

## A Baseline study on potato seed production systems in Meghalaya and Nagaland states of Northeast India

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# Preface or Abstract

The present working paper is based on a collaborative work undertaken by scientists of the International Potato Center, Central Potato Research Institute and Department of Horticulture, Meghalaya, India. The baseline survey report presents the existing scenario of potato production in rainfed sub-tropical highlands under long day conditions and constraints for low productivity in Meghalaya and Nagaland States. The information in the paper will serve as repository of valuable information and will benefit the researchers, developmental organization and policy makers to develop a comprehensive policy for improving food security and livelihood of resource poor farmers by enhanced productivity of potato by developing a sustainable farmer based quality seed production system in the States

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# A Baseline study on potato seed production systems in Meghalaya and Nagaland states of Northeast India

## INTRODUCTION

Meghalaya and Nagaland are two of the eight states of the Northeast of India. The other states are Arunachal Pradesh, Assam, Manipur, Mizoram, Sikkim; and Tripura lies in the Eastern Himalayas (Hindukush). The total population of the Northeast is 39 million, 88% of which lives in rural areas. The region is rich in flora and fauna. About 70% of the region is hilly, and the topography varies within each state. The annual rainfall varies from 80-500 cm. Rice is the staple food of the people in the Northeast. Potato is an important food and cash crop for the mountain people and is cultivated under rainfed conditions. From 2001-02 to 2003-04 the average potato production of the eight Northeastern states was recorded at 0.95 million tonnes from 0.12 million hectares with average productivity 7.8t/ha (Dhiman et.al., 2006). The average potato productivity of the Northeastern states including Meghalaya and Nagaland is low compared to the national average yield of 17.3t/ha. The Northeast has 10% of the total potato area of the country but contributes just 4% to total production due to very low productivity. The main limiting factors for low potato yields including Meghalaya and Nagaland are:

- i. inadequate supply of healthy planting material at reasonable prices due to the high transportation cost of seed from North India, a distance of more than 2000 km,
- ii. old, degenerated seed planted for many generations,
- iii. adoption of suboptimal management practices due to farmers' and extension workers' unawareness of improved agrotechniques for informal quality seed production,
- iv. fast degeneration of tuber seed by viruses due to farmers' ignorance of integrated disease management practices,
- v. unorganized informal seed producers, such as in North and Northwest India,
- vi. lack of knowledge of appropriate seed storage practices,
- vii. shifting (Jhum) cultivation in some areas in which land quality has been degraded by soil erosion and nutrient loss

In India, the Central Potato Research Institute (CPRI) is mainly responsible for basic seed production. Presently it produces about 2500 tonnes of breeder (basic) seed and supplies 2000 tonnes to the state Departments of Agriculture/Horticulture, the National Seed Corporation and

state Seed Corporations (Singh et.al., 2000). These organizations multiply breeder seed further to produce foundation seed and certify and provide it to farmers. The seed produced through the formal system is not able to meet the demand of the large numbers of farmers far from seed-producing zones such the Northeast. The formal or informal organized seed sectors operating in the region are too small to meet the demands of resource-poor farmers. Due to limited resources, poor farmers cannot afford to buy expensive tuber seed every year to produce potatoes. Increasing seed transportation costs from North India are also a major limiting factor to importing quality seed. A small quantity of breeder (basic) seed is imported from Himachal Pradesh which is more than 2000 km from the Northeast Region. Poor farmers are ignorant of the seed plot technique. The use of suboptimal management practices by farmers accelerates the degeneration rate of seed. The adoption of improved technologies can facilitate the farmers' use of the same seed for more generations without significant reduction in yields.

A baseline survey was conducted in Meghalaya and Nagaland States of Northeast India to study existing potato production systems and agroecologies, the limiting factors for poor potato productivity and develop a comprehensive work plan to compare efficiency and impact of seed produced through positive and negative selections and traditional ways to improve food security and livelihood of poor farmers through enhanced potato productivity.

## REVIEW OF LITERATURE

The Meghalaya and Nagaland states are mainly comprised of mountains. The climate is characterized as perhumid with warm summers and cold winters (Sehgal et al., 1990). The foothills and lower elevation below 1000 masl are not suitable for potato seed production due to higher temperatures during the crop growing period. The higher elevation above 1500 masl are cooler and therefore congenial for seed production due to low aphid population. The potato is an important food and cash crop for the people of the Northeastern state. The per capita availability of potato per year in Meghalaya and Nagaland states are 78.7 kg and 24.1 kg (Singh et al., 2003), respectively and is much higher compared to the national per capita of about 18 kg. The major inherent weaknesses in the seed production program in Northeastern Hill Region documented by Gupta et al., (2004) are: i) shifting (Jhuming) cultivation that has degraded the land by soil erosion and loss of nutrients, ii) high rainfall during the crop season provides a congenial environment for late blight spread, iii) nonavailability of quality seed at adequate prices during planting time, iv) use of imbalanced fertilizers, v) inappropriate plant protection measures and vi) lack of knowledge for improving agronomic and storage practices. Sah and et al. (2006) have documented information on planting seasons, potato-based cropping systems, export potential of fresh potatoes to neighboring states, which is off-season for importing states, and better market price due to high demand of potatoes are some of the strengths for potato production in Meghalaya. Drought at initial stage due to rainfed cultivation; farmers' ignorance of scientific know-how for potato production; high disease incidence, particularly late blight; and heavy and erratic rainfall are some of the weaknesses for potato cultivation in this region.

## BASELINE STUDY

### 1. Methodology

A format was developed to collect information on different aspects from potato growers and the Department of Horticulture/Agriculture at the time of meetings and field visits as given in Annex 1. The baseline study was conducted in areas suggested by the Central Potato Research Station, Shillong, and state Departments of Horticulture/Agriculture. The cooler areas suitable for potato seed production were selected for the survey. Four villages in Meghalaya state lying between 1600 and 1750 masl and two villages in Nagaland between 1450 and 550 masl were surveyed. The meetings were held with 56 farmers from four villages in Meghalaya and 14 farmers from two villages in Nagaland to understand the potato production system they follow and the limiting factors such as non-availability of quality seed of improved varieties, lack of knowledge on improved production technologies and poor storage and marketing facilities for poor productivity. All important issues related to production, marketing and post harvest practices

were discussed in meeting rooms in farmers' houses and in the potato fields. The potato crop grown in lowlands is mainly used for ware purposes, whereas potatoes produced on slopes are generally sold as seed. The traditional seed-production fields were visited with farmers to assess the crop vigor and health standard of the crops grown from different seed sources and the cultivation practices followed by farmers. Officials of the state Department of Agriculture and Horticulture associated with potato crop visited to collect information on potato production agroecologies and government policy for seed production and marketing to farmers. The State Government of Meghalaya potato farm was visited and a meeting was organized with the officer to gather information on basic (breeder) seed imported from CPRI, Shimla, and provided to farmers after one multiplication on the farm.

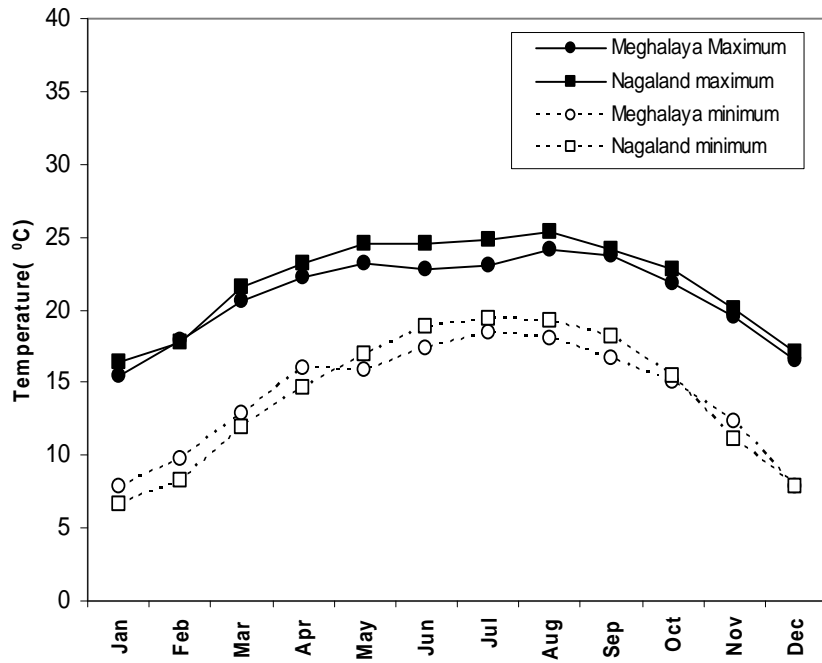
## **2. Survey report**

### **2.1 State Profile and Agroecology**

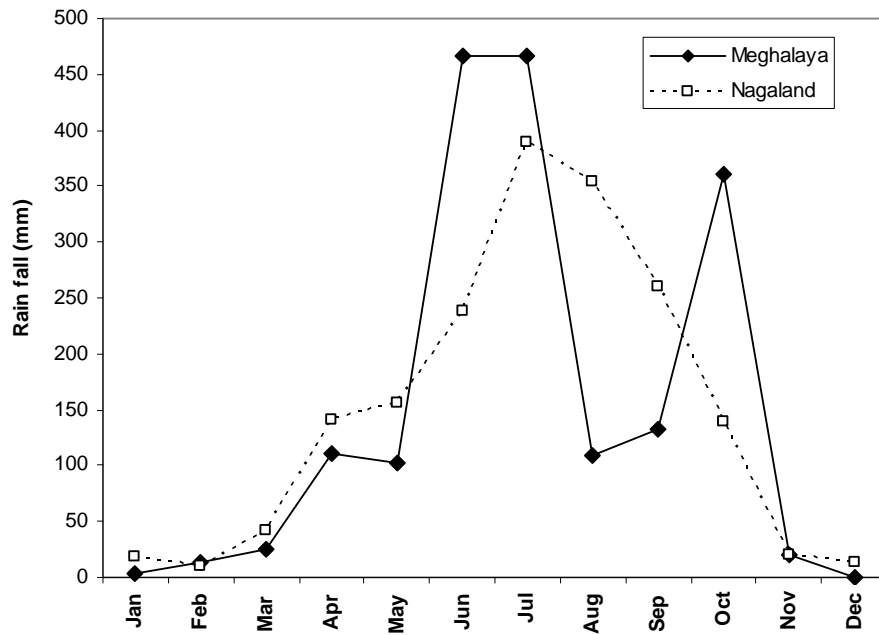
#### **2.1.1 Meghalaya**

Meghalaya is one of the eight states of the Northeastern Himalaya region. It is called “the Scotland of the East”. The two wettest places on earth are in Meghalaya state. The state is located between latitude 25° 1' and 26° 5' N and longitude 85° 4' and 92° 52' E. It has an area of nearly 22,000 sq km, predominantly mountainous. About 10% of the total area is under agriculture. The total population of the state is 2.3 million with a 63.1% literacy rate. Population density is 103 persons per sq km. The per capita income for the state is about US\$1 per day. About 80% of the population living in villages is dependent mainly on agriculture for their livelihood. The potato-paddy (rice) is the predominant cropping system in the valleys. Some farmers intercrop maize with potato. Cabbage, cauliflower and brinjal are some of the important vegetables grown after potato on slopes (terraces). The winter is cooler and summer is mild. The state has been divided into three major agroclimatic regions: i) the subtropical zone (100 to 300 masl), ii) the subtropical to semitemperate zone (300 to 1100 masl) and iii) the temperate zone (1100 to 2000 masl) (Anonymous, 2006). Potato is grown in the temperate zone during the spring season under rainfed conditions. The mean monthly minimum and maximum temperatures and rainfall of Shillong (1486 masl) in Meghalaya state are given in Figures 1 and 2. The low temperatures of temperate zones where the survey was conducted (Annex 1) are favorable to produce and maintain quality potato seed for more generations. The annual rainfall is sufficient for potato production but many times the potato crop suffers water stress immediately after planting. The average landholdings are about 1.5 ha. Some farmers take land on lease. The average number of family members is 7 to 9 (including 6 to 7 children). There is no family planning adopted by the rural people in Meghalaya. The education level in rural areas is very low. Women play a key role in decision making for household and outdoor activities. The society structure is matrilineal in Meghalaya compared to patrilineal in most states of North, West and Central India.

**Figure 1.**  
Monthly temperature of Shillong in Meghalaya and Kohima in Nagaland States. (Average over 5 years).



**Figure 2.**  
Monthly rainfall of Meghalaya and Nagaland states. (Average over 5 years)



### **2.1.2. Nagaland**

Nagaland has the unique characteristic of having the highest average landholdings, 6.8 ha, which is higher than the Northeast Regional average 1.59 ha and also of the Indian national level of 1.6 ha (Sakia, 2001). The cropped area in Nagaland is 9.02 per cent. Shifting (Jhum) cultivation, also called slash and burn cultivation, is the main type of farming where farmers cut plants and burn over a particular plot of land and cultivate for 3 to 4 years and then leave it fallow for 5 to 8 years to recuperate fertility. Farmers practice community-type farming. Some farmers take land on lease. The average family size is 6 to 10. Family planning is being adopted in urban areas only, where people are better educated. Women play a major role in agricultural activities and also participate equally with men in decision making. Nagaland state lies between 25°6' N and 27°4' N. latitude, and between the longitudinal lines 93°20' E and 95°15' E. The area of the state is nearly 16,527 sq km, predominantly hills. 1.9 million people live in the state with a 67% literacy rate (Government of Nagaland, 2006). The mean monthly minimum and maximum temperatures and rainfall of Kohima district (1444 masl) are given in Figures 1 and 2. The locations selected for the baseline study were about 10 km from Kohima in the hills as documented in Annex 1. The population density is 120 persons per sq. km. The annual per capita income is about US\$ 247. Nagaland has a basically agricultural economy. Over 70% of the population is dependent on agriculture. The main field crops grown after potato are rice, millet, maize and pulses. Cash crops like sugarcane in the lowlands and potato in the mountains are becoming popular. Coffee, cardamom and tea are grown as plantation crops. The potato-paddy is the predominant cropping system in the valleys and gentle slopes where TRC (terrace rice cultivation) are practiced. Most of the potato is grown in hills above 1500 masl in the spring under rainfed conditions. A small area is planted in foothills (lowlands) in winter under irrigated conditions. Potato is mainly grown on steep slopes as a monocrop. A few farmers intercrop maize with potato in the Jhum (shifting cultivation) system where crops are grown under rainfed conditions. Cabbage, cauliflower and chili are some main vegetables grown on slopes after potato harvest.

## **2.2 Potato cultivation**

### **2.2.1 Meghalaya**

Potato plays a major role in the livelihood of resource-poor farmers of Meghalaya. Nearly 160,000 tonnes of potatoes are produced from an 18,000 ha area with a productivity of 9MT/ha. In the lowlands/valley and uplands (slopes) farmers plant potato in February/March (Figure 3). In the lowlands, the potato crop is harvested in June. After potato harvest, rice is planted in same fields. Potato is planted on slopes at the same time but the harvesting period is spread from June to November due to two reasons. First, staggered harvesting is practiced to get better prices for produce by avoiding gluts on the market. Secondly, farmers keep the seed from the

October/November harvest for the next season. The harvested seed potatoes are kept in country stores for next year's planting. Potatoes harvested before October are generally not stored as seed due to greater losses in stores. The storage losses are high in rainy season due to high temperatures and high humidity. The farmers keep the potatoes in field even after senescence to reduce storage losses. The losses in stores are greater than those in the soil. For seed, the farmers select small size tubers from the bulk produce. A majority of farmers plant whole tubers. The farmers who do not have enough small size tubers cut up bigger tubers to plant them as seed. In some areas farmer obtain two crops of potatoes in one year. In addition to the spring crop, some farmers also grow potatoes in the autumn season. The area planted to the autumn crop is about 15 to 20%. The autumn potato is planted in October and harvested in December/January. Seed for the autumn crop is produced during the spring crop. In autumn, farmers plant local varieties instead of improved varieties because local varieties have shorter dormancy. To meet seed requirements for the autumn season, the farmers harvest the spring crop in June and keep part of produce in country stores under rice straw/grass for breaking the dormancy of the tubers. Rice straw facilitates in breaking tuber dormancy by increasing the temperature.

**Figure 3.**  
Potato cultivation in  
Mawphlang  
(1700 masl) in Meghalaya



### **2.2.2. Nagaland**

Nearly 12,200 tonnes of potatoes are produced in a 1,000 ha area with a productivity of 12t/ha. Potato is mainly grown in spring season. During 2001-2002 the total area under potato was 5100 ha, but it was drastically reduced to 1000 ha during 2004 due to nonavailability of good quality



seed. Discontinuation of the government policy of distributing certified seed at subsidized rates to farmers was the main reason for abrupt decrease in area. Most of the potato growers were dependent on the state government for potato seed. In the hills, potato is planted in February/March and harvested in May/June. In lowlands and gentle terraces after the harvest of potato, farmers transplant to paddies where irrigation facilities are available. On slopes, farmers practice potato + maize intercrop under rainfed conditions. On slopes, potato is generally harvested late in October/November. In the foothills potato is grown during the winter season between November and February. In some areas potato is also planted during August/September and harvested in November/December. Being off-season, the autumn produce is sold at premium price. The potato produced in lowlands/valleys is sold as table potatoes, whereas potato produced on slopes is used for both seed and table purposes. For seed, farmers follow the in situ method of potato storage. The vines of the crop die due to natural senescence by June/July but the farmers do not harvest their potatoes until October/November to avoid storage losses from keeping in country stores. The tubers remain in good physiological condition in the soil where in situ storage is practiced because of low soil temperatures. However the crop severely damaged by late blight is harvested early to avoid further losses due to tubers rotting under the soil.

Planting the whole tuber is widely practiced by farmers. The use of whole tubers reduces rottage under the soil and secondly it decreases the spread of contact diseases such as viruses and bacterial diseases from diseased to healthy tubers by the knife used to cut the tubers.

## **2.3 Seed systems**

### **2.3.1 Formal seed system**

#### **2.3.1.1. Meghalaya**

The state Department of Horticulture has the responsibility of providing good quality planting material to farmers. For the potato crop, the department purchases basic (breeder) seed from the Central Potato Research Institute (CPRI), Shimla. The breeder seed of Kufri Jyoti and Kufri Giriraj varieties procured and multiplied to foundation seed by Department of Horticulture at the experimental station in Upper Shillong for the last five years, i.e., 2002 to 2005, is given in Table 1. Kufri Jyoti is the main variety grown by farmers. The foundation seed is supplied to progressive farmers to produce certified 1, 2 and 3 if needed. The Department of Horticulture buys back the certified seed to distribute among other farmers. The buyback and mechanisms to sell to other farmers depends on farmers' seed demand. The total annual seed requirement of Meghalaya is about 45,000MT. The formal seed system is able to meet less than 2% of the farmers' total seed requirement. The rest of the seed used by farmers is informally produced.

**Table 1.** Breeder seed (basic) procured from Central Potato Research Institute, Shimla.

Year	Varieties	Breeder seed (tonne)
2002	Kufri Jyoti, Kufri Giriraj	4.0
2003	Kufri Jyoti, Kufri Giriraj	8.5
2004	Kufri Jyoti, Kufri Giriraj	8.5
2005	Kufri Jyoti, Kufri Giriraj	8.0
2006	Kufri Jyoti, Kufri Giriraj	3.0

Source: Department of Horticulture, Meghalaya

The crop health standard grown from breeder seed at the government farm was good, as seen in Figure 4. Some volunteer plants were noticed as seen in the figure.

**Figure 4.**  
Crop grown from  
breeder seed at  
Experimental Station



### 2.3.1.2 Nagaland

Breeder (basic) seed of improved varieties is procured from CPRI, Shimla, by the Department of Agriculture and provided to the contact/progressive farmers. In some years certified seeds are also purchased from Himachal Pradesh state through seed suppliers. The seed quantity of potato varieties purchased from CPRI, Shimla, from 2002–2006 is documented in Table 2.

**Table 2.** Breeder (basic) seed procured from Central Potato Research Institute, Shimla.

Year	Varieties	Breeder seed (tonne)
2002	Kufri Jyoti, Kufri Bahar, Kufri Sindhuri	3.5
2003	Kufri Jyoti, Kufri Bahar, Kufri Sindhuri	7.0
2004	Kufri Jyoti, Kufri Giriraj	8.0
2005	Kufri Jyoti, Kufri Chandramukhi, Kufri Kanchan	4.0
2006	Kufri Jyoti, Kufri Chandramukhi, Kufri Kanchan	2.5

The farmers multiply breeder seed in their fields. Only selected resourceful farmers are able to obtain breeder seed due to limited seed quantity. This seed is used for 4 or 5 generations and is replaced with new seed when there is substantial reduction in potato yield. The formal seed system is able to meet the seed requirements of nearly 2% of the potato growers. Occasionally, some farmers bring seed from registered seed growers of Regional Potato Farm, Mao, Manipur. Farmers use this seed for both seed and ware potato production. Part of the produce they retain as seed and utilize for 4 to 6 generations. The breeder seed supplied to farmers is bought back by the state Department of Agriculture partly or completely depending upon seed requirement. Some farmers sell the produce of breeder seed to fellow farmers. The seed produced by multiplying breeder seed in this system is not certified. It is called truthful seed. Truthful seed is quality tuber seed informally produced by farmers in their fields but of good quality. No official seed certification procedure is followed for truthful seed. This category of seed supplied by the Department of Agriculture to farmers in the last five years is given in Table 3.

**Table 3.** Truthful seed supplied to the farmers by Department of Agriculture.

Year	Varieties	Truthful Seed (MT)
2002	Kufri Jyoti, Kufri.Sindhuri, Kufri.Bahar	30
2003	Kufri Jyoti, Kufri Sindhuri, Kufri.Bahar	30
2004	Kufri.Jyoti, Kufri.Giriraj	20
2005	Kufri.Jyoti, Kufri.Kanchan, Kufri.Chandramukhi	90
2006	Kufri.Jyoti,,Kufri.Kanchan, Kufri.Chandramukhi, Kufri.Giriraj	450

**Source:** Department of Agriculture, Nagaland

In 2006, a massive quantity of truthful seed was purchased and distributed to the common farmers because this was declared the "YEAR OF FARMERS" by the Nagaland government. The seeds were procured through suppliers. They were brought from several sources including Khuzama near Mao, Manipur Potato Seed Farm. It is distressing that high quality breeder seed purchased at a high price and transported a long distance is not multiplied at farm-level by improved agrotechniques due to lack of resources and awareness. The farmers and the majority of employees of the Department of Agriculture are unaware of improved technologies for quality seed production and for them there is no difference between seed and ware potato production practices. The precious breeder seed could be utilized for more generations if integrated crop management practices are adopted for informal seed production system. No organization has carried out a formal study to understand the number of generations a breeder or basic seed could provide economic yields at farm-level in the warm perhumid agroecology of the Northeastern hills.

### **2.3.2 Informal seed system**

#### **2.3.2.1 Meghalaya**

Nearly 98% of farmers' seed requirements is met by the informal seed produced in the state. The majority of potato growers in Meghalaya have been using the same seed for more than 10 generations as farmers have mentioned during discussion (Annex 1). Some farmers have not replaced their seed for over 20 years. A few resourceful farmers are able to buy certified seed at a subsidized rate from the Department of Horticulture. They use this seed for minimum 4 to 5

years. The farmers practice similar agrotechniques for both ware and seed crops. For them there is no difference between the two. They retain small and medium-sized tubers from general produce as seed and sell the large and oversized tubers. The resource-poor farmers replace their stock when the yields are drastically reduced due to seed degeneration. The farmer buys fresh seed from fellow farmers or traders. Crop health standards at one location was satisfactory where the Central Potato Research Station and Department of Horticulture have been working jointly with farmers for the last three years. Crop health was not good at other sites where farmers are unaware of the importance of quality seed and improved management practices (Figure.5).



**Figure 5.**  
Scientists interacting with farmers in a potato field.

### **2.3.2.2 Nagaland**

The majority of potato growers in Nagaland use their own seed for more than 5 years. Resource-poor farmers replace their stock when the yields are considerably reduced due to seed degeneration. Farmers prefer to plant varieties like Kufri Kanchan (red skin) which has a slower rate of degeneration compared to other varieties. This is the most popular variety grown by farmers in Nagaland. The farmers continue to use degenerated seed due to nonavailability of quality seed at affordable prices. Informal seed is sold by both traders and farmers. Seed selection is made from bulk produce at the time of harvest. The farmers select clean skinned 40-60 gram seed-size tubers from the baskets. Seed selection is made by visual observation. This type of

selection procedure does not help select seed tubers free from tuber borne diseases such as viruses and bacterial wilt. The farmers do not practice dehaulming (removing vines) for: i) hardening of tuber skin, ii) to check spread of viruses, iii) to reduce bruising and iv) to obtain more seed size tubers. Poor farmers who cannot afford to buy the expensive seed often need to practice positive selection in their plots to select better seed.

## **2.4 Production technologies**

### ***2.4.1 Meghalaya***

The farmers plant potato in raised beds both in lowlands (valleys) and slopes. The bed size depends on the size of the plot/terrace. A distance of 70-80 cm is left between two beds for rainwater drainage. The bed height varies from 35-45 cm. The potatoes are generally planted at a distance of 40X30 cm. One tuber is planted per hill. If tubers are small then 2 to 3 tubers are planted per hill. The seed rate varies between 2.5 to 3.0 t/ha. In the traditional system the following steps are practiced at planting time: i) tuber is planted in a pit and covered with farmyard manure ii) inorganic fertilizers are placed over the farmyard manure and covered with soil. Most of the farmers apply urea as the sole source of nitrogen. Some farmers also apply single super phosphate (SSP). A few farmers who have come in contact with the staff of the Central Potato Research Institute have also started applying Muriate of Potash (MOP). The farmers apply 200-250 kg urea and 400-500 kg SSP per hectare. The complete dose of fertilizers is applied at one time at planting. No fertilizer is applied at earthing (hilling) up. During the meeting, the farmers were advised to apply the inorganic fertilizers in split doses particularly the urea to improve its efficiency. The nitrogen from urea compared to other fertilizers (DAP, CAN and  $\text{NH}_4\text{SO}_4$ ) leaches faster. Therefore, it is more appropriate to apply urea after the emergence of plants. It is not common to rough out (pull out) diseased and off type plants. Dehaulming (removing vines) is not practiced for seed production. The farmers have no knowledge of improved management practices. All operations from field preparation to harvesting of potato are done manually. Barely 2% of the farmers use a power tiller for field preparation. The limited number of resourceful farmers rent out their power tillers Crop rotation is not practiced due to small landholdings and secondly the potato is a vital source of livelihood for poor farmers.

### ***2.4.2 Nagaland***

Shifting cultivation where farmers clear the land and burn a particular plot of land and cultivate crops for 3-4 years is commonly practiced in Nagaland. After cutting and burning the forest, some farmers apply 4 to 6 tonnes farmyard manure (FYM) or cow dung to improve soil fertility level. Manure is applied one month before land preparation. All steps starting from application of

organic manure to field preparation, planting of crop, earthing up, intercultural operations and harvesting are done manually. Ridges and furrows are made for potato cultivation. The distance between two ridges is about 40-50cm. Tubers are placed on the ridges at a depth of 6-8 cm. Whole tubers are planted at 20-25 cm intra row spacing. In case of small size tubers (10-20 g), 2 to 3 tubers are planted per hill. The purpose of planting more undersize tubers per hill is to keep the stem density equal to medium size tubers for absolute ground cover to obtain good yields. The planting of whole tubers is commonly practiced. The seed rate varies between 2.0 to 2.5 t/ha. With few exceptions, farmers practice organic cultivation. During the survey, it was observed that a few farmers apply inorganic fertilizer for potato production. The farmers who incorporate inorganic fertilizers apply mainly urea as a sole source of nitrogen. Some farmers also apply Di-Ammonium phosphate (DAP). The farmers apply 50-100 kg urea or 100-200 kg DAP per hectare. The complete fertilizer dose is applied at planting. No fertilizer is incorporated at earthing up time. The broadcasting method of inorganic fertilizers adopted by farmers is not appropriate for efficient utilization of nutrients for maximum production. The judicious use of a similar quantity of fertilizers can enhance productivity. Farmers expressed a strong belief that, due to continuous application of inorganic fertilizer, yields are decreasing. The imbalanced use of fertilizers could be the reason for reduction in productivity. The roughing and dehaulming for seed production are not practiced by farmers. Farmers are ignorant about improved technologies for quality seed production at farm-level.

## **2.5 Potato varieties**

### **2.5.1 Meghalaya**

Kufri Jyoti is the main improved potato variety grown in Meghalaya. Besides this, Kufri Megha is the other variety planted by farmers. CPRI has recently introduced a new variety, Kufri Giriraj, released for the hills. But farmers still prefer to grow Kufri Jyoti and Kufri Megha because these varieties have i) slow degeneration rates, ii) better keeping quality, iii) longer dormancy compared to Kufri Giriraj. The Kufri Giriraj is good yielding variety but farmers informed us that from the third year its yield starts to decline fast. Beside improved varieties, farmers also grow local (Desi) varieties. The farmers cultivate local varieties due to: i) the slow rate of degeneration compared to improved varieties, and ii) the short dormancy of some selected local varieties facilitates using seed from summer production for autumn planting. Phansaw, Lahsyntiew, Lahsaw (red skin) and Lahtaret (white skin) are some of the local varieties grown by farmers. The farmers' fields have a mixture of varieties, noticed during field survey (Figure 6). The positive selection procedure at farm level can improve the seed quality used by farmers.



**Figure 6.**  
Mixture of varieties in  
crop planted by farmer.



### ***2.5.2 Nagaland***

Kufri Jyoti and Kufri Kanchan are the main varieties grown in Nagaland. Farmers still give preference to Kufri Jyoti because it is early bulking and has better resistance to late blight compared to other varieties. There is still no replacement for Kufri Jyoti. The occurrence of late blight is a common feature in the hills during the spring season.

## **2.6 Potato diseases and their management**

### ***2.6.1 Meghalaya***

The potato leaf roll virus and mild and severe mosaics were common, as observed in many potato fields. The intensity of infection varied on the standing crop, based on the seed source. The farmers rarely use insecticides to control aphids. Late blight (LB) is a major limiting factor for potato production in Meghalaya state. LB appears regularly in endemic form. The environment is conducive for LB. Many times the crop is killed before maturity. The Kufri Jyoti released as a LB-resistant variety has also lost resistance to new races. The farmers use both Dithane M-45 (contact fungicide) and Ridomil (systemic fungicide) to control LB. Bacterial wilt was not observed as a major problem.



### **2.6.2 Nagaland**

During spring, overcast and humid weather which is common in the region is congenial to the spread of late blight. This type of weather trend is noticed towards crop maturity. The majority of farmers do not apply any fungicides. The crop health standard grown from seed supplied by the department of Agriculture during 2006 under the program "YEAR OF FARMERS" was satisfactory except for a few plants infected by PLRV and mosaic viruses. The crop planted from informal seed procured from traders and farmers was poor and diseased. Bacterial wilt was observed in some fields but it was not a severe problem. Main pests were red ants, rodents, cut worms, white grubs and aphids. A majority of the farmers do not apply pesticides. Farmers try to kill the pests manually. Commonly the potato produced in Nagaland is organic except for a few farmers who apply inorganic fertilizers. The percentage of farmers applying inorganic fertilizers is below 10%.

## **2.7 Potato Storage**

### **2.7.1 Meghalaya**

Farmers store seed potatoes in country stores. There are no refrigerated stores in the state. The design of the country stores is simple as seen in Figure 7. The size of the country store is made according to the farmer's requirement. The seed in the store is stored in different ways such as i) in bamboo baskets, ii) in heaps, iii) in 3 to 4 layers of tubers on shelves. The walls of the stores are made of wood and the roof is of tin. The tin roof helps to protect store from heavy rains and to keep it warm during winter. Low temperatures during December/January can damage seed tubers if proper insulation is not provided. Seed tubers in the store are kept covered with rice straw or dried grass to protect from cold injury. The improvements in the designs of existing country stores can reduce storage losses and can also keep the seeds in good condition.

**Figure 7.**  
A country potato  
store built near the  
residential area



### **2.7.2 Nagaland**

A privately managed refrigerated cold storage facility exists in Dimapur but no potato is stored in it. Dairy products, costly fruits and off-season vegetables are stored in this cold store. Farmers store potatoes in country stores made of locally available materials. They store potatoes in two ways: a) a shed-type structure of bamboo/wood is made of the appropriate length and breadth with metal roof to protect tubers from low temperature injury. Potatoes are kept on the ground in a single layer. Some farmers store potatoes in 3 to 4 tiers of racks to increase storage capacity, b) in the southern Angami region bordering Manipur some farmers store potato in pit stores. A pit of appropriate size is dug and an inner lining of the pit is made of stones. The mouth of the pit is covered with straw and then soil after the potato is stored inside. The losses due to rotting in pit stores are about 5% as informed by farmers. The seed tubers in pit stores are mainly stored by farmers who cultivate potatoes in the high hills. Transporting seed from hill to village at harvest and back at the planting time is difficult and costly. Pit stores are made exclusively to store seed.

## **2.8 Marketing**

### **2.8.1 Meghalaya**

Farmers market their produce in the nearby town or city. Farmers' groups collect their potatoes and transport them collectively. One person, from inside or outside the group of farmers, but whom everybody considers reliable, works as facilitator to market the potatoes. The facilitator charges a commission from the farmers according to the quantity marketed. Some farmers

growing potatoes on the slopes practice staggered harvesting to avoid gluts on the markets and to get better prices for their produce. The farmers are able to retain the potatoes in the field for two to three months due to low soil temperature.

### ***2.8.2 Nagaland***

In Nagaland, there is no organized marketing system for potato. Farmers themselves carry potatoes directly to retailers in nearby markets in the cities. Some potato dealers from adjoining areas of Manipur also purchase potato from the southern Angami region of Jakhama. Manipur state has to buy potatoes from outside to meet local demand.

## **3.0. Establishment of positive and negative seed production sites**

### ***3.1.1 Nagaland***

A training program was organized in Nagaland on 23 and 24 August for the farmers and workers of the Department of Agriculture to be formally associated with positive and negative seed production at farm level. Twenty farmers were selected and trained to carry out on-farm trials to study the feasibility and benefits of positive seed production technology. Ten farmers were selected and trained separately to conduct trials to produce, multiply and maintain quality seed at farm level through negative seed production technique. The participants were trained in positive and negative seed production techniques including improved agrotechniques for quality seed production at farm level. Lectures were delivered on the major potato diseases of the region and how to control them and post-harvest management. Field training was organized to demonstrate proper implementation of improved technologies for quality informal seed production.

## CONCLUSIONS

Agriculture is the main source of livelihood for more than 70% of the population of Meghalaya and Nagaland states of Northeast India. The potato is the second most important food and cash crop after rice in Meghalaya. The potato productivity of Nagaland and Meghalaya states is nearly half the average productivity of the rest of India. Nonavailability of quality seed at adequate prices for resource-poor farmers and lack of knowledge of improved technologies are the major factors limiting productivity. The informal seed sector is not organized as it is in the North Indo-Gangetic Plains. The potatoes are grown in irrigated lands lowlands during winter, and in the midlands and uplands during spring/summer under rainfed conditions. Most of the potato is produced in mountains. Agroecologies above 1500 masl are congenial for quality seed production. Late blight is the major constraint to increase production. CPRI and CIP should emphasize LB-resistant varieties with good keeping quality in country stores for screening new clones/hybrids. Secondly, improvement in the informal seed production system is essential to enhance productivity. CIP has developed a work plan to study and implement positive and negative seed production technologies to improve informal seed quality for enhanced potato productivity and to alleviate poverty. The policy makers such as the Departments of Horticulture and Agriculture of Meghalaya and Nagaland states have been officially involved in the execution of the project activities.

## REFERENCES

- Anonymous.** 2006. Government of Nagaland and Confederation of Indian Industry. North-East Agri-Expo 2006. Opportunities for Agri-Businesses including Horticulture, Floriculture & Food Processing in North-Eastern Region. Organized by Government of Nagaland and Confederation of Indian Industry, Dimapaur, India, 27-31 March.
- Dhiman, K.R., P.H. Singh, Kumar Shantanu , and S. K. Pandey.** 2006. Agricultural scenario in North Eastern Region of India. *Technical Bulletin No. 76*, PP: 1–7. *Integrated Development of Horticulture in Northeastern states of India*
- Gupta, V.K., Shantanu Kumar, Sah Uma, Kumar Shiv and P.H. Singh.** 2004. Quality Seed Potato Production in NEH Region of India. *Technical Bulletin No. 62*. Shimla, H.P. India: Central Potato Research Institute (Indian Council of Agricultural Research).
- Sah, U., Shantanu Kumar, N.K Pandey, and S.K. Pandey.** 2006. Traditional potato cultivation practices in Meghalaya. 2006. *Technical Bulletin No. 72*. Shimla, H.P. India. Published by Central Potato Research Institute, Shimla (Indian Council of Agricultural Research),
- Saikia, A.** 2001. Performance of Agricultural Economy of the North Eastern India: Constraints and Priorities. Presented in workshop "Prioritization of strategies for Agricultural Development in Northeastern India" organized by National Centre for Agricultural Economics and Policy Research (NCAP).
- Sehgal, J.L., D.K. Mandal, C. Mandal, and S. Vadivelu.** 1990. Agro-ecological Regions of India. *NBSS Publication.24*. Nagpur, India: National Bureau of Soil Survey and Land Use Planning (Indian Council of Agricultural Research).
- Singh, P.H., V.K. Chandla, S.M.Paul Khurana, I.D. Garg, K.C.,Thakur, Sarjeet Singh, and S.S. Lal.** 2003. Potato cultivation in North Eastern India. *Extension Bulletin No. 34 (E)*. Shimla, H.P., India: Central Potato Research Institute (Indian Council of Agricultural Research).
- Singh Sarjeet., V.K. Grag, Shiv Kumar, and G.S Shekhawat.** 2000. *Seed Potato Production Manual*. Shimla, H.P. India: Central Potato Research Institute, Shimla (Indian Council of Agricultural research).



#### **CIP's Mission**

The International Potato Center (CIP) works with partners to achieve food security and well-being and gender equity for poor people in root and tuber farming and food systems in the developing world. We do this through research and innovation in science, technology and capacity strengthening.

#### **CIP's Vision**

Roots and tubers improving the lives of the poor.



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