Roadmap for Agricultural Development in North-Eastern Hill (NEH) Region, India
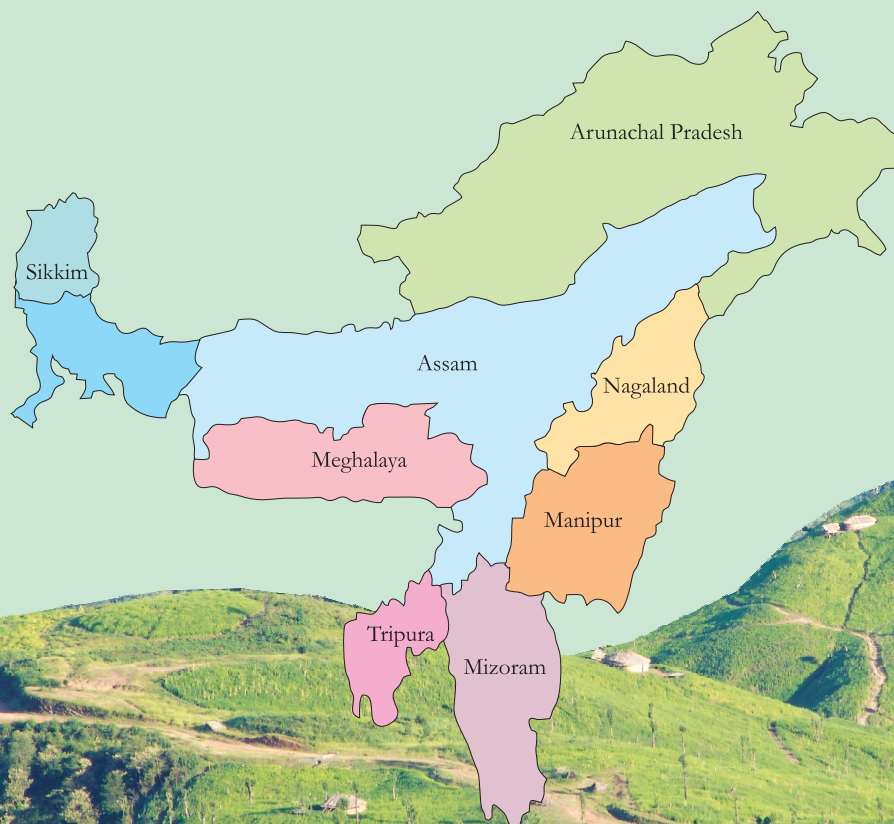
Arunachal Pradesh

Sikkim

Assam

Nagaland

Meghalaya

Manipur

Tripura

Mizoram

POLICY BRIEF

The Context

The North Eastern Hill (NEH) Region of India comprises seven states *viz.* Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim, habitats 124 tribal communities. Each tribe has distinct agricultural practices in one way or the other even within a district. NEH region occupies about 1.2% human population (Table 1), 1.5% livestock population (Table 2) and 5.6% geographical area of India with net sown area of 1.76 m ha (Table 3). Predominantly a rural population (70%), the human density in all the states but Tripura is substantially less than the national average.

Table 1. Human population (million nos.)

States	Total population	Population density (nos/sq km)
Arunachal Pradesh	1.38	17
Manipur	2.86	128
Meghalaya	2.97	132
Mizoram	1.10	52
Nagaland	1.98	119
Sikkim	0.61	86
Tripura	3.67	350
NEH Region	14.57	126
India	1210.57	325

Source: Census (2011). Office of the Registrar General & Census Commissioner. Ministry of Home Affairs, Govt. of India

Table 2. Livestock and poultry population (million nos.)

States	Total livestock	Total poultry
Arunachal Pradesh	1.41	2.24
Manipur	0.70	2.50
Meghalaya	1.96	3.40
Mizoram	0.31	1.27
Nagaland	0.91	2.18
Sikkim	0.29	0.45
Tripura	1.94	4.27
NEH Region	7.52	16.32
India	512.06	729.21

Source: 19th Livestock Census (2014). All India Report. Published by Department of Animal Husbandry, Dairying and Fisheries. Ministry of Agriculture, Govt. of India, New Delhi, pp. 120

Almost three quarters (73.87%) of the geographical area of the region is covered with forest cover as against the national average of 21.55% (Table 4). However, the

Table 3. Geographical area, net sown area and cropping intensity

State	Geographical area (m ha)	Net sown area (m ha)	Cropping intensity (%)
Arunachal Pradesh	8.37	0.225	133
Manipur	2.23	0.383	100
Meghalaya	2.24	0.286	120
Mizoram	2.11	0.145	100
Nagaland	1.66	0.384	130
Sikkim	0.71	0.077	176
Tripura	1.05	0.255	189
NEH Region	18.37	1.755	135
All India	328.73	140.13	142

Source: Land use Statistics at a Glance (2005-2006 to 2014-2015). Published by Directorate of Economics and Statistics, Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Govt. of India, New Delhi, pp. 134

Table 4. State of forest cover

State	Total forest area (m ha)	Geographical area (%)
Arunachal Pradesh	6.70	79.96
Manipur	1.73	77.69
Meghalaya	1.71	76.45
Mizoram	1.82	86.27
Nagaland	1.25	75.33
Sikkim	0.33	47.13
Tripura	0.77	73.68
NEH Region	14.31	73.87
India	70.83	21.55

Source: Forest Survey of India (2017). India State of Forest Report. Published by Ministry of Environment and Forests, Govt. of India, pp. 363

states like Manipur, Mizoram and Nagaland have more than 50% area under open forest category and are highly prone to land degradation. Meghalaya also have the similar situation. The region, by and large, is characterized by fragility, marginality, inaccessibility, cultural heterogeneity, diverse ethnicity and rich biodiversity. The region receives an average annual rainfall of about 2000 mm accounting for around 10% (42.5 m ha m) of the country's total precipitation of 420.0 m ha m.

The soils are rich in organic matter; acidic to strongly acidic in reaction. The soil depth varies from shallow in inceptisols and antisols to very deep in the alluvial soils.

The region being a repository of rich biodiversity is recognized as a *'Climate Marker'*. Different cultural backgrounds of the inhabitants coupled with variable

A typical *jhum* landscape alongwith hutments for watch and ward

Tapiocal : A potential crop for *jhum* farmers

food habits and climatic situations resulted in cultivation of diverse and mixed crops of cereals, pulses, oilseeds, vegetables, fruits, spices and flowers. Agroforestry, animal husbandry and fisheries are the integral parts of their cropping/farming systems. Around 56% of the area is under low altitude, 33% mid altitude and the rest under high altitude. Agricultural production system is, by and large, Complex, Diverse and Risk prone (CDR). The system is characterized by large variation in cropping intensity (range 100-189% with an average of 135%), mono-cropping and subsistence farming.

Shifting cultivation, locally known as *jhum*, is the mainstay of economy in most north-eastern hill states except Sikkim. *Jhum* cultivation is predominant in the region, partly due to social ethos of the various ethnic groups, and partly to topography and prevailing land tenure system. There are various estimates for area under shifting cultivation (Table 5).

Table 5. Area under shifting cultivation

Agency	Year	Area (m ha)
NEC*	1975	2.80
FAO*	1975	7.40
Task Force on Shifting Cultivation*	1983	3.81
Forest Survey of India*	1999	1.60
Ministry of Agriculture, GoI*	2002	1.65
Wastelands Atlas of India, 2011**	2008-09	0.72

Source: *Tripathy, R.S. and Barik S.K. (2003). Shifting cultivation in North East India. In: Bhatt *et al.* (eds.) *Approaches for Increasing Agricultural Productivity in Hill and Mountain Ecosystem.* Published by ICAR Research Complex for NEH Region, Umiam, Meghalaya, pp. 317-322
 **Wastelands Atlas of India* (2011). Jointly Published by Department of Land Resources, Ministry of Rural Development Govt. of India New Delhi and National Remote Sensing Centre ISRO, Govt. of India Hyderabad, pp. 268

Shifting cultivation was considered sustainable so long the *jhum* cycle was 10-15 years. However, of late, it has been reduced drastically in most of the states to 1-3 years. On average, about 3.85 lakh families are engaged in slash and burn agriculture (Table 6).

There is a greater degree of soil loss which is one of the major challenges under slash and burn agriculture. According to an estimate, annual loss of top soil is much higher (46 t/ha) during the first year of *jhum* which further increased to 136 t/ha during second and 174 t/ha during third year of *jhum*, respectively. Soil loss during first year of *jhum* itself is 4-fold higher than the All-India average soil loss of 11 t/ha. Similarly, due to lack of proper water conservation and utilization measures, only 0.88 m

Harvesting of paddy (left) and other produce by *jhumia* farmers

Table 6. Extent of shifting cultivation

State	Shifting culti-vation cycle	Nos. of families practising shifting cultivation
Arunachal Pradesh	3-10	54000
Manipur	4-7	70000
Meghalaya	5-7	52290
Mizoram	3-4	50000
Nagaland	5-8	116000
Tripura	5-9	43000
NEH Region	-	385290

Source: *Basic Statistics of North Eastern Region* (2015). Published by North Eastern Council Secretariat, Shillong, Meghalaya, pp. 411

ha m out of 42.5 m ha m water is effectively used for farming. Information gathered from different sources indicates that in NEH, around 20.74% area is irrigated of which surface flow accounts 18.78% and rest is through surface lift and groundwater lift irrigation system. Farmers also use an indigenous technique called '*Bamboo Drip Irrigation*', particularly for less water requiring and high value crops. Such local innovations and traditional ecological knowledge (TEK) on agriculture-based natural resource management is praiseworthy in the region owing to a close socio-cultural bondage to the natural resources.

The region challenged with very high degree (up to 46% in Sikkim) of land degradation with an average of 24.59% of the total geographical area of the region, which is almost double than the national average of 14.75% (Table 7).

Table 7. Wasteland area

State	Geographical area (m ha)	Waste-land area (m ha)	% of geographical area
Arunachal Pradesh	8.37	1.49	17.79
Manipur	2.23	0.56	25.30
Meghalaya	2.24	0.41	18.40
Mizoram	2.11	0.50	23.52
Nagaland	1.66	0.53	31.77
Sikkim	0.71	0.33	46.13
Tripura	1.05	0.09	9.20
NE Region	18.37	3.91	24.59
All India	328.73	46.70	14.75

Source: *Wastelands Atlas of India* (2011). Jointly Published by Department of Land Resources, Ministry of Rural Development Govt. of India New Delhi and National Remote Sensing Centre ISRO, Govt. of India Hyderabad, pp. 268

Land degradation in the NEH is mainly attributed to shorter *jhum* cycle coupled with hydrological instability. Nevertheless, on account of diversified nature of the farming systems, the *jhum* cultivation is critical not only for food security, but also household nutritional security besides sustaining the livestock and other household requirements like firewood, small timber and fibre etc.

Shifting cultivation is considered **'Organic by Default'** mainly because consumption of inorganic fertilizers and other agro-chemicals is very low in the region and hence provides ample opportunity to develop "Organic Agri-food" systems hubs. Arunachal Pradesh, followed by Nagaland and Mizoram has the lowest consumption of inorganic fertilizers compared to other states (Table 8).

Table 8. Fertilizer consumption (kg/ha/yr)

State	Fertilizer			Total
	N	P	K	
Arunachal Pradesh	1.62	0.11	0.33	2.06
Manipur	28.94	7.79	4.89	41.62
Meghalaya	34.41	10.20	2.65	47.26
Mizoram	12.62	2.27	3.29	18.18
Nagaland	2.82	1.93	1.21	5.96
Tripura	18.47	12.60	11.93	43.00
NEH Region	16.48	5.82	4.05	26.35
All India	84.84	34.08	11.74	130.66

Source: *Agricultural Statistics at a Glance* (2016). Published by Directorate of Economics and Statistics, Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Govt. of India, New Delhi, pp. 489

Farming is predominantly rice-based with exception in the state of Sikkim where maize is the major food crop. Mixed farming system is the order as most of the farmers opt to produce their household food and nutritional needs from their own farm. The system, therefore, supports a large horticulture and animal husbandry base in addition to the main cereal and pulse crops. Livestock is an indispensible and integral part of every farm as it fulfils the animal protein requirement of the population, majority of which have non-vegetarian food habit. The livestock also complements synergistically with the other components such as fishery, horticulture and field crops, registering an integrated farming system approach towards sustaining hill farming.

Various alternative land use models have been suggested for supplementing/ sustaining *jhum* by various research and development organizations (Table 9). However, adoption of these land use patterns require massive investments and support by local institutions, capacity building of *jhumia* farmers across their ethnicity and quality human resource for technology transfer.

Table 9. Successful Experiments having Potential to Manage Shifting Cultivation

(i) ICAR 3-tier model (experiment by ICAR).
(ii) NEPED (Nagaland Environment Protection and Economic Development) (experiment by Government of Nagaland).
(iii) SALT models (sloping agriculture land technology) (experiment by GBPIHED).
(iv) SWEET (Sloping Watershed and Environmental Engineering Technology) (experiment by SFRI).
(v) Intensive watershed based livestock production system (experiment by ICAR).
(vi) Modified shifting cultivation practices undertaken by *jhumias* with introduction of cash crops like large cadamum, medicinal plants, broomgrass, beetle leaf and beetle nut, cinamomum, fruit orchards and orchid cultivation (documented by NAEB and SFRI).

Source: Tripathy, R.S. and Barik S.K. (2003). Shifting cultivation in North East India. In: Bhatt *et al.* (eds.) *Approaches for Increasing Agricultural Productivity in Hill and Mountain Ecosystem.* Published by ICAR Research Complex for NEH Region, Umiam, Meghalaya, pp. 317-322

The region however suffers from weaknesses such as poor infrastructure like roads and markets, and is challenged with high vulnerability to climate change and natural calamities like floods, submergence, landslides, soil erosion, etc. All these have resulted in a low and uncertain agricultural productivity. The low utilization of modern inputs in agriculture has further reduced the ability of

Horticultural interventions in *jhum* fallow land

Biomass : A major source of energy for rural households

the farm households to cope with high risks in production and income.

Indigenous farming systems, home garden including shifting cultivation is great strength of agriculture in the NEH. Being part of the humid tropics, the rate of regeneration of vegetation is much faster in NEH compared to other parts of the country. Agrobiodiversity in the region also offers unique opportunity to diversify the indigenous production systems for food and nutritional security of local folk.

Since the agricultural practices of NEH are totally different than rest of the country, it was envisaged to organize a scientific deliberation involving key stakeholders in the region so as to suggest the way forward on *'Sustainable Modernization of Hill Agriculture'* for holistic agricultural development in NEH region.

The Seminar on Hill Agriculture

Significant research efforts have been made on hill agriculture over a period of time to promote various farming systems across the ethnicity and agro-climatic zones for ensuring food and nutritional security. However, the pace of upscale of these sustainable farming system practices has remained very slow. Keeping in view the introduction of scientific interventions, addressing growing complexity of challenges of natural resource degradation and climate change and to deliver to sustainable development goals (SDGs), a two day National Seminar on **"Challenges and Opportunities for Farmers' Prosperity in Hill Agriculture"** was jointly organized by National Academy of Agricultural Sciences (NAAS), New Delhi; ICAR Research Complex for NEH, Umiam; Indian Association of Hill Farming, Umiam and International Maize and Wheat Improvement Centre (CIMMYT), New Delhi at ICAR Research Complex for NEH Region, Umiam, Meghalaya during 29-30 November, 2018. The seminar was inaugurated by Shri Wailadmiki Shylla, Hon'ble MLA, Govt. of Meghalaya and Shri Allentry F. Dkhar, Adviser and Secretary to the Chief Minister, Govt. of Meghalaya. A total of 60 lead researchers, research &

Community managed agroforestry in *jhum* fallow land

Inauguration of the seminar by lighting of lamp

A view of inauguration of the seminar (above) and participants of the seminar

extension managers, policy planners from ICAR, State Agriculture Universities, Central Agriculture University and State Governments participated in the seminar and deliberated on the following:

- Frontier technological options for hill agriculture,
- Issues and strategies for agricultural development in NEH region including potential farming/cropping systems, organic agriculture, etc. and
- Road map for upscaling sustainable and resilient agriculture technologies in Hill agriculture.

The Road Map for Sustainable Modernization of Hill Farming

Based on the deliberations by the stakeholders during the national seminar, the key recommendations emerged as way forward through suitable action for their implementation by the state governments and research organizations in the North-Eastern Hill region:

(i) Develop dynamic database on land use pattern including acreage under shifting cultivation for scientific land use plans

Currently, no authentic data is available on area under shifting cultivation. The last available data was in the year 2010. Shifting cultivation is a major system of land use and with traditional wisdom, is considered as a sustainable farming system. But there is an ample opportunity for its improvement through sustainable modernization to continue to conserve the natural resources and rich indigenous traditional knowledge for the future. ICAR Research Complex for NEH Region in collaboration with North Eastern Council (NEC), North Eastern Space Application Centre (NESAC), Central Agricultural University, Imphal, and North Eastern Hill University (NEHU) should initiate focused program on database creation along with collection and collation of statistical information on land use pattern, area under shifting cultivation, abundance of *jhum*, current fallow, net sown area (upland & low lands), etc. using finer resolution recent satellite data for regional scale for a scientific and sustainable land use plans in harmony with local community, ethnic groups and nature. Mass awareness among ethnicity would be required to adopt improved *jhum* practices as documented by Nagaland Environment Protection and Economic Development (NEPED).

(ii) Rehabilitation of degraded lands through agroforestry interventions

About 90% forest area of NEH is under the administrative control of village councils who regulate/manage the forest ecosystems for various purposes including *jhum* cultivation. Inappropriate and non-judicious practices in *jhum* cultivation are the most important factors responsible for forest degradation in the region. *Jhum* is not only practiced for cultivation of food crops but also to meet out the requirements of timber, firewood, and minor forest produce. Since, the productivity of *jhum* is determined by the biomass recycled into the system, mass scale afforestation is need of the hour, especially in Nagaland, Manipur and Mizoram, where more than 50% of the geographical area is under open forest category and therefore highly prone to land degradation. Community nursery for saplings of locally adapted and ethnic group preferred forestry/agroforestry species can be highly helpful.

(iii) Development of weather forecasting system and risk mitigation strategies

Weather is quite uncertain on hill regions and impacts significantly agriculture and community. Therefore, establishment of a network of robust forecasting system and risk mitigation strategies (cold/heat tolerant cultivars, short duration alternative crops, post frost management) and analysis of extreme climatic variability (cold

waves and frost/heat stress) in hill farming is a must. Greater emphasis should be laid on precise information delivery system for climate change induced extreme weather variability for mitigating the risks. Also there is a need to strengthen the data generation system and develop database of climate, markets and other related aspects to support decision making for mitigating weather related market risks.

(iv) Integrated farming systems adapted to farmer's circumstances

The region has large number of promising indigenous integrated farming systems. However, very few of them like *Apatani*, *Zabo*, homegarden, *Alder* based farming system, etc. have been studied scientifically. There is a need for in-depth study (bio-physical and socio-economic) in order to identify potential farming systems across the ethnicity and agro-climatic zones using science based resource optimization approaches with environmental stewardship (for example use of Farm Design model). These models further need to be targeted for defined typologies for upscaling to generate employment and environmental conservation besides food and nutritional security. For example, in water surplus ecologies, integrated fish farming system models including rice-fish culture with due care of fish diversification, especially the minor carps, need to be propagated. Scientific validation of innovations and ITKs in farming systems with traditional wisdom is also required across the ethnicity for effective natural resources management.

(v) Specialty organic agriculture hub

The existing agriculture in NEH is considered as *'Organic by Default'*. Many of the NEH states could act as a hub for promoting organic agriculture, particularly the non perishable commodities by strengthening the research, supply of critical inputs and creating a network by involving FPOs/FIGs/SHGs, researchers, extension functionaries, and certifying & marketing agencies. Each of the NEH state could be identified for organic production of a particular commodity having specialty as '*Specialty Organic Agriculture Hub'* with high quality standards of that particular commodity and appropriate market linkages (domestic as well as export) to fetch price premium to the farmers. Centre of Excellence including a referral quality laboratory needs to be created in the region for organic farming in order to ensure the quality of bio inputs.

(vi) Promote conservation agriculture based sustainable intensification

Traditionally, agriculture in NEH is closely linked with forestry and based on biomass recycling. As such the nutrient requirements of the crop is met out either by the decomposition of leaf litter in improved *jhum* or through slash and burn biomass in traditional *jhum*. However,

quantification of bio-inputs to sustain unit area of *jhum* cultivation is lacking. Also systematic information on intensive tillage mediated biomass incorporation v/s no-till/reduced till mediated biomass mulching and their effects on soil erosion, soil moisture retention, temperature buffering, yield, income, etc. is not available. There is a great role for Conservation Agriculture to play in sustainable intensification of hill agriculture. However, in depth studies are required on conservation agriculture in low input and hill agriculture production systems for enhancing the service functions of hill agro-ecosystems.

(vii) Strengthen pig and goat farming through production of superior germplasms/ improved varieties and strengthening local feed industry

Small-scale rural entrepreneurship need to be developed in pig, poultry, goatry and dairy sector. It would open up the avenues of self employment among youth and rural communities and also address the issue regarding paucity in seed production. Focused attention is also required for production of superior germplasms/ improved breeds of pig and goat through large-scale propagation of artificial insemination at the farmers' doorstep. There is also a need to document, characterize and register the indigenous livestock species keeping in view the diversity of indigenous livestock in the region. NEH is also deficit in livestock (especially pig and poultry) feed and hence there is a need to promote local feed industry through strengthening the maize production as well as feed industry infrastructure.

(viii) Manage threats of emerging zoonotic diseases

Given the growing threat of zoonotic diseases, it is important to have basic research and disease surveillance mechanisms to be put in place. A policy decision is, therefore, needed for strengthening of biosecurity measures with special reference to transboundary and infectious diseases. The research needs to be prioritized for antimicrobial resistance (AMR), creating awareness among farmers about AMR and other zoonotic diseases (*viz.* cysticercosis in human etc.) and imposing restrictions for marketing of antibiotic drugs without prescription of registered medical practitioners. It is recommended that a high containment BSL IV laboratory needs to be established at ICAR Research Complex for NEH Region in order to handle emerging and exotic pathogens as most states have international borders.

(ix) Strengthen small and hill farm mechanization and reduce drudgery

Mechanization is a critical for timeliness of operations in agriculture, reduce production costs as well as reduce drudgery. However, the NEH region lacks the

support of appropriate farm mechanization needed to foster agricultural growth. Promotion of small and hill farm mechanization *viz.* small sized machines/tools/implements for agricultural operations, local processing machines (small oil mills and improved *dal* mills) will potentially enhance the productivity of the region while reducing human drudgery and climatic risks and increase farm income. A *'Mission on Hill Farm Mechanization'* should be launched with provision of needed funds, infrastructure and human resources.

(x) Develop post-harvest management and value addition hubs

Since the region is bestowed with rich horticultural diversity, post-harvest technologies, particularly primary processing of perishable commodities in the cluster area of production of niche crops viz. pineapple, jackfruit, high value fruits and vegetables etc. is need of the hour besides infrastructure development for value addition and marketing. Large scale accreditation/certification of mother blocks is also required in order to ensure the supply of quality planting materials.

(xi) Promote agri-preneurship and agri-start-ups to empower youth in agriculture

The region has high potential to harness the power of agricultural bioresources and also to motivate and attract rural youth. Concerted efforts to be made to promote agri-preneurship through capacity building and training through agri-business incubators and such other mechanisms to enable agri-startups and improve employability in agriculture in the NEH region.

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