

## Status of Natural Resources and Suitable Crops & Cropping Systems for North Eastern Region

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The North Eastern Region of India comprising the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura has a total geographical area of 26.23 million hectares with a population of 39.08 million (2000-01). The region is mostly hilly and mountainous. Agriculture is the main occupation of the people. Crop production in this region is carried out under diverse slopes (0-100%) and altitudes (50-3000 m.msl) having different agro-climatic conditions (tropical to temperate). Cultivated area in this region is low and concentrated mainly in small valleys, plot areas, foothills and hill slopes. Crops are grown mostly rain fed at subsistence level although there is immense potentialities for development of agriculture and its allied sectors like

forestry, horticulture and animal husbandry. Shifting cultivation and monocropping is still prevalent in these states. Cropping intensity is also low (133.2 per cent). Constellation of factors such as difficult terrains, dense forest, low pressure on land, poor transport, inadequate marketing facilities, socio-economic status of people and land tenure systems are mainly responsible for low agricultural productivity of the region. Rice and maize in cereals, potato and ginger in cash crops and rapeseed-mustard in oilseeds are commonly grown in this region. Soybean is grown in small area (mostly in the kitchen garden) as a pulse crop in almost all the north eastern hill states Table 1.

TABLE 1—LAND USE UTILIZATION PATTERN IN N.E. REGION (000ha) in 1998-99.

State	Geographical area	Land utilization	Forest	Gross cropped area	Net cropped area	Net irrigated area	Cropping intensity (%)
Arunachal Pradesh	8374	5495	5154	250	185	36	135.1
Assam	7844	7850	1930	3941	2701	572	145.9
Manipur	2233	2211	602	216	140	65	154.3
Meghalaya	2243	2241	932	266	221	48	120.4
Mizoram	2108	2108	606	116	109	9	106.4
Nagaland	1658	1560	932	286	261	63	109.6
Sikkim	710	710	875	127	95	16	133.7
Tripura	1049	1049	257	444	277	35	160.4
Total (N.E.Region)	26229	23224	11288	5646	3989	844	133.2
Total (All India)	328726	306044	68973	192619	142600	57053	135.1

### Major Constraints of Crop Production

The inaccessible area, lacks of proper communication/transport, geographical isolation, lack of infrastructural facilities as well as dearth of adequate trained manpower have resulted into low agricultural productivity of the region. In addition, some of the major problems responsible for low productivity of the region are as under:

- Shifting cultivation is prevalent in this region resulted in heavy soil erosion and land degradation due to clearing of forests. Indiscriminate deforestation is also a problem in the region. There is soil and nutrient loss in this process and ultimately affects soil fertility and crop yield.
- Management practices are very difficult in varying attitude and diverse slopes and different agro-climatic condition.
- Availability and spread of suitable high yielding varieties of crops for rainfed upland and rainfed lowland are negligible. There is lack of suitable cultivator of rice and are not found suitable for most growing conditions (low temperature high altitude) under Al and Fe toxic soils. Non-availability of HYV seeds is also a major set back for this region.
- Average consumption of fertilizers (nitrogen, phosphorus and potash) is very low as compared

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to national average resulted in low production (Table 2).

- This region receives highest rainfall throughout the year. Excessive rainfall in catchment area causing flood in valleys resulting into crop damage and difficult agricultural operations. Approximately 50 per cent areas under rice always suffer due to flood over year in this region (Table 3).
- The incidence of insect-pests and diseases are high during the wet season causes low productivity.
- Profuse and heavy weed infestation in rainfed uplands is more prevalent in this region resulted in low production of cereals and oilseed during monsoon season.
- Lack of drainage in the valleys during monsoon season and less area under irrigation during winter and summer months restrict adoption of multiple cropping.

- Low temperature, low rainfall and low sunshine hours in winter months affect productivity of rabi crops.
- Land tenure systems in the hills region are different than the plains region. Individual ownership of land is almost lacking. This has resulted into under utilization of land.

#### Agro-climatic Zones of N.E.H. Region

The entire north eastern region comprising the States of Arunachal Pradesh, Assam, Manipur, Meghalaya, Nagaland, Sikkim, Tripura alongwith 3 districts of West Bengal, viz., Darjeeling, Jalpaiguri and Cooch Behar falls under agro-climatic sub-Himalayan zone 2. On the basis of topography, agro-meteorological parameters, soil types, crops grown etc. the region has been divided into following six agro-climatic Zones (Krishnana 1988).

However, it may be mentioned that although these zones show district differences in agro-climatic characteristic, it is difficult to draw a clear line of demarcation between two zones.

Zone	Altitude range (m.msl)	Areas covered	Crops grown
(1)	(2)	(3)	(4)
I. Alpline zone	>3500	Parts of Sikkim, Arunachal Pradesh and Darjeeling district (W.B.)	Pasture
II. Temperate sub-Alpine zone	1500-3000	Tuensang, Zuneheboto and Mokochung dist. of Nagaland Western Arunachal P., Khasi hills of Meghalaya, North Eastern Manipur, parts of Sikkim & Mizoram (East & South East)	Small millets, potato, rice, maize, soybean, vegetables.
III. Sub-Tropical hill zone	1000-1500	Tirap of Arunachal Pradesh, Jaintia & Garo hills of Meghalaya, parts of Sikkim, North east Mizoram, Kohima, & Wokha of Nagaland	Rice, maize, wheat, mustard, soybean, pea, ginger, turmeric.
V. Sub-tropical zone (valley areas)	400-1000	Imphal of Manipur, Bagti & Longnak of Nagaland, Jaintia of Meghalaya, Buhchangphai areas of Mizoram	Irrigated rice & other crops as above.
V. Mild-tropical hill zone	200-800m	South Jaintia and North Khasi hills of Meghalaya, West Manipur, lower Sikkim, Dimapur & Ghaspani of Nagaland, Jampnu of Tripura, North & West Mizoram.	Upland rice, maize, pulses, cotton, wheat
I. Mild-tropical plain	0-200m	Lohit, Pasighat & Singhpohs of Arunachal P., West Garo hills of Meghalaya, major parts of Tripura, Dimapur area of Nagaland plains	Irrigated & rainfed rice, oilseeds, sugarcane, jute, sweet potato, Potato

#### status of Existing Cropping Systems in N.E.H. Region

In general, the productivity of crops in this region is low and none of the major food crops (rice and maize) are efficient on all India basis (Table 1). Low input use;

low cropping intensity and land tenure problems are the primary feature of existing cropping systems in this region. Present status of land use and productivity of major crops are presented in Table 2. Depending upon the soil type, food habits of the people and systems of farming, several

crops are grown in the region out of which cereals occupy major portion (66.5 per cent) of the total gross cropped area of about 5.6 million hectares. Among cereals, rice is the most important crop covering about 62.2 per cent of gross cropped area. Maize, wheat and small millets are the next important cereals crops covering about 2.8 per cent, 1.6 per cent and 0.8 per cent respectively of the

gross cropped area. Among oilseeds, rapeseed-mustard and sesamum are important covering about 5.0 per cent gross cropped area. Local beans, pigeon pea and pea are the important pulses grown in the region. The other important crops are potato, ginger, sugarcane, sweet potato, cassava, chillies and soybean.

TABLE 2—AREA, PRODUCTION AND PRODUCTIVITY OF CROPS IN N.E. REGION (1998-99)

Crops	NEH			All India		
	Area (000 ha)	Production (000 tonne)	Productivity (kg/ha)	Area (000 ha)	Production (000 tonne)	Productivity (kg/ha)
Rice	35511.8	5500.9	13391	44361	84871	1913
Maize	155.5	216.1	12912	6557	12068	1841
Wheat	90.1	118.2	9974	25068	68763	2743
Small Millet	42.6	31.5	3622	1438	600	417
Total pulses	158.3	28.4	5251	20026	10665	533
Total foodgrain	3967.9	5977.1	13162	119783	195916	1636
Total oilseeds	406.0	243.0	5799	232	18400	791
Potato	110.3	758.5	6870	13372	23161	17321
Turmeric	13.5	13.2	1015	141.4	437	3093
Ginger	12.7	69.77	5493	63.89	208	3262
Topiaca	8.0	46.00	5750	254.0	5523	2174
Sweet potato	18.0	72.0	4000	154.7	1205	7789
Soybean	9.0	12.5	1388	4672	5088	1089

Fruits and vegetables occupy 4 percent of the cultivated area. Due to lack of irrigation facilities, crops are grown mostly rainfed and very less area is covered under second crop. This has resulted into low cropping intensity (133 per cent) in the region. Cropping intensity is higher in Tripura (160 per cent) followed by Manipur (154 per cent), Assam (146 per cent), Arunachal Pradesh (135 per cent), Sikkim (134 per cent), Meghalaya (120 per cent), Nagaland (110 per cent) and lowest in Mizoram (106 per cent).

Shifting cultivation known as 'jhuming' in the north eastern region is still practiced in this region (Table 3). Prevalence of jhuming is a challenging problems for agricultural development and degradation of natural resources (land, water, forests). Out of 4.3 m.ha in the country, 1.9 m.ha is affected by jhuming in this region. Some of the indigenous methods like bund method of potato cultivation and cultivation of pineapple etc. along the slopes are detrimental to soil fertility and should be replaced by scientific land use such as contour bunding, terracing and strip cropping etc. However, some of the oldest systems of cropping/farming are worth mentioning. A few of them are excellent in the specific situations of this region are given below :

TABLE 3—AREA AND FAMILY ENGAGED IN SHIFTING

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States	CULTIVATION		
	No. of families engaged in jhuming	Total area affected by jhuming ('000 ha)	Jhuming cycle (years)
Andhra Pradesh	2200	150.0	3
Bihar	12200	81.0	5-8
Madhya Pradesh	2500	125.0	10-15
Orissa	141000	2649.0	5-14
Arunachal Pradesh	54000	210.0	3-10
Assam	58000	139.2	3-10
Manipur	70000	360.0	2-10
Meghalaya	52290	265.0	4-7
Mizoram	50000	189.0	5-7
Nagaland	116046	633.0	3-4
Tripura	43000	111.5	4-9
Total NEH Region	443340	1907.5	-
Total All India	622236	4356.5	-

Source: (Subramaniam, 1990)

### (i) 'Zobo' Farming System of Nagaland

This is a unique indigenous system of impounding water (Zobo) for farming which has a combination of forest, agriculture and animal husbandry on a flat ridge located at a higher elevation than the river level from where tapping of water is out of question. The farming system comprises of protected forestland on the hilltop, well-planned water-harvesting tank at the middle and cattle yard and paddy field towards foothills. The actual catchment (1.5 ha) area is kept under natural vegetation on upstream side of the pond to serve as water resources for the pond during monsoon. Use of green manure, application of cow dung and diversion of runoff through open cattle yard are the methods of manuring paddy field.

### (ii) Rice Based Farming System of Apatani Plateau (Arunachal Pradesh)

Apatani system of farming is a unique and efficient method of hill farming where rice cultivation is combined with fish culture on terraces and finger millet on terrace risers with an excellent integrated land, water and nutrient management. A remarkable system of irrigation tapping streams and canalizing through series of terraces is practiced. Nutrient and fertility level is maintained through recycling of rice straw by decomposition and burning *in situ*, decomposition of weeds, addition of pig and poultry droppings, ash, rice husk, and other household wastes.

### (iii) High Altitude Farming in Kameng Himalaya (Arunachal Pradesh)

Indigenous method of farming at high altitude by the Buddhist Monpas of Senge village (2500 m.msl) is an unique example of transition from shifting cultivation to settled subsistence hoe farming. Monpa farmers grow both kharif and rabi crops on the natural hill slopes without tracing it. While sheep droppings and oak leaves serve as manure in kharif crops, the human waste and litters are sprayed in barley field during rabi season. The farming is sustainable and soil fertility is restored through yearly rotation of maize and millets, minimum tillage with hoeing, inter culturing and mixed cropping of vegetables beans, pulses etc.

### (iv) Fruit Based Croppiug Systems of Sikkim

In Sikkim, several crops viz., ginger, vegetables, beans, maize, soybean, finger millet, black gram, rice bean and sweet potato are intercropped in mid hills mandarin orchard. In high hills potato, barley, radish, cabbage and turnip are intercropped in apple orchard. Because of low productivity of apple, farmers get most of their remuneration from intercrops. After the introduction of wheat and mustard by ICAR, Sikkim centre during winter season, there is possibility of

taking second and third crops in succeeding season without deteriorating the fertility status of the soil. Most of the new cropping systems developed are either maize based or rice based considering the food, environment and social security of people of entire state (Singh et. al. 1998).

### (v) Bamboo Drip Irrigation Systems of Meghalaya

Drip irrigation is a most economical use of irrigation water especially in orchard/trees. Bamboo drip irrigation system is in use by the tribal farmers of Jaintia and Khasi hills of Meghalaya. This system is used to irrigate betel leaf and black pepper crops in the arecanut plantation. Bamboo drip irrigation is also used to irrigate mixed orchards of jackfruit and pineapple etc.

### (vi) Organic/Natural Farming

Use of agro-chemicals (fertilizers, pesticides etc.) in this region is much less than the national average. High rainfall, wet terraces, huge surface runoff due to sloppy land etc. are not conducive for efficient use of agro-chemicals. Moreover, indiscriminate use of these chemicals may cause pollution in the lower altitudes/valley lands. Organic farming is still in existence in this region. Use of organic sources (cow dung, pig dung, FYM, poultry droppings, ash, husk, green manure) and recycling of crop and weed residues are practices to restore soil fertility for sustaining crop productivity. In many places, panicle portion of rice is harvested leaving rest of the plant (straw) in the field for incorporation into the soil for decomposition to maintain soil fertility.

### Management of Crops for Higher Yield

The experimental results from different parts of the North Eastern region have shown that crop productivity per unit area and total production can be increased through proper management of crops. The important management factors for crop production are discussed as under:

### Crop Components in the Cropping Systems

Selection of efficient crops and their varieties, food habits, productivity and area covered by a crop are very important for inclusion in the cropping system. Performance and location specific crop variety under each agro-ecosystem must be evaluated. For improving productivity of any crop, suitable varieties and appropriate inputs such as fertilizers, irrigation, insecticides, fungicides and weedicides should be used. Normally, in most of the areas in this region, rice does well in lowland and therefore, should be grown in lowland/valley land. In upland situations, rice suffers from severe weed competition, water stress, and pest and diseases (root-aphid, termites, blast

etc.) but performance maize crop is encouraging. For upland, rice variety IRAT-141, VL-206 and IRAT-144 found to be very promising under mid altitude situations of Meghalaya and Mizoram. RCPL 1-87-8 found suitable under iron toxicity wetland conditions in valley land. NEH Megha Rice-1 & 2 is suitable for high altitude. In maize RCM-1-1 performed better than Vijay composite and other local varieties. In upland mid altitude of Meghalaya Maize (green cobs) groundnut/soybean followed by rice+groundnut/soybean/rice and mustard performed well (300 per cent cropping intensity). At Basar (Arunachal Pradesh), maize+bean (1:2) gave maximum net return during kharif. Maize and rice alone gave lowest economic return. Rice+ginger, maize+ginger etc. not compatible component in cropping system for upland. Row ratio between main crop and intercrop must be evaluated to achieve higher productivity in mixed stand. Rice+groundnut/soybean at 3:1 row ratio and maize+groundnut/soybean at 1:1 row ratio found to be optimum at Barapani (Meghalaya) conditions. Rice and maize being the main crop of this region, any new cropping system should be either rice based or maize based for different locations and situations. We have already developed rice-wheat, maize-wheat and wheat-soybean cropping systems suitable for this region (Singh et. al. 1998).

#### Effect of Dates of Sowing/Transplanting

Dates of sowing/transplanting are major factor influenced yield of most of the crops. Therefore, crop should be sown at optimum date of sowing for the main crop, intercrop or crops in sequence to achieve target yield. Farmers should be aware about the pattern of pre as well as post monsoon rainfall so that sowing of crops is done in time. Generally, maize is sown in north-eastern states in between last weeks of February to last week of March on the pre-monsoon rain. Main kharif crop of rice, groundnut and soybean performed well when sown between middle of May and middle of June. Likewise, transplanting of rice should be completed by 1st week of June in high altitude, middle of July in mid altitude. For pre-kharif rice, sowing must be done by the 2nd fortnight of March. For mid-altitude Rabi crop (mustard), sowing should be done in the 2nd fortnight of October. Row to row as well as plant-to-plant is another factor, which influenced production potential of any crop. Maintenance of proper plant population per ha is very important to achieve optimum yield. Spacing for important crops are as follows-for rice (direct seeding)-20 cm apart, for rice (transplanting)-20x10cm apart, for maize-60cmx25cm apart, for groundnut-30cmx10cm apart and for soybean-45cmx10cm, respectively.

#### Nutrient Management

The soils of these regions are deficient in almost all the plant nutrients because of low inherent capacity of soil & medium humus content, less soil depths due to low deposition of parent material. In order to achieve the higher yield of crops and maintenance of fertility of soil, it is necessary to apply plant nutrients through organic or inorganic sources. Well-decomposed organic matter should be applied as much as possible as it helps to ameliorate soil, uptake of other macro and micronutrients. Based on the experimental evidences, for rice 60-80:60:40 kg, maize 100:60:40 kg, groundnut and soybean 20:60:30 kg NPK/ha found to be optimum. In intercropping systems i.e., rice+groundnut/soybean, maize+groundnut/soybean, application of additional,  $P_2O_5$  @ 20 per cent of normal dose found to increase crop yield. Lime @ 2 t/ha and or FYM @ 5-10 t/ha application every 3-4 years is essential to maintain soil fertility.

Fertilizer use efficiency in these high rainfall areas is low. Therefore, suitable nutrient carrier should be chosen for obtaining higher yield of crops (Patel & Munda, 1991). Rock phosphate coated urea (RPU) and gypsum coated urea (GCU) applied on two equal splits (Basal+PI stage) gave higher yield than three split application of urea in rice. In maize, urea super granule (USG) gave highest grain yield than that of GCU, RPU, AA and urea.

Increasing cost of fertilizer coupled with low recovery of applied nutrient due to high rainfall and heavy surface runoff, it has become necessary to lessen burden on chemical, fertilizer and find out alternative sources to supply nutrients to crop plants. Moreover, indiscriminate use of fertilizers may create pollution hazards in the lower ridges due to wide variation in altitude and slopes. The scientist to replace commercial fertilizer by biological fertilizer put considering the above facts a thought forward. Biofertilizer Azolla was tried in Barapani for its growth and multiplication, it has been observed that out of six strains trient viz., a. microphylla, A. rubra, a. mexicana, A. Filiculoides, a. Carolina was found to be most suitable strain under the agro-climatic condition of Meghalaya. A. carolina fixes about 30-35 kg N/ha per month. During the crop season, about 90-150 kg of N could be obtained by use of Azolla in paddy field.

Bio-fertilizer azolla could be supplemented with nitrogen fertilizers in lowland rice. Application of fresh azolla, composted azolla or green manure of Ambrossia was quite promising. Fresh azolla @ 10t/ha or composted azolla @ 2 t/ha+50 per cent N through inorganic source gave maximum grain yield of rice (Patel et.al., 1991).

The application of 50 per cent of the optimum dose of fertilizer to each crop of rice and wheat in sequence gave optimum yield and net income. The application of farmyard manure (FYM) worked for rice only. There was a

substantial reduction in yield with a decreasing rate of fertilizer to wheat as compared to rice. The content of exchangeable  $\text{Ca}^{2+}$ ,  $\text{K}^+$  and available P in the soil increased by application of fertilizer and manure, whereas the organic carbon content increased only by the application of FYM (Rai et al. 1990). Application of 120, 34.4 and 49.8 kg N, P and K/ha increased the grain yield of rice by 46 per cent and wheat by 85 per cent over the control in rice-wheat cropping system and yield of maize by 202 percent and wheat by 176 percent in maize-wheat cropping system (Singh et al. 1987).

### Weed Management

Keeping the crops free of weeds for certain period during the crop growth is very important to achieve maximum yield of crops. Because during this period, crops face severe competition from weeds for nutrients, moisture, space and light. Studies on cropweed competition showed that the critical period for keeping the crops free of weeds are 50 DAT/DAS, 60 DAS and 45 DAS for rice, maize and soybean/groundnut, respectively (Singh et al. 1998).

Weed problem is very severe particularly in upland throughout the North eastern region. In upland, crop yield is severely affected due to profuse growth of weed. Experimental results showed that pre-emergence application of butachlor @ 1.5 kg ai/ha followed by one mechanical weeding (hoeing) at 40 DAS was very effective in upland rice (Singh et al. 1998.) Pre-emergence application of butachlor @ 0.75 kg ai/ha within 2 days of sowing followed by post-emergence application of 2, 4 D @ 0.5 kg ai/ha was highly effective and economic in upland rice.

In maize, pre-emergence application of atrazine or simazine @ 1 kg ai/ha found to be effective in controlling weeds and maximizing maize yield (Singh and Patel, 1991).

Application of isoproteuron @ 1 kg ai/ha + 1 per cent urea solution followed by 2, 4-D Na salt @ 0.5 kg ai/ha along with 0.5 per cent triton found to be effective in controlling weeds and increasing yield of wheat crop (Singh et al. 2002)

In rice+groundnut intercropping systems pre-emergence application of butachlor @ 1.5 kg ai/ha performed well. There was no toxic effect of butachlor on groundnut. Similarly, pre-emergence application of simazine @ 1 kg ai/ha within 2 days of sowing followed by one hand weeding at 40 DAS was highly effective in controlling weeds in maize + groundnut intercropping systems.

In soybean and groundnut, pre-emergence application of either pendimethalin or butachlor @ 1 kg ai/ha followed by one weeding at 30 DAS was very effective in controlling weeds and obtaining higher yield of soybean and groundnut (Singh & Patel, 1991).

In rice-wheat cropping system, weed-free crop mechanical weeding (25 and 50 DAS) during the cropping season registered highest grain yield with minimum weed infestation. Among the herbic treatments benthocarb (50 EC) @ 3 l/ha and 2, 4 D salt @ 1kg/ha were found better than oxidiazon @ 1 kg/ha and benthocarb (Singh et al. 2002)

### Water Management

Normally, there is no need of irrigation during monsoon season. In winter season, rabi crops need adequate irrigation, as post-monsoon rainfall is not sufficient for successful crop production. Experimental results show that water harvesting and conservation during both seasons (kharif and rabi) gave higher yield in upland conditions. In upland, water retention is very poor which leads to moisture stress for upland rice even in the monsoon season. Therefore, water harvesting in situ by bunding is necessary for obtaining higher yield of upland rice. During rabi season, moisture stress in upland is very severe. Therefore, conservation of residual soil moisture or winter rain is very important. Application of mulch @ 5 t/ha along with phosphorus is useful for obtaining higher yield of rabi crops (mustard etc.) especially in tilla land which suffers from acute moisture stress (Singh et al. 1998).

### Relative Contribution of Management Factors

Input investment on profitable crop production is related to the proper allocation of management inputs. In upland rice productivity, maximum contribution was obtained from weed control (39 per cent) followed by improved variety (25 per cent) and line sowing method (19 per cent). Contribution from fertilizer application and plant protection measures towards grain yield of upland rice was less (Patel et al. 1988). Under wetland situation, application of recommended dose of fertilizer contributed as high as 70 per cent towards grain yield followed by weed control (13 per cent) and plant protection measures (10 per cent). The situation in wet terrace land conditions of Sikkim, Nagaland etc. the relative contribution of management factors were different. Under such conditions, inclusion of improved rice variety (70 per cent) contributed maximum towards grain yield. Application of fertilizer was second important component for increasing rice yield in wet terrace land. Similarly in maize, inclusion of improved variety (67 per cent) was mainly responsible for increasing grain yield of maize followed by recommended dose of fertilizers (24 per cent).

### Topo-sequence

Cultivation of crops in topo-sequence is useful on hill slopes. Normally, rice is taken in the bottom and cassava, buckwheat etc. grown at the upper terraces. Maize is grown next to rice. Soybean and groundnut may be grown in middle terraces.

## Intercropping System

Crop production in this region is mostly rainfed and rainfed upland constitute maximum area (>70 per cent) under cultivation. Grain yield of rice and maize is very poor in upland situations. Productivity per unit area can be increased by intercropping systems or parallel multiple cropping systems in upland rice or maize. Experimental Results showed that rice+groundnut/soybean at 3:1 row ratio and maize+soybean/groundnut at 1:1 row ratio gave maximum total yield and net return (Singh et al 1998). Parallel cropping of arhar in rice and maize is promising provided suitable plant protection measure is taken against pigeon pea pod borer.

## Harvesting

Crops should be harvested in time to avoid loss in yield. Rice should be harvested in 35—40 days after heading depending upon altitude, variation, being more in high altitude conditions. Groundnut, soybean and maize should be harvested in about 120, 145 and 125 days after sowing.

## Future Strategy

There should be appropriate combination of food, fodder (animal husbandry) and fuel under crop production because mixed farming systems are very much prevalent in this region. Crops grown in isolation may not be sustainable due to small & fragmented land use systems. Keeping this in view, research on crop production systems for hills are suggested as below:

1. The entire valleys of the region should be utilized for rice production. At least two crops of rice (HYV) should be taken. For this, irrigation potential has been created. Package of practices for double and triple cropping in each zone has been evolved.
2. The farmers' practices of raising vegetables like tomato, French bean and chilies during pre-kharif following by rice in main varieties and suitable package of practices.
3. Studies on intercropping systems of agricultural crops in agro-forestry and horticulture systems according to soil depth, gestation period of horticultural/agro-forestry plantations along with their allopathic effect are necessary.
4. Studies on root systems of trees/plants in horticulture and agro-forestry systems for efficient intercropping of food, fuel and fodder on hill slopes.
5. Studies on identification and development of package of practices for fodder production (trees and grasses) during lean period for successful livestock production.

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