (crops of new world) etc.
- A centre of regional (Asiatic) diversity for buckwheat, some minor millets, cucumber, *Momordica* spp., *Brassica* spp., rice-bean, citrus, *Sachharum* spp., many rhizomatous and tuber crops and bamboos.
- Besides cultivated crop species, a large number of plants being gathered for food, sustenance and health in the NE region exhibit rich diversity.
- Of the 326 species of wild relatives of cultivated plants reported to occur in India, at least 132 occur in the NE region.
- Secondary vegetation and open-forest habitats of disturbed sites constitute diversityrich areas.
- Species like *Musa*, *Amomum*, *Persimon* etc. also occur in dense forests.
- One of the hot-spots of diversity.
- Endemic richness of plant genetic diversity in:
    - Lushai hills, Tura, Balphakram and Khasi hills
    - Nagaland and Changlang
    - North Cachar
    - Darjeeling and Kameng

Table 1: Declared *in-situ* conserved areas in NE India

State	Geographical area (km^2)	Conserved area (*in situ*) (km^2)	% of the geographical area
Arunachal Pradesh	83,743	9,069	10.8
Assam	78,438	2,595	3.3
Manipur	22,327	225	1.0
Meghalaya	22,429	302	1.35
Nagaland	16,579	223	1.35
Mizoram	21,081	941	4.46
Tripura	10,486	769	7.33
Total	2,55,083	14,124	

* Declared *in situ* conserved area : 5.53%
* Dense forest cover: 88,633 km^2, i.e. 35% of the total geographical area in the region

Basic facts on NE medicinal plants

- Percentage of Indian flora in NE region : 43%
- Medicinal plant species in forest areas : 70%
- Remaining in non-forest land : 30%
- Harvested for marketing : 5%
- Threatened medicinal plant species : 10%

Richness of plant bio-diversity in NE India

PLANT DIVERSITY

- Total Indian flora: 17,000 species
- North-Eastern region flora: *Ca.* 7,000 species
- Endemic percentage: 43%

ECONOMIC PLANTS

- Bamboo: 78 taxa
- *Citrus*: 17 species and 52 varieties
- Banana: 18 species
- Aroids: 15 species and 200 cultivars
- Orchids: 693 species

CROP PLANTS

- Rice: 9,650 landraces
- Maize: 15 races and 3 subraces
- Beans: 12 types and 70 cultivars
- Brinjal: 10 species and 50 cultivars
- Yam: 20 species and 103 landraces
- Red chillies: 200 landraces

Institutes in NE India working on bio-diversity conservation

- NBPGR, Shillong (Plants)
- Botanical Survey of India, Shillong (Plants)
- Zoological Survey of India, Shillong (Animals)
- ICAR Research Complex for NEH Region, Umiam (selected crop plants)

- North-Eastern Hills University (specific plants and endangered species, ecological aspects)
- Botany Department, Gauhati University (Ethnobotanical aspects of plants)
- Life Science Department, Assam University (Home gardens conservation, medicinal plants, orchids, indigenous rice)
- Life Science Department, Dibrugarh University (Fish bio-diversity)
- Assam Agricultural University, Jorhat (Rice, citrus, banana, ornamentals)
- NRC on Orchids, Pakyong, Sikkim (Orchids and bulbous plants)
- Rain and Moist Deciduous Forest Institute, Jorhat (Tree species, bamboo)
- Institute of Bio-resources for Sustainable Development, Imphal
- Network project on Ginger (Turmeric)
- Central Agricultural University, Imphal, Manipur (Rice, *Capsicum*, *Allium* etc.)

Crop bio-diversity in NE India: some concerns

Changing ecosystem: Habitat destruction owing to forest clearance, mining, flash floods, land-slides, climatic changes and land-use changes.

Demography

- Total geographical area around 25.5 million ha; 90% people live in villages; 67 major tribes with groups and subgroups, 119 communities.
- Unchecked and continuous exploitation of natural resources as a majority of the population subsists on agriculture and surrounding natural resources.

High-yielding varieties and exotics: Genetic erosion as a result of high-yielding varieties, leading to loss of crop-bio-diversity.

Change in cropping pattern

Bun (vegetables on raised beds): Mostly in Meghalaya (Khasis).

Zabo (cereals on slopes or terraces): Mostly in Nagaland.

It leads to reduction in the number of species cultivation and hence less chance of genetic variability.

***Jhum* cultivation**

- Fallow cycles reduced from 20 years to 5-10 years.
- No chance of natural recovery of soil fertility.
- Many natural growing species, ecotypes, genotypes are lost every year.

Changing food habits

- Easy availability of other food items and change in taste.
- Reduction in primitive cultivars or semi-domesticated cultivars, or obsolete varieties, landraces etc.

Collection, conservation and characterization of crop bio-diversity: efforts of NBPGR

- Collections from 1985 to 2005
- Number of exploration trips: 150

  Total crop accessions collected : 17,452

  Cereals (4,958); pseudo-cereals (606); grain legume (2,192); oilseeds (1,059); tuber crop (1,209); vegetables (3,327); spices and condiments (1,607);
- Fibre crops (299); fruit crops (933); sugar crops (121) and miscellaneous (1,141) = 17,452.

Crop accessions characterized

- Crops include rice, maize, ricebean, ginger, turmeric, *Colocasia, Dioscorea,* chilli, *Perilla,* buckwheat and job's tear millet
- More than 2,000 crop accessions are characterized each year.

Germplasm distribution (1987 to 2005)

Indenters	:	10 per year (average)
Kinds of crops	:	8-10 (average)
Total accessions distributed so far	:	5,362

Crop bio-diversity conservation: strategies

Conservation of plant agro bio diversity

In situ	*Ex situ*	
	In field	**In laboratory**
Gene sanctuary Biosphere reserve Sacred grove On-farm conservation	Botanical garden Herbal garden Arboretum Field genebank	Seed genebank Cryogene bank *In vitro* repository DNA bank

***Ex-situ* conservation: NE specific (1978 to 2005)**

Long-term storage	:	4,793 accessions
In-vitro repository	:	206 accessions
Cryo-preservation	:	69 accessions
Field genebank	:	50 species (medicinal plants)

Table 2: Successful examples of activities in *in-situ* and *ex-situ* conservation

In situ	Establishment of *Citrus* gene sanctuary in Nokrek range of Garo hills
Ex situ	• Orchid sanctuary at Lessa, Arunachal Pradesh • Maintenance of various orchid species at NRC on Orchids at Pakyong, Sikkim and ORDC, Tipi, West Kameng in Arunachal Pradesh • Plantation of *Aquallaria agallocha* (aromatic plant) at Hojai, Nagaon, Assam • Introduction and multiplication of various medicinal plants by NEDFI at Khetri, Assam as well as in SFRI, Itanagar • Establishment of two regional genebanks with MTS facility at ICAR (NEH) and NBPGR, Umiam. • Establishment a bambusetum at ICAR (NEH), Basar, Arunachal Pradesh

Assam

Areas explored: Parts of Mikir hills, parts of Barak valley, Dhemaji and Lakhimpur districts. **Variability collected:** Rice (deep water and resistant to stemborer, BPH, BLB, GM) in Mikir hills,winged-bean, *Trigonella* sp., *Coccinea* sp., *Curcuma longa, Cucumis sativus,* ricebean, *Mangifera sylvatica*, amaranth (leafy types), *Syzygium*, *Artocarpus*, bamboos,*Terminalia, Michelia, Colocasia* sp. *and* minor fruits.

Arunachal Pradesh

Areas explored: Temperate regions of Upper Subansiri, South Siang and Dibang valley

Variability collected: Rice (cold tolerant, resistant), *Cucumis sikkimensis, Trichosantheis* sp., bamboos, *Citrus* species, *Coptis teeta,* orchids, *Prunus, Pyrus, Rubus, Illicium, Actinidia* and endangered medicinal and aromatic plants.

Mizoram

Areas explored: West Aizawl, Blue Mountain area and adjacent areas of Chittagong hill tracts

Variability collected: *Mangifera sylvatica,* wild relatives of *Camellia, Musa; Terminalia, Aquillaria, Dillenia, Toona,* bamboos, rhizomatous crops, coloured cotton.

Meghalaya
Areas explored: Ranikor, Maheshkhola and parts of Balphakram reserve forest
Variability collected: Rice (resistant to SB, GM, BLB), millets, *Cucumis sativus, C. hystrix, C. melo* var. *momordica, Amorphophallus bulbifera, Dioscorea alata, Nepenthes, Terminalia, Dillenia, Toona, Ensete, Phyllanthus* and other rhizomatous crops.

Manipur
Areas explored: Tamenlong and Chandel districts
Variability collected: Blackkernelled rice, *Cucumis melo* var. *momordica, C. sikkimensis,* mango (polyembryonic and dwarf types), *Musa bulbisiana, Parkia*, amaranth (stem type), leafy vegetables and *Perilla.*

Nagaland
Areas explored: Tuensang, Wokha and Mon districts
Variability collected: Rice, ricebean, millets, mango, maize, banana, bamboo, chillies, *Perilla*, various *Citrus* species, french bean, orchids and *Coix*

Tripura
Areas explored: All the districts of the state except West Tripura
Variability collected: Amaranth, *Cucumis* spp., ivy gourd, *Dioscorea alata,* indigenous brinjal, coloured cotton, *Dolichos* bean, *Vigna vexilata, Perilla, Terminalia, Dillenia, Toona,* ash gourd, wild *Musa,* bamboo, rhizomatous crops, wild relatives of guava and *Zizyphus,* orchids

Some constraints

- Insurgency activities and various political issues
- Tribes and their languages
- Inaccessibility to the remote areas
- Lack of concerted effort
- Lack of expertise in the relevant field
- Bio-piracy

Future thrust

- Extensive work on exploration, collection, evaluation and conservation of various crops of NE region is needed.
- Unexplored areas like Loktak lake need to be explored; explorations need to be trait-specific or for value-addition.

  Wild species of paddy, vegetables, fruits, horticultural crops, under-utilized fruits, vegetables, spices, ornamentals and medicinal and aromatic plants need more emphasis in collaboration with SAUs, Government organizations and NGOs.
- Programme of on-farm *in-situ* conservation needs strengthening.
- Research programmes need to be formulated on the basis of the knowledge of genetic erosion in the indigenous landraces.
- More efforts are required for medicinal plants and for development of packages of practices for their popularization and commercialization.
- Co-ordination among all the organizations associated with the conservation and utilization of crop bio-diversity.
- Human-resource development and need-based training required for actual stakeholders. Awareness generation campaign should be started to promote conservation and sustainable utilization of crop bio-diversity.

ANIMAL GENETIC RESOURCES AND THEIR CONSERVATION

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Traditionally India has been a mega bio-diversity centre, and rearing of domesticated animals was a practice here since time immemorial. Almost all the major livestock species including cattle, buffalo, sheep, goat, pig, camel, horse, donkey, yak and mithun are found in India. Apart from poultry, domesticated avian species such as duck, goose, quail, turkey, pheasant and partridge also exist in India. In domesticated species there are over 140 well-documented and defined breeds, whereas as per FAO watch list there are about 220 breeds. The existence of wild ancestral species of sheep like *Ovis musimom, Ovis orientalis* and *Ovis amon,* wild goats like Himalayan ibex, Himalayan tahr, Nilgiri tahr and markhor, wild yak (*Bos mutus*) and gaur (*Bos gaurus*)' red jungle fowl and land snow partridge in natural habitat further make this subcontinent a treasure of farm animal bio-diversity. Conservation of all forms of life has been the ethos of human society in India since ancient times.

North-Eastern region of India is identified as one of the hot spots of biological diversity, as an enormous wealth of flora and fauna has been sustaining here for centuries. Several livestock species have been evolved and this region has been the hub of domestication of several species. Yak has been domesticated in the northern Himalayan ranges in Tibet and areas bordering this Buddhist dominated area. Mithun (*Bos frontilas*) was domesticated in Chin hills in Indo-Myanmar borders. Wild Asiatic buffalo is still dwelling in the hills of Assam and other NEH states. Pigmy pig is endemic to this area, which is endangered. Several species of wild jungle fowl including red jungle fowl are found in this region. However, many of the indigenous livestock breeds of this region are in danger of extinction.

The major basis of maintaining such a large bio-diversity was the sustainable management of resources and their ecosystem. Further, this diversity in the genetic resource of livestock has been the integral component of Indian agriculture. Now it is well documented that indigenous livestock breeds should offer resistance to many tropical diseases. The greater tolerance to heat and water scarcity make them ideal germplasm for their wider use for production in hot and resource-poor agro-climatic zones besides their rich gene pool for introgression in high-producing breeds from developed countries.

Diversity in Animal Genetic Resources

Cattle: Cattle breeds such as Red Sindhi and Sahiwal, which have their breeding tracts in Pakistan and Tharparkar, for which we share the breeding tract with Pakistan, are available with a few institutional herds and private breeders. They should be further improved and conserved. Similar attention should be given to Gir, Kankrej and Ongole breeds of Gujarat and Andhra Pradesh. These should be utilized in grading up of non-descript cattle under harsh environments. Less-known breeds of cattle such as Punganur, Red Kandhari, Vechur, Doeni, Siri, Umblachery and Gangatiri need to be studied as genetic resource and steps should be taken for their conservation and improvement.

Buffalo: Murrah and Nili-Ravi are two most important breeds of riverine buffaloes in India. They need to be improved further. Other important buffalo breeds, viz. Surti, Jaffrabadi, Mehsana, Bhadawari, Nagpuri and Pandarpuri, need to be studied and improved through selection. Lesser-known breeds such as Kaziranga, Toda, Marathwadi, Sambalpuri, Kalahandi and Paralakhemandi would require extensive survey for their description and evaluation, followed by improvement and their conservation within their specific ecological niche.

Sheep: Of the 42 breeds of sheep, all the breeds of Jammu & Kashmir and other indigenous breeds like Pugal, Nilgiri and Garole need immediate steps for conservation. Garole sheep is known to possess the famous fecundity gene for litter-bearing capacity. Chokla is an important carpet wool sheep whereas Magra is known to produce the most lustrous carpet wool among all indigenous breeds.

Goat: Out of the 20 breeds of goats, Jamunapari, Barbari, Beetal and Surti are threatened by extinction and would need steps for conservation. These breeds have played an important role in genetic improvement of goats. Other breeds of goats like Black Bengal and Osmanabadi, known for higher reproduction rates, also need to be studied and improved for economical meat production. Changthangi goat produces one of the finest animal fibres (Pashmina).

Feral island goats of Andaman and Nicobar Group of Islands are also known as saline goats for their ability to thrive on sea weeds and water.

Camel: In addition to 4 important breeds of camel, viz. Bikaneri, Jaisalmeri, Kuchchi and Mewati, there are less-known breeds such as Malvi., Marwadi, Mewadi, Sindhi and Shekhawati. There is a need for proper description, evaluation, conservation and improvement of these breeds. Double-hump camel of Nubra valley in Ladakh is endangered, with less than 100 animals.

Horse: Little efforts have been made for description and evaluation of indigenous breeds of horses and donkey. Breeds like Marwadi, Kathiawadi, Zanskari and Spiti are some important, which would need immediate attention for conservation and improvement. Manipuri pony is a light sports animal. Nothing is known of genetic make-up of donkeys in India, in spite of their large variation in phenotypic characters and still being one of the best beasts of burden. There is a need to conduct a survey for description and evaluation of different types of donkeys available in the country.

Pig: There is a large variation in pigs, as reflected in size, colour, performance etc. The Ankamali pigs of Kerala and Ghori pigs of north-eastern region have been described to some extent in recent years. There is a need for proper description and evaluation of these types and steps need to be taken for their conservation and improvement.

Yak: Yak is a multi-purpose high-altitude bovine. Yak is found in all the states bordering Tibet in India, like Ladakh region of J & K; Kinnaur, Spiti and Chamba districts of Himachal Pradesh; Sikkim and Arunachal Pradesh in north-eastern parts of the country. There are differences in size and reproduction performance of yaks located in different regions. These differences need to be studied and utilized in conservation.

Mithun: Mithun is also known as the sacrificial ox of India. Some studies with respect to their physical conformation and performance as well as the pattern of domestication have been conducted. There are differences in size of mithuns found in different parts of north-eastern States. Studies for description and evaluation of these types should be undertaken.

Poultry: A number of species of poultry, viz. chicken, ducks, Guinea fowl and quail, make important contribution to food and income. There is large genetic variation in these species, which are required to be characterized and utilized for improvement and their conservation. There are 18 breeds of indigenous poultry known, of which Aseel, Kadaknath, Kashmir Favourella, Miri, Ankheshwar and Punjab Brown are still available in good numbers, and efforts should be made to conserve them and document the other listed poultry breeds of the country.

Pet animals: Description and evaluation of indigenous and exotic breeds of pet animals (dogs, cats and birds) need to be undertaken and their improvement requires immediate attention, as these species are becoming very important as pet animals for household and other useful purposes for policing, defence and other duties.

Strategy for Conservation of Livestock Bio-diversity

The traditional methods of animal conservation are still very important, yet new approaches are emerging to meet the growing challenge of saving the native germplasm from becoming extinct. These may include keeping a representative population of the breed *in situ* as well as *ex situ*. The bio-technological tools developed in recent years can be effectively used for the conservation of livestock genetic resources in India.

A number of methods have been used for conservation of livestock-genetic resources. These include *in-situ* conservation of the breeds or populations; and cryopreservation of semen, ova, embryos and skin, blood, DNA fragments etc. These methods are relevant when the breed is rare or near extinction. In India the situation is not so acute as to call for large-scale *ex-situ* conservation efforts. What is necessary, however, is technology evaluation and perfection at selected institutions, which can be used whenever and wherever required. The action programme should focus on the following aspects for the conservation of bio-diversity in domesticated livestock.

1. The livestock census should be breed-wise, and all the breeds should be identified.
2. Breed description and characterization of all the breeds should be carried out to understand their unique

qualities and potential contributions.

3. To prioritize the breed for characterization and conservation.
4. Participation of farmers and stackholders should be ensured in breed conservation through breed societies or associations.
5. Creation of database on indigenous animal-genetic resources.

ROLE OF FISHERIES IN OVERALL DEVELOPMENT OF NORTH-EAST REGION

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Role of Fisheries

Aquaculture and fisheries

- Possibility of integration with other farming practices
- Agriculture
- Livestock
- Forestry

Available potential

- Capture fisheries: rivers and streams, beels and lakes, reservoirs, flood plains
- Ponds and tanks

Potential to contribute to

- Livelihood development
- Food and nutritional security
- Equitable development

Fisheries sector

- Over 300 species of fish
- Fish: a preferred food
- Adequacy of natural resources
- Community-oriented local society
- Consumption of processed products

Why integration?

- Availability of underutilized local resources
- Optimization of resource use
- Better profit margin
- Spreading risk

Integration potential

- Traditional integration models
- Community pond
- Domestic animals or crop system
- Livestock, horticulture, rice
- VAC system or homestead ponds

Challenges

- Capture fisheries
- Depleting production
- Destructive fishing
- Degradation of ecosystem
- Lack of enabling policy
- Lack of services support
- Lack of seed

Aquaculture

- Lack of promotion of location-specific technologies
- Lack of local availability of quality seed

- Inefficient service-delivery system

Recommendations

- Low-cost integrated, homestead-based aquaculture
- Co-management approach for sustainable use of capture-fisheries resources
- Integration of extension services system
- Action research
- Capacity building of KVKs or State departments

SESSION II: RECOMMENDATIONS

MANAGEMENT OF NATURAL RESOURCES IN N.E. REGION THROUGH INTEGRATED FARMING SYSTEM OF AGRICULTURE AND LIVESTOCK

After brain-storming discussion, the following recommendations were evolved.

1. There is need to follow soil-and water-conservation measures rigorously for sustainable progress in agriculture on watershed basis, by following integrated farming-system approach. The upstream catchment should be kept under natural vegetation, followed by ponds in series to catch the water from upstreams in middle reaches with earthen embankments, and also from ponds in series in lower trends to conserve maximum amount of water by utilizing the available resources in the locality.
2. The steep slopes may be utilized for silvi-pasture and agro-horticulture system, whereas the lower trends may be utilized for rice-fish culture in rice fields and ponds. The livestock should be the integrated part of the system with the addition of small enterprises like mushroom, lac-cultivation, backyard poultry, honey-bee and seri-culture, depending on the choice of the family or location.
3. There is great scope to diversify the area, particularly in medicinal plants, vegetables, pulses (lentil), groundnut and soybean etc. The *utera* cultivation (seeding in standing crops of paddy) of field pea, berseem etc., which has been in practice in central India, may be tested in this region for cropping intensity. *Brassica* niger is another crop requiring low water input, which may be tried in the area for honey-bee enterprise.
4. The under-crops of turmeric and ginger, with main crop of fruits, have been very remunerative in central India and may be tested in this region.
5. There is need to form SHGs or farmers' clubs with women empowerment and full back-up in terms of training for post-harvest processing, value addition and marketing. Thus a paradigm shift is needed in watershed-based integrated -farming approach for sustainable progress in agriculture, following steps in holistic manner.
6. Extensive work is needed on exploration, collection, evaluation and conservation of various crops of NE region.
7. Unexplored areas like Loktak lake need to be explored; explorations need to be trait-specific or for value-addition; wild species of paddy, vegetables, fruits, horticultural crops, under-utilized fruits, vegetables, spices, ornamentals, and medicinal and aromatic plants need more emphasis in collaboration with SAUs, Government organizations and NGOs. The programme of on-farm *in-situ* conservation needs strengthening.
8. Research programmes need to be formulated on the basis of the knowledge of genetic erosion in the indigenous landraces.
9. More efforts are required for medicinal plants and for development of packages of practices for their popularization and commercialization.
10. Co-ordination is necessary among all the organizations associated with the conservation and utilization of crop bio-diversity.
11. Human-resource development and need-based training should be undertaken for the actual stakeholders. Awareness-generation campaign should be initiated to promote conservation and sustainable utilization of bio-diversity among crops.
12. Indigenous livestock of NEH region needs to be surveyed and characterized both at phenotypic and molecular level, particularly for Manipur pony, Banpala sheep, and Dam and Mali pig.
13. Wild Asiatic buffalo, which is progenitor of riverine buffalo, needs to be conserved *in situ*.

14. Indiscriminate cross-breeding should be banned, since it is causing severe threat to the bio- security of the indigenous breeds.
15. Non-descript native cows should be upgraded with either Sahiwal or Gir.
16. Backyard poultry should be encouraged and model backyard poultry farms should be established by KVKs in their influence area.
17. The state should develop regional livestock databank, so that species-wise breeding policy can be framed with the help of NBAGR. Livestock management in North-East region is, by and large, nomadic except in the plains and hence the contribution from this component in the farmer's income is much lower than that in the central plains of India. To tackle this problem there is need for government intervention.
18. Credit availability should be facilitated at low or zero interest rate for land development, viz. for contour bunding, terracing and other soil-and water- conservation measures.
19. Regulated markets and processing facilities should be established for all the livestock products.
20. Strong network of research and extension should be created.
21. Low-cost, integrated, homestead-based aquaculture should be developed.
22. Co-management approach for sustainable use of capture fisheries resources is necessary.
23. Integration of extension services system is the need of the hour.
24. Action research needs serious attention.
25. Capacity building of KVKs or State Departments needs early attention of planners.

SESSION III

SUB-THEME: GENERAL DISCUSSION ON UNIVERSITY PROBLEMS AND SHARING OF EXPERIENCES

Chairman: Dr R. N. S. Gowda
Co- Chairman: Dr Manmohan Singh
Rapporteurs: Dr N. Iboton Singh
Dr Nabachandra Singh

Speakers: All participants

SESSION III: RECOMMENDATIONS

GENERAL DISCUSSION ON UNIVERSITY PROBLEMS AND SHARING OF EXPERIENCES

The following recommendations emerged after a brain-storming discussion:

1. Identify the issues as ICAR and non-ICAR issues.
2. Letter to be addressed for adopting the Model Act.
3. Enhancement of RAWAE and Internship for Agriculture and Veterinary standard under consideration in the ICAR should be pursued for early orders.
4. Resource crunch faced by the ICAR and IAAU should be taken up with Planning Commission for perennial flow of funds.
5. NET conditional advertisement may be given for recruitment in SAUs.
6. KVKs should remain exclusively as knowledge centres, and the State Government or the Line department should take up the extension activities.

SESSION IV

SUB-THEME: ROLE OF WOMEN IN AGRICULTURAL DEVELOPMENT OF N.E. REGION

Chairman: Dr S. P. Tiwari
Co- Chairman: Dr Nem Singh
Reporteurs: Dr J. M. Laishram
Dr Shiv Datt

Topic/Speaker:

(i) Role of women in integrated-farming system of agriculture and livestock, particularly in N.E. region: Prof. C.S. Chakrabarti, Vice-Chancellor, WBUAFS, Kolkata.

(ii) Integrated systems of Agriculture and Livestock in tribal areas, and scope of improvement and modernization for their upliftment: Dr R.N.S. Gowda, Vice-Chancellor, KVAFSU, Bidar

PARTICIPATION OF WOMEN IN INTEGRATED FARMING IN LIVESTOCK SECTOR

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West Bengal University of Animal and Fishery Sciences, Kolkata 700037

BASIC CONCEPT OF INTEGRATED FISH FARMING

The basic concepts involved in this type of integrated farming are the utilization of synergetic effects of interrelated farm activities and conservation, including full utilization of farm wastes. The farm wastes applied in the fish pond are decomposed first by different available bacteria and then the nutrients like N P and K are released into the water, which make the pond water fertile for production of phytoplankton through photosynthesis.

After manure application, in addition to organic detritus, usually two feed-chains are formed, one from heterotrophic bacteria and another from autotrophic algae. These feed-chains overlap with each other, producing natural fish-feed organisms like plankton, different benthos and detritus, and thus set up a natural feed web for various species of fish with different feeding habits. Thus different fish species find a suitable niche, and as per their feeding habit they enjoy the whole pond water, leading to their proper growth.

ADVANTAGES OF INTEGRATED FARMING

There is a great advantage in integrated farming system. First, more than one crop can be obtained easily from the same area within a particular time, resulting in saving of space and time. Secondly, wastes can be properly utilized within the different components of the system as feed and fertilizer, resulting in 40-50% saving in cultural aspects like purchase of feed and fertilizers or manures. Thirdly, the waste material of one component is very usefully utilized for the production of another component. Fourthly, it checks environmental pollution. It is well established that waste water-fed aquacultures have checked aquatic as well as environmental pollution in many ways. Thus, the integrated aquaculture can be treated as eco-friendly aquaculture. Edwards (1993) strongly recommended the adoption of semi-intensive integrated farming system for its low impact on the environment, low cost of fish production and its protein-production efficiency than any other system.

DIFFERENT TYPES OF INTEGRATED FISH FARMING

There are mainly three types of integrated fish farming, which are widely accepted throughout the world, viz. (i) fish-cum-livestock integration, (ii) fish-cum-crop integration, and (iii) fish, crop and livestock integration.

FISH-LIVESTOCK INTEGRATION

In this integration the wastes from livestock animals are used in the fish pond as fish feed and manure. The

acceptable livestock components integrated with fish are pig, duck, cattle, goat, chick, sheep, goose, rabbit and keed.

FISH-PIG INTEGRATION

Pig-fish integration is the best of its kind, since this is economically viable for Indian conditions. In this system pig manure (pig dung and urine is used directly or indirectly after decomposition in a pit) is into the pond or applied to the pond in a specific dose regularly. The pig dung acts an excellent pond fertilizer and increases the primary productivity of the pond water and consequently increases fish production through recycling of organic wastes from one farming system to another without any environmental degradation.

Further, to some extent the wastes are directly consumed by fish, because the pig excreta contains 70% digestible food particles for the fish, and through another route (indirectly) the wastes can be upgraded as a substrate for growing intermediate organisms like worms, insects and fishes, which are subsequently utilized by fish as fish-food organisms. No supplementary fish feed or pond fertilization is required in this system. The expenditure on fish culture is greatly reduced, because the pig excreta acts as substitute for fish food and pond fertilizer, which accounts for 60% of the input cost in fish culture.

PIG-HUSBANDRY PRACTICES: One aspect of this problem is the use of pig waste as manure.

The objective of this type of fish-animal integration is to use the organic waste fish feed or fish-pond manure to obtain high yield of fish. In this integration, pigs are preferably reared on the bank of the pond. The sty generally is built on the bank of the pond and provided with a floor sloping towards the pond for drainage of the excreta into it. There is report that another type of sty may be constructed over the fish pond. Typically the structure is supported on wooden stills over the pond and provided with a satlice-type floor, which permits the excreta and uneaten food to fall directly into the pond water, requiring regular washing of the pond. But experience suggests that the pig pens and fish ponds should better remain separated, because when housed directly over the pond the humid conditions encourage respiratory problems and farrowing difficulties in pigs. In addition, housing over the ponds can limit the use of chemicals for cleaning and medical purposes.

DUCK-FISH INTEGRATION

Combined duck-fish culture has been widely practised in the Far East and Eastern Europe, especially Hungary. Leads to higher fish yields as well as improved feed conversion and reduced fat content. Integration with ducks. This raising of ducks, and fish in the same pond is more rational compared with any other system, because the pond can provide living and foraging area for the duck as well as for the fish.

Two methods of raising of duck with fish have been reported. One is extensive raising, in which only a small amount of supplementary duck feed in provided and the number of ducks is limited, resulting in lower yield of fish due to insufficient duck manure to fertilize the pond. The second is intensive raising, in which the ducks are fed at the same rates as on land and stocked at a higher density per unit of pond area, resulting in availability of higher amounts of duck dropping in the pond to make the water fertile, which leads to production of sufficient natural food for the fish.

Further, some amount of uningested duck feed is also loaded in the fish pond, and subsequently higher yield of fish can be obtained in the system. This method is very popular in Africa, where duck-stocking densities are 1,000-25,000/ha instead of 150-500 ducks/ha under extensive raising practised in Europe. An intermediate practice of these two methods has been evolved as semi-intensive method. Here the ducks are raised a 300 to 1,000/ha of water area, and this method is suitable for Indian conditions.

FISH-AGRICULTURAL CROP INTEGRATION

It is believed that integration of fish with agricultural crop is an age-old practice and still exists in some parts of India.

Small amount of fishes are always caught from rice field and the number increases during rainy season. It probably gave rise to the practice of deliberate stocking and harvesting of fish from the field used for agricultural crop production.

In rice-fish farming the main crop is rice; hence the culture practice for fish in rice field is to be modifed according to the field pattern. Ditches, canals and field the height of bunds have invariably to be constructed for ideal paddy-cum-fishery. The after water level in the rice-field should be maintained at least 30-35 cm for growing fish along with paddy. In areas where the water supply is not sufficient, this type of integration is not possible. Further, rice takes hardly 100-120 days to complete the production, but this time is not sufficient for growth of fish to a marketable size.

CATTLE-FISH INTEGRATION

Cattle-fish integration is also an old practice in Asian countries like China, Taiwan, India, Indonesia, t Philippines and Bangladesh. The poor and small farmers generally use cattle-dung in their ponds to fertilize t pond water as well as to get higher fish production. The waste production from cattle farming alone in India has be estimated to be more than 4,000 million tonnes per year. It has already been established that cow-dung is mo stable, cheaper and favaourite organic manure used extensively for pisciculture. It is also the safest and is most favoured by the fish. The cattle is a ruminant and has specialized system of repeated grinding and digesti decomposition of food, catalysed by a good number of micro-organisms in the rumien. The suspensibility of catt manure not only enables the fish to get more feed but it also reduces oxygen consumption and avoids formation harmful gases. It has also been shown (Anonymous 1993) that five cows can produce 9,500 kg milk along with 3 kg fish/ha/year with a net profit of Rs 63,250. The North-West plains of India have the greatest potential for cattl fish integration.

Similar to pig stys, cow-sheds may also be constructed in the vicinity of fish ponds, and the waste or the slur from the bio-gas plants may be drained into the ponds. Thus it has been estimated that one adult cattle can provi manure and feed for a fish pond of 0.13 ha of water-spreading area.

SHEEP OR GOAT-FISH INTEGRATION

Use of sheep or goat dung and urine in aquaculture is not common. No systematic attempts so far have bee made at field level to harness this resource for aquaculture. But it has been proved that sheep and goat excre contain high levels of nitrogen (3%), phosphorus (1%) and potassium (2%), with low moisture content (68%). Th sheep and goat dung are most stable and do not pose any serious risk in pisciculture. As they feed on green leaves an fodder, their excreta are rich in NPK. Thus the excreta of sheep and goat can be used to fertilize the pond water an feeding fishes to some extent. Most of the rural people of India possess both sheep and goat in domesticated form They give birth to 4-6 off-springs at a time at least twice a year.

POULTRY-FISH INTEGRATION

In the present-day aquaculture, poultry-fish integration has become a unique venture, which provides high extra income. It is quite simple and is economically viable, especially for rural development, because this type integration makes available a cheap source of protein for the rural population.

About 80% of the Indian population lives in rural areas and most of them are under -nourished and need not onl protein from animal sources but also some avenues of employment generation. Due to small land-holdings, the rur farmers possess some livestock animals in the form of a few heads of cattle, pigs, ducks and chicken, which are use as ready source of money during their hardships. Hence in this context integrated farming is popular, but it should b more scientific to derive greater income from this system.

INTEGRATED SYSTEMS OF AGRICULTURAL AND LIVESTOCK IN TRIBAL AREA AND SCOPE OF IMPROVEMENT AND MODERNIZATION FOR UPLIFTMENT

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Tribal populations are concentrated in most of the hilly areas of the country. More than 15 states could b identified with the type of spread of tribal people, particularly Assam, Chattisgarh, Himachal Pradesh, wester ghats of Karnataka, Andhra Pradesh, Kerala and North-Eastern states of Arunachal Pradesh, Assam, Meghalaya Manipur, Mizoram, Nagaland and Tripura.

The underprivileged and tribal population with nomadic culture generally increases with time, and spread gradually in these states, requiring their social upliftment. The shyness of the people, shortage of technical skill i agriculture and allied farming, primitive agro-economic system, high rainfall, frequent floods and soil degradatio are all contributory factors for hindrance of their growth.

Features of livestock-production systems of underprivileged families area

- Mixed farming system and diversified crop and livestock activities are common.
- Low external-low output and highly internalized system, making maximum use of available resources like crop residues, feed, labour, animal waste etc.
- Extensive grazing with limited supplementary feeding in semi-arid areas and limited grazing or semi-stall feeding in other areas.
- Local breeds of livestock or poultry preferred over improved stock as a part of risk management, except where there is organizational support.
- Traditional system of livestock management and feeding is preferred and adoption of scientific recommendations is very low.
- Livestock output is low but represents a major share of daily cash income to the family.
- Women play a major role in livestock production and sale of produce.

Table 1: Characteristics of crop-livestock regions in India (1990-2000)

Characteristic	North	South	West	East	North-East
Human population (million)	231	220	279	222	22
People below national poverty line (%)	25	18	25	38	22
Major agricultural activity	Wheat, paddy, buffalo, cattle	Paddy, coarse, cereals, fruits, cattle, buffalo	Wheat, coarse, cereals, pulses, cattle, buffalo	Paddy, wheat, Vegetables, cattle	Paddy, vegetables, fruits, cattle
Irrigated area (%) in arable land in 2001	63.5	28.2	22.3	35.0	10.4
Crop value (%) in agriculture	71.6	78.3	76.4	76.9	80.6
Livestock value (%) in agriculture	28.4	21.7	23.6	23.1	19.4
Density/1,000 human population in 1997 Bovines	308	238	374	315	361
Ovine	121	197	243	228	119
Poultry	188	668	238	349	920

Note: LU=Livestock unit
North: Haryana, Himachal Pradesh, Jammu & Kashmir, Punjab and Uttar Pradesh; South: Andhra Pradesh, Karnataka, Kerala and Tamil Nadu.; West: Gujarat, Madhya Pradesh, Maharashtra and Rajasthan.; East: Bihar, Orissa and West Bengal; and North-East: Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura

Sources: Government of India (1999-2000, 2004), Rao *et al* (2004)

In India 70 to 80% of the total livestock produce is contributed by the underprivileged families, and livestock are central to their livelihood and culture. Hence to improve the livelihoods of these underprivileged families we need to understand their way of life, livestock-production systems and their perception about the role of livestock in their livelihoods.

Who are underprivileged?

From economic perspective, they are classified according to the use of land holdings, viz. landless, marginal farmers and small-holder farmers, who are categorized as below-poverty line (BPL families), described by the Government, as scheduled or backward castes, scheduled tribes and pastoralists. Within each category there are

many social groups in the country.

India is blessed with large livestock population, regarded by some as an asset provided in plenty by nature and b others as a burden. Since 1971, when poverty eradication become the main theme of development planning livestock production has been recognized by the Indian government as important tool for poverty alleviation wit adequate funding in R & D programme. These include Dairying, Small ruminants, Traditional poultry production Quail farming and Pig farming. These models were developed on the basis of western programmes, but the emerged with mixed or varied results owing to adoption of technology unsuitable to local conditions and inability t select appropriate interventions and approaches to reach the poor farmers in effective manner. However, Thoma and Rangnekar (2004) pointed out that the resource-poor farmers have to overcome technical, economical an social constraints to derive benefit by increasing the demand of livestock products and compete with commercia producers.

The population of underprivileged families varies considerably between and within the states. For example, th percentage of population represented by underprivileged families ranges from 19 to 32% in Andhra Pradesh, 8 t 49% in Gujarat, 25 to 65% in Orissa and 14 to 16% in Rajasthan.

Tribal production system

Many studies carried out by Rangnekar (1992, 1996, 1999) on livestock and poultry production by tribal women of Rajasthan and Gujarat indicated that their animal-and poultry-management systems as well as the perception an priorities are different from those of non-tribal farmers. Their production is "low input-low output system". Mos tribal families own livestock (small or large ruminants), many of them having a mix of species and most of these are non-descript. Backyard poultry-keeping is also very common among the tribals. However, many families now own improved animals because of several developmental programmes of the government. Most of these animals are grazed outside in their fields or nearby forest; however, it is a common practice to keep the animals in houses a night. Supplementary feed is offered only to productive animals and this is made up of locally available home mix. Among the tribal families, the contribution of menfolk in livestock production is minimal and the women are responsible for production as well as marketing activities. Thus the women are overburdened and have to manage the activities within resource and time constraints (a majority of tribal families are resource poor and organizational support to them too is lacking). However, in some areas NGOs and Government organizations (GoS) have developed village-level organizations, which provide services, whereas in many areas these still remains out of the main stream. Although livestock and backyard poultry make a major contribution to family income and nutrition, a majority of the women are not willing to keep more number of animals or birds in view of limitation of resources and time. They are also not willing to keep improved animals or birds with high production potential, because these are considered risky. The tribal women prefer assured subsistence to risky high productivity.

Livestock in livelihood of families in North-Eastern states

Under conditions of relatively small land: human ratio and low agricultural productivity in almost all tribal areas, animal husbandry forms a complementary source of employment and livelihood. Its impact is however marginal due to lack of quality breeds, feed and fodder, and animal health-care.

Dairying is an enterprise in north-eastern region. Livestock in this region comprises cattle (3.3 million), buffalo (0.2 million), sheep (0.9 million), goat (1.07 million) and pig (1.43 million). In the hills draught power is used for tilling soils, and many tribal populations are not accustomed to rearing of crops for feed and fodder. Absence of commercialized livestock farming is another problem.

Mithun (Gravaeus frontalis) is a large ruminant confined to north-eastern region. The animal is very selective in geographical distribution in some parts of Arunachal Pradesh, Manipur and Nagaland. Another important animal of this region is yak. Yak and mithun, referred to as ship of highland area, are good examples of integration of agro-ecology, sustenance livelihood, culture and livestock rearing. These animals are of special importance in the hills at an altitude about 2,000 above main se-level and are considered almost sacred in view of their ability to survive those harsh climates and for their multiple use.

According to Prasad (1993), livestock production fits well with socio-economic and agro-ecosystem of the region, and livestock-based farming system has great relevance for the region. According to him, livestock based farming can also improve the family income substantially. He pointed out that good-quality forage could be a constraint to improvement in productivity; however, there is vast potential to fit forage crops in agricultural system of eastern region. The number of potential niches identified for forage production in the hills for cropped and non-

cropped lands includes growing of grasses and trees along the terrace risers or bunds and farm bunds, developing horticulture-patrol system, growing of high-density maize and rice-bean and thinning them to get fodder and allow green production as use as development silvipastures on wasteland etc. He also recommended that production of farmyard manure should be initiated and biog as system should be introduce for proper use of the waste matter.

Integrated farming

Integrated farming of crop, livestock, poultry, piggery and fish farming is important for this region.

Paddy-cum-fish farming

Fish-culture practice followed in the integration of paddy-cum-fish farming is the composition of fish culture system in semi-intensive way. Paddy-cum-fish farming along with shifting cultivation is the normal practice in North-Eastern states.

Raising of carp fish in paddy field and their culture during monsoon months in brakish-water paddy showed promising results. Raising of Indian carps has been successful at an altitude of 5,000 feet in Apatani plateau in Arunachal Pradesh (Sinha, 1985).

Pig-fish farming

Raising of pig can be combined with fish culture by constructing animal-housing unit on the pond embankment, to transport the pig waste directly into the pond, where the dung acts as excellent pond fertilizer and raises the biological productivity of the pond and consequently increases the fish production of the pond.

Ducks

Duck farming is very popular among tribal as a profitable backyard enterprise, because average egg production from ducks is higher than from local fowls. They have great foraging capacity and they produce bigger eggs.

Dairy animals

Raring of buffaloes and cattle in this region is simple, because of scavenging nature in the forest region with low input cost. The estimated productivity of the region per lactating animal (1.03 litres/day) is much lower than the animal average (2.91 litres/day). This region also has the largest number of non-descript animals in the country, among the population predominantly of the tribal and the socially and economically deprived groups. The dairy-developments programmes have not received prominence in this region. Development of poultry and small ruminants emerged as an important animal husbandry activity here because of the acceptability of poultry and goat meat in this region. The advent of stall-feeding technology for production of goats provides scope to generate employment opportunity to tribal and rural poor.

Poultry

Poultry is not performing well because of high cost of production as well as of feed. Therefore in this area growing of maize helps as mixed farming to reduce the cost of production and to earn more profits.

Absence of an integrated approach to deal with animal health in this area is largely hindered by mortality and morbidity, causing huge loss to the farmers. Hence for control of many infectious diseases, proper vaccination is essential in this area.

Requirements of a model

Scope for improvement or implementation of a model in a new area requires the following conditions.

- Review and analyze the existing knowledge and technology followed by adaptation and development of technologies suitable for the local conditions.
- Ensure that the competencies of the professionals within the implementing organizations are of the highest standard.
- Explore the opportunities for developing skills of the professionals, enabling them to generate demand-driven services and the associated transfer of know-how.
- Ensure that inputs are timely available at competitive prices.
- Ensure that suitable breeds are available or being made available, preferably using local germplasm.
- Appropriate technology for collection, storing and marketing of products and by-products has to be available.
- Ensure that quality feed and feed ingredients at competitive prices are available.

- Ensure that the training of beneficiaries is standardized for training materials and methods and that it has a high standard.
- Policy implications demand the implementation and sustainability of the programme.
- Community-based interventions for poverty reduction should identify the available assets and address the constraints initially, using the owners' own resources.
- Policy-makers should recognize livestock as an important tool for poverty alleviation.
- The programme and project planning and the implementation process should specifically ensure the inclusion of the poor, marginal and ultra-poor, with special emphasis on women.
- There should be clear-cut definition for the responsibility of government organizations, NGOs and the private sector for implementation of pro-poor programmes.
- There should be accountability and transparency of the services and supplies regarding quality and quantity.
- Staff technical and micro-credit staff should preferably be separated to avoid that NGOs are favoring short-term interest.
- Ensure that more female extension workers are available for knowledge and technology transfer to poor women.
- Disparity in the interest rate among the NGOs should be removed and a uniform 4% flat rate should be applied.
- To reduce the risk and vulnerability for the poor, there should be provision for insurance schemes covering national calamities.
- Appropriate marketing facilities should be introduced and promoted in the programme area.
- Monitoring and evaluation systems including quality assurance should be built within the programme.

SESSION IV: RECOMMENDATIONS

After threadbare deliberations, the following recommendations were evolved.

1. In the complex, diverse and resource-poor type of agriculture in the North-East, the role of women is significant and needs to be promoted further, especially for skill-based cottage industries and homestead farming components.
2. A number of simple devices suitable for women's stature have been developed for crop production and processing in the NE region, which need to be developed and extended for adoption.
3. There is need to integrate the crop, livestock, fish etc. in need-based integrated system involving tribal population and women. An integrated system based on eco-bio-geographical and socio-economic and location-specific criteria should be developed.
4. After morphological and ecological assessment, genetic assessment and indigenous bio-diversity should be undertaken with sincerity and devotion. This is necessary to protect our genome before indiscriminate and unscientific hybrids animals, state-level animal bank database.
5. Research programmes should be undertaken considering the need of the society in a time-bound manner, with a specific target.
6. Industrialists and entrepreneurs should be persuaded to set agro-based industries.
7. All water-bodies should be properly maintained, augmented and utilized.
8. There is need for providing marketing and processing links on large scale.
9. There is need to train the people in using other energy-saving handlooms to replace or improve the 'lipu, handloom. Information also needs to be given to women for changing the patterns or designs of weave for national and international market.
10. Many simple farm-produce processing technologies have been developed using minimum equipments and small investments. Women need to be trained for handling these equipments or gadgets. If these women can be trained in these mechanized techniques, it may be used as an important entrepreneurial activity.
11. Improved technologies of fermentation with proper-quality control are desirable with packaging technologies using soybean, and other produce should also be promoted.
12. ITK should be documented, validated and utilized.
13. To improve the efficiency and rate of plucking, there is need to propagate light-weight cloth bags for collecting the leaves and use finger-blades for culling the tea leaves instead of hand-plucking.
14. Value addition of fruits, vegetables, bamboo shoots, fish and production of bio-fuel by planting Jatropha can be taken up. Use of waterlogged areas of Assam and Tripura for cultivation, production and processing of lotus stem, makhana and singhara needs attention of scientists for proper technology dissemination.
15. Use of green fodder may be promoted. Feed availability is a limiting factor, for which soybean and maize should be promoted and used.
16. Women should be organized at village, block and district levels. Funds by line departments such as Tribal Welfare Department, Rural Development Department etc. should be released directly to women organizations. Women's grants can be prepared with Micro-credit plan of village and implemented with or without bank-credit support.
17. Line departments should train women or their representatives in management of agriculture, animal husbandry and fisheries to provide basic skills, so that they are empowered to acquire skill faster.

SESSION V

SUB -THEME: ORGANIC FARMING, SOLID-WASTE MANAGEMENT AND ALLIED FARMING COMPONENTS FOR ECONOMIC DEVELOPMENT IN N.E. REGION

Chairman: Dr S. R. Vardhan Reddy

Co- Chairman: Dr B. K. Kikani

Raporteurs: Dr Ingo Meetei

Dr Y. Chakraborti

Topic/Speaker:

(i) Scope of organic farming in crop and livestock integrated system: Dr M. P. Yadav, Vice-Chancellor, SVBPUAT, Meerut

(ii) Scope of allied agricultural enterprises like apiculture, sericulture and mushroom growing in N.E. region: Dr Bhagirath Senapati, Vice-Chancellor, OUAT, Bhubaneshwar

SCOPE OF ORGANIC FARMING IN CROPS AND LIVESTOCK INTEGRATED SYSTEM IN NORTH-EAST REGION

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Organic farming is an agricultural production system, which avoids or largely excludes the use of synthetic compounds such as fertilizers, pesticides, growth-regulators and livestock-feed additives. Under organic food-production system, crop nutrients are provided through various components such as composts, bio-fertilizers and crop residues. In this context vermicompost has been gaining popularity amongst the organic food producers.

Organic farming is based on increasing the natural biological cycles in soil, plants and animals, e.g. development of natural immunity in young animals, building up soil fertility through the use of nitrogen fixation by legumes; increasing the soil-organic matter and avoiding pollution and minimizing the use of non-renewable natural resources such as the fossil fuel, used for the manufacture of fertilizers and pesticides. The principles of organic farming also encompass high standards of animal welfare and improvement of the environmental infrastructure of the farm.

The objectives of organic farming are to manage natural resources in a self-sustaining manner without the use of chemical inputs, and to maintain strong links between sustainable and profitable agriculture and the environment. Organic farming is gaining wide acceptance world-wide, including India, for providing food, sage feed and fodder and livelihood security to the rural communities, besides improving the exports. The rainfed and hilly regions of the country including north-east, having low use of chemical fertilizers and pesticides, are potential areas for promoting organic farming. The farmers of these regions therefore need to be organized into bio-villages and covered under certification process catering to the domestic and international markets.

The North-Eastern region has sufficient resources for producing organically-farmed products. It has the potential of contributing 20 lakh ha agricultural land towards organic farming. At present India has 50,000 ha (excluding North-East) agricultural land under organic farming. The ICAR is developing a road-map to encourage organic farming in this region soon.

The Government of India has accreditation and certification mechanism for export of some organic agricultural products as outlined by APEDA. However, the existing expensive and rigorous regulatory system is not suitable for small growers and domestic markets of India. The Department of Agriculture, Government of India is soon going to have its own organic standards in harmony with international standards and certification system for organic agriculture in India.

Our country possesses 482 millions livestock, comprising cattle, buffaloes, sheep, goat, pig, horse, camel, mithun and yak, besides 440 million poultry. These are providing 922 million tonnes excretal matter in the form of dung and urine, besides fodder and dedding wastes are key components for organic system of farming.

Harnessing of the complementary of crops and livestock farming systems ensures minimized risks, and increased sustainability of the production system and environment in rainfed areas, which constitute 65 % of the total arable land in India. Green-manures, bio-pesticides, organic herbicides, bio-fertilizers, crop residues and FYM can be successfully applied to improve organic production. The excreta from pigs, ducks and poultry in the North-East region can be used successfully for the production of biogas for obtaining bio-fuel as well as organic manure. The livestock owners of the region should maintain breeds that might ensure such a system of management.

The judicial application of the above-described sources of organic farming will help in increasing the carbon content, and the organic mass and water-holding capacity of the soil. Existing traditional practices such as use of ash, preparations made from animal dung and urine, garlic and neem as also non-chemical insecticides have shown that several plants and micro-organisms are effective in controlling common pests of plants. Production of biogas from livestock, poultry and fish excreta or waste will be an adjunct to organic farming by producing good manure and energy for electrification, thus reducing the use of fossil fuel. As the success of organic farming depends on the availability of organic inputs, concerted research and development efforts are the immediate need for augmenting their supplies in future. While adopting organic farming, there may be reduction in the yield of crops for 1 to 3 years, depending on the crop, soil type and climate. Hence to promote organic farming, subsidy may be provided in the beginning for 3 years to minimize losses to the farmers.

Some of the management practices for improving soil health and bringing organic amendments consist of composting (FYM, NADEP, vermicompost), crop rotation including legume crops, conservation tillage and soil-carbon sequestering through cover crops and agro-forestry.

In a study conducted by VPKAS, Almora in North- West Himalayas for 30 years by growing soyabean as rainy season (kharif) crop and wheat as winter season (rabi) crop with application of NPK+FYM, N+FYM, NP+FYM, NK+FYM and without any fertilizer or manure, it was observed that the application of FYM to soyabean crop improved the productivity of both the crops; soil-organic carbon; nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, zinc etc; electrical conductivity; and bacterial population in the surface soil besides improving the soil-physical health and structure.

Statutory support for organic farming may be increasingly linked in future to ensure environment-friendly production system. The world market of organic products is estimated at $ 26 billion and is projected to attain $ 100 billion by 2015. India is ideally placed to take advantage of this situation, as many regions of the country are organic by default. Such regions and high-value crops need to be identified. The government should provide support through certification, India branding, extension services and subsidizing of bio-inputs. Organic zones need to be promoted on the pattern of AEZ and SEZ.

PROSPECTS OF APICULTURE, SERICULTURE AND MUSHROOM CULTIVATION IN NORTH-EASTERN HILL STATES OF INDIA

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In spite of striking agricultural progress, particularly during the period of Green Revolution (1965-1980),

leading to quantum jump in productivity and production of food grains, poverty-induced under the malnutrition is wide-spread in rural India. We have now come to realize that in addition to increasing the land productivity, increase of animal products and aqua products has become inevitable to ensure food and nutrition security to our people. It is seen that the contribution of crops sub-sector to the agricultural economy in the country has decreased from 76% in 1981 to 66% in 2002, and that of livestock sub-sector has increased from 18% to 25% and of fishery sub-sector from 1.9% to 4.4% during this above period.

Farming position in NE India

The farm population in the country is increasing annually @ 1.84%, whereas the average farm size is becoming smaller each year, and the cost-risk-return structure is becoming adverse. About 80% of our farm families belong to small and marginal categories. Therefore multiple livelihood opportunities through integration of various enterprises like crops, livestock, pisciculture, apiculture, sericulture, mushroom production, poultry and duckery farming, agro-processing, rural biomass utilization etc. are essential to improve the productivity and income of small farms. Integration of science-based on-farm and non-farm livelihood systems in rural areas not only helps in achieving higher productivity and profitability of the farmers and sustainability to the production systems, but also can foster job-led economic growth in the villages. There is need for judicious choice of a few enterprises by each rural family, taking into consideration the socio-economic status, family resources and several other aspects including the market demand etc.

There is absolute necessity for accelerating the growth rate in agriculture on sustainable basis, through increase of capital investment in agriculture including that on infrastructural development like roads, godowns, irrigation and drainage facilities, goods train services, marketing facility, farmers-to-market linkages through ICT etc; improvement in timely supply of growth-accelerating agro-inputs like plant nutrients, bio-control agents and bio-pesticides; emphasis on new area approach, viz. hybrid rice in eastern India, soybean in NE region etc.; as well as on agro-processing and value addition to agricultural products , particularly horticultural products; and promotion of inland aquaculture, emphasis on livestock sector, credit availability at low interest rate etc.

The North-Eastern Hills Region consisting of eight states, viz. Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura–having 8% geographical area (26,219 million ha), 3.02% area of the total holdings (4.9 million ha), 3.16% of total number of holdings, 3.01% marginal holdings, 3.57% small holdings of the country–is rich in natural resources. The marginal and small farmers in NEH states constitute 79.7% and possess 37.8% of the farm area compared with 80.3% possessing 36.0% farm area in the country.

This is a high-rainfall region with annual rainfall 2,000-4,000 mm, and a total forest cover 64% (16.94% m ha) of the geographical area with less than 20% area put to agricultural uses. There are 57,697 villages (452 in Sikkim to 26,312 in Assam) and 39.08 million human population in NEH states, constituting 9.0 and 3.8% of the country respectively.

The animal wealth of this region constitutes 42.16 million livestock (0.42 million in Sikkim to 22.09 million in Tripura) and 31.99 million poultry birds, which are 8.7 and 7.6% respectively of the country. Although the inland fishery resources cover 5.63 lakh ha water bodies, the states like Mizoram and Sikkim have meagre area, only 2,000-3,000 ha alone each, whereas Manipur and Meghalaya have 10,000 ha each.

Fruits are grown in 2.81 lakh ha area (5.6% of the country) having quite low yield, i.e. 1.5 3.7 t/ha in Sikkim, Mizoram and Nagaland, compared with national average 9.9 and 22.7 t in Madhya Pradesh, 19.9 t in Tamil Nadu and 15.9 t in Karnataka. The major fruit crops grown in the NEH states are apple (Arunachal Pradesh), citrus (Assam, Manipur, Meghalaya, Mizoram and Tripura), litchi (Assam and Tripura), mango and banana (all the states), papaya (Assam, Arunachal Pradesh and Meghalaya) and pineapple (Assam, Manipur, Meghalaya, Tripura, Arunachal Pradesh and Nagaland).

Since agriculture and agro-based industries can play a vital role in the improvement of rural economy and the fact that there is limited availability of land, agriculturists should look for supporting rural industries, such as apiculture, sericulture and mushroom cultivation in regions where the ecological conditions are favourable for these enterprises.

Perspects of apiculture in North-Eastern Hill states

The glorious tradition of bee-keeping and honey hunting is well known in India. The country has diversified bee flora suitable for bee-keeping almost throughout the year. The role of bee-keeping in providing nutritional, economic and ecological security to rural communities cannot be overlooked, as it has always been linked with the

cultural and natural heritage of rural communities.

There are four major honeybee species viz., rock bee (*Apis dorsata),* little bee (*Apis florae),* Indian bee (*Apis cerana)* and western bee (*Apis mellifera).* Out of them the former two are wild and the latter two are domesticated species. Indian bee (*Apis cerana)* is a brownish black, locally available, domesticated Asiatic species. The bee-keeping practice of North-East India is mainly based on this species. This is indigenous to India, with average honey yield of 12 kg/ hive/ annum, with foraging range 0.8-1 km. The N.E. hill region contributes only 1.3% of the total production of the country, with an average honey yield of 5 kg/ hive. In this region Assam, Manipur and Meghalaya are the major producers of honey. There is scope to improve bee-keeping activity in Arunachal Pradesh, Sikkim and Mizoram, and to produce organic honey in Tripura.

Western bee (*Apis mellifera)* is an exotic golden yellow species, most widely and commercially reared in the world. It is larger in size than *Apis cerana,* having average honey yield 35-40 kg / annum, with foraging range 2 km. The species is successfully introduced in northern India and effort is being made to introduce it in Assam and other North-East states. In India bee-keeping with the European honey bee started in Punjab during the 1970s. The epidemic appearance of a deadly viral disease, Thai Sac Brood (TSB), during the late seventies in *A. cerana* colonies in North-Eastern region of the country and its subsequent spread to eastern and southern states during the 80s and 90s have triggered the import of *A. mellifera* from Punjab into various states. Although a gradual decrease in virulence of the disease has also been observed in the subsequent infections, the recurrence of sacbrood virus epidemic in current years has also been reported.

The introduction of *Apis mellifera* in various parts of the country proved successful, as the bees resisted TSB disease and produced higher and better quality of honey. Presently it has gained popularity in Jammu & Kashmir, Punjab, Himachal Pradesh, Haryana, Uttar Pradesh, Bihar and West Bengal.

The climate in almost all zones like Peninsular region, North-eastern region and North hills region is suitable for apiculture, except Indo-Gangetic plains where the summer is very hot. The optimum thermal range required for bee activity is 13 to 38°C; the bees usually do not forage in hot (>40°C) or cold (<10°C) weather conditions or during incessant rains.

There are four subspecies of Asian hive-bee (*A. cerana),* viz *A.c. cerana, A.c. himalaya, A. c. indica* and *A. c. japonica;* the former three races occur in India. Their distribution is as follows.

Apis cerana cerana	:	North-western region including Himachal Pradesh and Jammu & Kashmir
Apis cerana himalaya	:	North-eastern region including the north-eastern Himalayan states
Apis cerana indica	:	South India, including Kerala, Tamil Nadu, Karnataka, southern Andhra Pradesh and Orissa

A. cerana is gentle to handle, is industrious and well adapted to the ecological conditions of south and south-east Asia. The three Indian races can be further differentiated into seven sub-groups or ecotypes, two in *A.c. cerana*, three in *A.c. himalaya* and two in *A.c. indica*. The Asian hive bee (*Apis cerana)* is considered to be the oldest species in terms of evolution of honey-bees, and the species or races evolved in nature were considered as best suited to the local floral vegetation and climate. There is excellent scope for the genetic improvement of this native species through selective breeding programmes.

However, it has been apprehended by the Indian bee scientists that bee-keeping with *A. cerana* has several advantages over the exotic bees. The indigenous bees are less susceptible to nosema disease and are not seriously affected by Varroa and also are less prone to the attack of predatory wasps. Bee-keeping with *A. mellifera* requires chemical treatment of colonies but not with *A. cerana*. Moreover, for pollination purposes *A. cerana* is superior to *A. mellifera* in certain aspects, e.g. it is more suitable for cross-pollinating entomophilous crops grown in the small holdings of this region because of its shorter flight range and longer foraging hours than the European honey-bee.

Further, in several apicultural by advanced countries, bee-keeping with *A. mellifera* is agriculture based, whereas in India bee-keeping with the Indian honey-bee has been by and large forest based. In recent years cultivated areas are being increasingly used for honey production. The European bee (*A. mellifera)* has larger population of bees per colony than *A. cerana*, and needs large amounts of pollen for its survival and growth. Therefore availability of pollen in large quantities before and during the nectar flow is a critical factor for the success of European bee in any region of the country.

Bee-keeping is considered an ideal remunerative enterprise in context with agriculture for the following reasons:

- Bee-keeping constitutes an important sustainable income-generating resource for the rural inhabitants.
- The raw materials for honey production come froms the nature.
- No additional land space is required for bee-keeping.
- It does not compete with agriculture and animal husbandry for any input.
- Apiculture provides the rural mass valuable nutrition through honey and also industrial products like wax.
- Bee products constitute important ingredients of traditional medicines.
- Honey has medicinal uses for its antibacterial action.

The bees are considered to be the most important pollinators, because they are the only insects whose immature stages are reared exclusively on pollen and nectar. McGregor (1976), an eminent pollination scientist in the USA, had estimated that "One third of man's diet is derived directly or indirectly from insect-pollinated plants". Honey-bees play a vital role in the pollination of a large number of cultivated crops, which is often underestimated in developing countries. However, it is an established fact that income from agriculture by the use of honey-bees in crop pollination is many a times higher than their value as honey and beeswax producers. According to M. S. Swaminathan, apiculture can play a useful role, and at a very little expenditure the honey-bees will not only provide food and income, but will also improve the productivity of horticultural and other field crops by their pollination activities.

The country has more than 50 million ha under crops that are benefited by bee -pollination. But so far only 20-25% of the bee flora is being exploited. Taking an average of only one bee colony /ha to be provided, a total of 9 lakh bee colonies shall be needed compared with the presently available 1.98 lakh bee colonies, to cover 9 lakh ha area under horticultural crops of North-Eastern Hills states.

Therefore it can be taken up as an agricultural practice specially in areas where oilseed crops (niger, mustard, sesame gum and sunflower) and horticultural crops (guava, citrus, litchi, coconut, ber etc.) are extensively grown. Further, establishment of apiculture-based floriculture (calendula, cosmos, marigold, gladioli, aster, chrysanthemum, rose, dahlia, zinnia etc.) will make bee-keeping enterprise more rewarding. An apiculture-based farming system should include bee-foraging plants as given below

Crops (65% of the area to be covered):

*Kharif: Pigeonpea (*arhar), greengram (mung), niger, pumpkin, sunflower

Rabi: Kusum, mustard, sunflower, mung, sesame gum, pumpkin

Fruit trees (20% of the area to be covered):

Drumstick, jujube (ber), lemon, mango, guava, litchi

Ornamental and other plants

Silver oak, bottle brush etc., neem and karanj (15% of the area to be covered) (products of these latter two plants will be utilized for suppression of insect pests)

The rich diversity of bee species and of natural and cultivated vegetation in the country allows maximum utilization of bees and bee plants. The Indian forests could provide shelter and food to over 120 million bee colonies. Even if we consider reduction in the forest area in recent years due to deforestation etc., the country can still hold over 100 million bee colonies, providing self-employment to over 10 million rural and tribal families. In terms of production, these bee colonies can produce over 700,000 tonnes honey and 30,000 tonnes beeswax.

There is a growing concern among consumers in many countries over the residues in honey, though honey is still considered as a natural and health food. Despite the alarming trends world-wide about the effect of crop pesticides on native and commercial pollinators, the agricultural sector in India is still heavily dependent on pesticides, which are harmful to pollinators such as honey-bees. Although there is requirement of 150 million honey-bee colonies in India for successful pollination of commercial crops, this requirement could not be fulfilled due to pesticide poisoning and bee disease. Therefore conservation and management of native bees and the maintenance of a thriving bee-keeping industry are felt imperative for sustainable agriculture and rural development. In 2004, under its regular programme, FAO also started participating in international activities for assurance of honey quality and safety. One of such efforts is to support organic bee-keeping for production of honey and honey-bee by-products with reduced levels of residues and contaminants.

Economics of bee-keeping

Bee-keeping is recognized as a low-input and high-output activity, suitable for rural, tribal and other weaker sections of the population. It is a resource of sustainable income generation to the rural and tribal farmers, which provides them valuable nutrition in the form of honey, protein-rich pollen and brood. The bee products like bees-wax, bee-venom and royal jelly also give additional benefit to the farmers.

Depending on the potential existing in an area, bee-keeping can be a subsidiary occupation that can add significantly to the meagre income of the rural farmer from his main occupation. In areas with good potential, it can be a full-time commercial activity, producing different apicultural materials.

In bee-keeping there is a need to make one-time investment towards the purchase of some basic bee equipments and bee colonies, and in the subsequent year a bee-keeper may continue to incur consumable or variable working capital towards maintenance of the colonies. The profit is usually realized from the second or third year onwards. The output: input ratio in the primary unit with 5 colonies is 1.07. This increases with increase in the number of colonies. In units with higher number of colonies, both productivity and efficiency increase. On a medium scale the ratio of commercial units is 1.3 for *A. cerana* and 1.7 for *A. mellifera* bee-keeping.

Table 1: Expenditure and income in bee-keeping

Honey-bee species	Fixed capital (I year) (Rs)	Expenditure (10 colonies)			Profit from III year onwards	Income/ hive from III year onwards
		Consumable or working capital/year (Rs)	Total expenditure in first year (Rs)	Total expenditure from the II year onwards		
Indian hive-bee	15,370	1,070	16,440	1,070	12,980	1,298
Italian honey-bee	38,440	2,525	40,965	2,525	30,075	3,007

PERSPECTIVES OF SERICULTURE IN NORTH-EASTERN HILLS STATES

The North-Eastern Hills region is the only place in the world where all four commercially known varieties of silk, viz. mulberry, eri, muga and tasar, are produced. Since sericulture and weaving are a part of the cultural traditions of the NE Hills people, it can be an ideal sideline activity for the rural people engaged in agriculture. Further, it is also labour-intensive industry and is ideally suitable for the unskilled family labour like women-folk, children and handicaped persons. The four silkworms grown for silk production are given below.

Mulberry silkworm (*Bombyx mori):* It accounts for 91.7% of the total raw silk produced in the country. It is a monophagous insect that feeds only on mulberry leavevs. Presently its cultivation is concentrated mainly in states like Arunachal Pradesh, Assam, Manipur and Mizoram, with silk production ranging from 1 million tonnes (in Arunachal Pradesh) to 57 million tonnes (in Manipur). Moriculture requires conditions (temp, 15 -37^{0}C; rainfall, 600-2500 mm; elevation, 300-900 m above main sea level; relative humidity, 65-80%) suitable for mulberry growth. Being a hardy pernennial plant, it is ideally suitable for wasteland. Moreover, the returns from it are more than from other crops. The net income is Rs 15,000/ha/ year, which is much more than that of either paddy (Rs 4,500) or sugarcane (Rs 12,700). One hectare of mulberry creates remunerative employment for 12-13 persons throughout the year.

Indian tropical tasar (*Antheraea mylitta):* It is a polyphagous insect that feeds on the leaves of arjun tree (*Terminalia arjuna),* asan (*Terminalia tomentosa*) or oak (*querus*) and on plants like *Zizyphus*. The worms are multivoltine and can be reared throughout the year. The grey white, tough and pendunculate cocoons are made of a single unbroken filament and are reelable. This caterpillar is raised in the forest regions of Manipur and Mizoram.

Eri silkworm (*Philasamia ricini):* Assam is known as the original home of eri silk and the state tops in NE Hills region with production of 474 million tonnes eri silk. It is multivoltine and polyphagous, and mostly feeds on castor leaves and also on besseru and tapioca leaves. Ericulture is extended from the lowest level of plains up to an altitude of 5,000 feet and in thermal range of 12.8-36.7^{0}C. Cocoons are non-reelable. Rearing of eri silk is simple and does not require high skill at any stage. Therefore it is being practised traditionally by the tribals in the NE Hills region. Eri yarn is good material of warm clothing for the rural folk and its pupae are rich in protein, which are usually

consumed by the tribals. One can earn enough money from 1 ha castor plantation through of sale of eri cocoons, castor seeds and eri pupae.

Muga silkworm (*Antheraea assama):* It occurs in Brahmaputra valley and adjoining hills in Assam and Mizoram. Assam is the world's largest producer of golden-coloured muga silk. It is multivoltine and its indoor rearing is recently introduced. The cocoons are reelable.

MUSHROOM CULTIVATION IN NORTH-EASTERN HILLS STATES

A long period of rainy and cold climate, high relative humidity, moderate temperature and slopy topography in North-Eastern hills states provide a favourable condition for the growth of many fungal flora, including varieties of fleshy, delicious and nutritive sporocarps. But due to lack of concerted efforts, many edible sporocarps are untapped from the forest region.

About 85% of the population of the region is rural based, which depends on agriculture for sustainability. Paddy, an important traditional crop, covers a large patch but contributes for very low to GDP, because of poor productivity. Production of wheat, maize, pulses, oilseeds, vegetables and fruits have nowadays gained momentum. Among plantation crops, tea contributes significantly, meeting over 50% of India's tea requirement. Bamboo plantation also makes a remarkable landmark, which can sustain small-scale industry and handicraft. But by and large a majority of agricultural labourers and cultivators do not find adequate engagement from January to June.

Mushroom, with great variety of species, constitutes a cost-effective means of both supplementing the nutrition to mankind and generating self-employment. Besides, it also contributes to reduction in environmental pollution.

Mushroom production in India is showing a upward trend; from a meagre 400 tonnes in 1985 to 30,000 tonnes and 1995 and 70,000 tonnes in 2003-04. So also the productivity has increased many fold, 6 kg/q compost in 1970 to 22 kg/q compost in 2004. However, North-East Indian states shared only 1,000 tonnes mushroom production in 1996, which increased to 1,250 tonnes in 2004, indicating a low growth rate. Diverse species of *Agaricus, Pleurotus, Volvariella* and *Lentinula* can suitably be grown in different periods throughout the year, utilizing the agricultural by-products or wastes. There is enough scope for technology development and spread, which can add to the engagement and earnings of the resource-poor farmers.

Mushroom cultivation is very simple and easy, which can be followed by marginal and small farmers including tribals and landless labourers. It also provides gainful engagement to farm women. The mushroom substrates are mostly the wastes from farms, plantations or factories. These by-products can be recycled to produce additional food in the form of mushrooms. Mushroom cultivation requires small financial outlay and the crop cycle is short.

Table 2: Edible and medicinal mushrooms grown in India

No.	Common name	Scientific name	Commercially cultivated species
	Edible mushrooms		
1	Paddy-straw mushroom	*Volvariella* species	*volvacea, diplasia, esculenta*
2	Oyster mushroom	*Pleurotus* species	*sajor-caju, florida, flabellatus, ostreatus, eous, citrinopeletus*
3	Button mushroom	*Agaricus* species	*bisporus, bitorquis*
4	Milky mushroom	*Calocybe* species	*indica*
5	Black-ear mushroom	*Auricularia* species	*Auricular polytrica*
6	Winter mushroom	*Flammulina* species	*velutipe*
7	Blue oyster	*Hypsizygus* species	
8	Pholiota	*Pholiota* species	*nameko*
	Medicinal mushrooms		
1	Black-forest mushroom (Shiitake)	*Lentinula* species	*Edodes*
2	Maitake	*Grifola* species	*frondosa*
3	Reishi	*Ganoderma* species	*lucidum*
4	White-ear mushroom	*Tremella* species	*fuciformis*

Table 3: Growth parameters of cultivated edible mushrooms for North-Eastern Hills states

No.	Common name / Type	Scientific name	Climatic requirements		Suitable growth period
			Temperature (^{0}C)	Relative humidity (%)	
1	Paddy-straw mushroom or Chinese mushroom	*Volvariella volvacea* *V. diplasia*	25-38	90-95	Mar – Sep
2	Milky mushroom	*Calocybe indica*	25-40	80-85	Mar – Sep
3	Reishi mushroom	*Ganoderma lucidum*	28-30	90-95	Mar – Sep
4	Oyster / dhingri mushroom	*Pleurotus sajor-caju* *P. florida* *P. flabellatus* *P. eous*	20-25 25-30 20-28 25-35	80-85 75-90 90-95 90-95	Jul – Feb
5	Button mushroom	*Agaricus bisporus* *A. bitorquis*	15-17 22-26	80-85 80-85	Oct–Feb
6	Shiitake mushroom	*Lentinula edodes*	12-20	85-90	Oct–Feb

Table 4: Substrate requirement and duration of edible / medicinal mushrooms

No.	Common name	Method of cultivation	Substrate	Duration (days)	Biological efficiency (%)	Shelf-life
1	Paddy-straw mushroom	Indoor or outdoor bed method	Paddy-straw supplemented with pulse powder or composted substrate	15	10-15	12 hr
2	Oyster mushroom	Indoor-bag method	Cereal straw with addition of organic nitrogen (wheat bran rice bran or cotton-seed meal etc.)	21	50-90	24 hr
3	Button mushroom	Indoor tray or bag method	Composted substrate	60	15-20	3-4 days
4	Milky mushroom	Indoor-bag method	Cereal straw	30-40	60-75	3-4 days
5	Shiitakka	Indoor- bag method	Sawdust with supplements (rice bran or wheat bran)	60	70-100	3-4 days
6	Reishi mushroom	Indoor-bag method	Sawdust with supplements (rice bran, or wheat bran or wheat straw)	60	30	Preserved after processing

The value-added products are mushroom in brine, dried mushroom, mushroom+soup powder, canne mushroom, mushroom pickle, mushroom squash, mushroom sauce, mushroom nodule, weaning foods, mushroor biscuits, mushroom ketchup etc.

Mushroom-processing techniques

1. **Drying or dehydration :** Freeze or vacuum drying, hot-air drying, drying in solar drier, sun-drying microwave drying, and osmotic dehydration
2. **Mushroom in brine**
3. **Mushroom canning**
4. **Pickling and lactic acid fermentation**
5. **Irradiation**
6. **Other products:** Mushroom kidney fry, mushroom salads, cheese sandwiches, mushroom-stuffed capsicum stuffed morels, mushroom fritters, meat-stuffed mushroom, mushroom lot dog, mushroom burger, mushroon omelette, mushroom and pouched eggs, mushroom-stuffed potato.

Table 5: Economics of important cultivable edible mushroom

No.	Type of mushroom	Unit size	Fixed cost	Recurring cost (Rs)	Gross income/ month (Rs)	Net income/ month (Rs)
1	Paddy-straw mushroom	25 feet x 12 feet 120 beds / month	21,000	4,000	8,100	3,675
2	Oyster mushroom or milky mushroom or black- ear mushroom	25 feet x 12 feet capacity 225 beds / 2 months	21,000	3,000	5,600	3,675

Sources of technical support

- National Research Centre for Mushroom, Chambaghat, Solan, Himachal Pradesh.
- Mushroom Research Centre, Indian Institute of Horticulture Research, Bangalore, Karnataka
- Centre of Tropical Mushroom Research and Training, Department of Plant Pathology, Orissa University of Agriculture and Technology, Bhubaneshwar, Orissa.
- Mushroom Research Centre, G. P. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand
- Mushroom Research Centre, Indira Gandhi Krishi Vishwa Vidyalaya, Raipur, Chhattisgarh.
- Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu.
- Department of Plant Pathology, C. S. Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh.

SESSION V: RECOMMENDATIONS

ORGANIC FARMING, SOLID-WASTE MANAGEMENT AND ALLIED FARMING COMPONENTS FOR ECONOMIC DEVELOPMENT IN N.E.

After brain-storming discussion, the following recommendations were evolved.

1. Apiculture, sericulture and mushroom cultivation may be encouraged where the ecological conditions are favourable, to improve the rural economy.
2. Use of green-manures, bio-pesticides, organic herbicides and farmyard manure needs to be popularized to improve soil health and to introduce organic farming.

RECOMMENDATIONS

Session I

Session I: Concept, Principle and Importance of Integrated Farming System

1. To address the issue of technology delivery in the present-day context, capacities of existing ICAR institute and universities located in NE region should be enhanced in terms of equipments and manpower.
2. Regional referral laboratory needs to be established in ICAR NEH region to promote organic agriculture o animal husbandry
3. A regional consultative group needs to be established under the chairmanship of seniormost VC in the region t frame education and development agenda in a partnership mode, to facilitate addressing of farmers' issues an propagation of intensive integrated farming-system models developed for the region by ICAR Researc Complex.
4. The North-East region imports large quantities of animal products from outside the region. Besides severa other factors, the availability of higher cost of feed is the main limiting factor. The region is agro-climatically ideally suited to produce maize and soybean, the two important components of animal feed. It is recommende that cultivation of these crops should be popularized in a mission mode with forward and backward linkages.
5. To improve the productivity and profitability of various components of farming systems like crop, animal fishery etc., the availability of quality seed, planting material, fish seeds, chicks etc. should be ensured. Th region lacks the basic infrastructure to meet the requirement. It is recommended that systematic planne programmes are undertaken and necessary infrastructure created.
6. In huma-resource development, creation of awareness and development of technical skills in various aspects o production and rearing of various components of farming systems is essential for improving the productivity o the system. The scientists of KVKs should be given required training to serve as master trainers.
7. Research infrastructure in the region is extremely poor. It should be suitably strengthened.
8. The region receives high rainfall but the benefit from such high rains are not reflected in the overall croppin patterns. A greater part in most of the states is under monocropping, mostly rice. Rain-water conservation fo its better utilization in non-rainy or drought period will help in increased cropping sequence and croppin during winter (*rabi*) season.
9. Soil and water conservation, especially terrace cultivation, on the hill slopes is the most important scientifi practice for realizing higher yields of crops with reduced soil and water loss.
10. As the region is endouted with high rainfall and water-table depth is shallow, shallow-water tube-wells wil prove highly beneficial in valley areas, table-lands etc., making available irrigation water for the second crop i rabi and more than one vegetable crop during *rabi* or summer season.
11. For improving the livelihood of the farmers and their farm income on year-round basis, crop diversification an integration of crops with livestock and fishes as complementary activity is considered to be the mos sustainable practice. Separate models could be developed considering the need of the farmers and the resource available with him, including their socio-economic considerations.
12. The North-East region, especially the shifting (*jhum)* cultivation area, should be targeted for promoting organi agriculture. Technology transfer and extension activities are important for promotion of agriculture.
13. Subsidiary and allied activities like apiculture, sericulture, lac-culture, mushroom cultivation, agro-base handicrafts, family-based minor food processing etc. along with agriculture will help in improved livelihood o poor and small farmers.
14. Promotion of some of the crops like maize, soybean, ricebean, and the forage and feed crops in crop-livestock integration will be quite useful for the overall improvement of farm productivity.

Session II

Session II: Management of Natural Resources in the Integrated Farming System of Agriculture and Livestock in N.E. region

1. There is need to follow soil- and water-conservation measures rigorously for sustainable progress in agriculture on watershed basis, by following integrated farming-system approach. The upstream catchment should be kept under natural vegetation, followed by ponds in series, to catch the water from up-streams in middle reaches with earthen embankments and also ponds in series in lower trends to conserve maximum amount of water by utilizing the available resources in the locality.
2. The steep slopes may be utilized for silvi-pasture and agro-horticulture system, whereas lower trends may be utilized for rice-fish culture in rice fields and ponds. The livestock should be the integrated part of the system with the addition of small enterprises like mushroom, lac-cultivation, backyard poultry, honey-bee, seri-culture etc., depending on the choice of the family or location.
3. There is great scope to diversify the area especially under medicinal plants, vegetables, pulses (lentil), groundnut, soybean etc. The *utera* cultivation seeding in standing crops of paddy) of field pea, berseem etc., practised in central India, may be tested in this region for cropping intensity. The Brassica niger is another crop, requiring low-water input, which may be tried in the area for honey-bee enterprise.
4. The undercrops of turmeric and ginger with main crops of fruits have been very remunerative in central India, which may be tested in this region too.
5. There is need for formation of SHGs or farmers' clubs with women empowerment and full back-up in terms of training for post-harvest processing, value addition and marketing. Thus a paradigm shift is needed in watershed-based integrated farming approach for sustainable progress in agriculture, following holistic activity step-wise.
6. Extensive work is needed on exploration, collection, evaluation and conservation of various crops of N.E. region.
7. Unexplored areas like Loktak lake need to be explored; explorations need to be trait-specific or for value-addition. Wild species of paddy, vegetables, fruits, horticultural crops, underutilized fruits, vegetables, spices, ornamentals and medicinal and aromatic plants need more emphasis in collaboration with SAUs, Government organizations and on- Government organizations.

   The programme of on-farm *in-situ* conservation needs strengthening
8. Research programmes need to be formulated on the basis of knowledge of genetic erosion in the indigenous landraces.
9. More efforts are required for medicinal plants and for development of their packages of practices for their popularization and commercialization
10. Co-ordination is needed among all the organizations associated with the conservation and utilization of crop bio-diversity.
11. Human-resource development and need-based training to actual stakeholders are necessary. Awareness-generation campaign to promote conservation and sustainable utilization of crop bio-diversity should be initiated.
12. Indigenous livestock of NEH region needs to be surveyed and characterized both at phenotypic and molecular levels, in particular of Manipur pony, Banpala sheep, Dam and Mali pig.
13. Wild Asiatic buffalo, which is progenitor of riverine buffalo, needs to be conserved *in-situ.*
14. Indiscriminate cross-breeding should be banned, since it is causing severe threat to the bio- security of the indigenous breeds.
15. Non-descript native cows should be upgraded either with Sahiwal or Gir.
16. Backyard poultry should be encouraged, and model backyard poultry farms should be established by KVKs in

their influence areas.

17. State should develop regional livestock databank, to frame species-wise breeding policy with the help o NBAGR. Livestock management in North-East region is, by and large, nomadic except in the plains, and henc the contribution from this component in the farmers' income is much lower than that in central plains of India To tackle this problem there is need for government intervention.
18. Credit availability should be facilitated at low or zero interest rate for land development, viz. contour bunding terracing and other soil- and water -conservation measures.
19. Regulated markets and processing facilities for all livestock products should be established for all livestoc products.
20. Strong network of research and extension should be created.
21. Homestead-based low-cost integrated aquaculture should be promoted.
22. Co-management approach for sustainable use of capture fisheries resources is necessary.
23. The extension services system should be integrated.
24. Research should be action oriented.
25. Capacity building of KVK or State Department needs attention.

Session III

Session III: General Discussion on University Problems and Experiences Sharing

1. Issues should be identified as ICAR and non-ICAR issues.
2. Letter should be addressed for adopting the Model Act.
3. Enhancement of RAWAE and Internship for Agriculture and Veterinary standards, under consideration in the ICAR, should be pursued for early orders.
4. Resource crunch faced by the ICAR and IAAU should be taken up with Planning Commission for perennia flow of funds.
5. NET conditional advertisement may be given for recruitment for SAUs.
6. KVKs should be knowledge centres only. The State Government or Line department should take up extensive activities.

Session IV

Session IV: Role of Women Towards Agricultural Development of N.E. Region

1. In the complex, diverse and resource-poor (CDR) type of agriculture in the North-East region, the role of women is significant and needs to be promoted further, especially for skill-based cottage industries and homestead-farming components.
2. A number of simple devices suitable for women's stature have been developed for crop production and processing in the NE region, which need to be developed and extended for adoption.
3. There is need to integrate crop, livestock, fish etc. under need-based integrated system involving tribal population and women. The integrated system based on eco-bio-geographical and socio-economic and location- specific criteria should be developed.
4. After morphological and ecological assessment, genetic assessment of indigenous bio-diversity should be undertaken with sincerity and devotion. This is necessary to protect our genome before indiscriminate and

unscientific hybrid animals, state-level animal bank database.

5. Research programme should be undertaken considering the need of the society in a time- bound manner with a specific target.
6. Industrialists and entrepreneurs should be pursued to set agro-based industries.
7. All water bodies should be properly maintained, augmented and utilized.
8. There is need for providing marketing and processing links on large scale.
9. There is need to train the people in using other energy-saving handlooms to replace or improve the lipu handloom. Information also needs to be given to women for changing patterns or designs of weave for national and international market.
10. Many simple farm produce-processing technologies have been developed using minimum equipments and small investments. Women need to be trained for handling these equipments or gadgets. If these women can be imparted mechanized techniques, it may be used as an important entrepreneurial activity.
11. Improved technologies of fermentation with proper quality control are desirable with packaging technologies using soybean, and other produce should be promoted.
12. Indigenous technical knowledge should be documented, validated and utilized.
13. To improve the efficiency and rate of plucking, there is need to propagate light-weight cloth bags for collecting the leaves, and the use of finger blades for culling the tea leaves instead of hand-plucking.
14. Value addition of fruits, vegetables, bamboo shoots, fish and production of bio-fuel by planting *Jatropha* can be taken up. Use of waterlogged areas of Assam and Tripura for cultivation, production and processing of lotus stem, *makhana* and *singhara* needs the attention of scientists for proper technology dissemination.
15. Use of green fodder may be promoted. Feed availability is a limiting factor, for which soybean and maize should be promoted and used.
16. Women should be organized at village, block and district levels. Funds by line departments like Tribal Welfare Department, Rural Development Department etc. to be released directly to women organizations. Women's grants can prepare micro-credit plan of the village and implement it with or without bank-credit support.
17. Line departments should train women or their representatives in management of agriculture, animal husbandry and fisheries to give basic skills, so that they are empowered to move through the skill ladder faster.

Session V

Session V: Organic Farming, Solid-Waste Management and Allied Farming Components for Economic Development in N.E. Region

After brain-storming discussion, the following recommendations were evolved.

1. Apiculture, sericulture and mushroom cultivation may be encouraged where the ecological conditions are favourable, to improve the rural economy.
2. Use of green-manures, bio-pesticides, organic herbicides and farmyard manner (FYM) should be popularized to improve soil health and to introduce organic farming.

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VCs, AUS visiting Loktak lake at Imphal

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