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Food legumes for livelihood and nutritional security in North Eastern Himalayan Region: Prospects and constraints

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ABSTRACT

India is no longer dependent on other countries for foodgrains, thanks goes to policy planners, researchers and the farmers who made concerted efforts that ushered in green revolution in the 1960's. However, despite being the largest producer of pulses in the world, we are still not self sufficient in pulses. India is the largest producer of pulses in the world with 25% share in the global production. Chickpea, pigeonpea, greengram, blackgram, lentil and field pea are important pulse crops contributing 39%, 21%, 11%, 10%, 7%, 5%, respectively to the total production of pulses in the country. The production and productivity of pulses in the country was 14.56 million tonnes and 625 kg/ha respectively from an area of 23.63 million hectares during 2007-08. The country has to realize the pulses production potential to become self sufficient. There is a real challenge where about 11 million ha of arable acidic soils with pH < 5.5 suffer from deficiencies as well as toxicities of certain nutrients and have very low productivity. Liming at the rate of 2 to 4 quintals/ha along with half of the recommended fertilizers raises the potential to double the productivity especially for oilseeds and pulses in the acid soil regions of the country. North East India soils are acidic in nature, and this region can contribute considerably to pulses production. The present paper presents an overview of the livelihood and nutritional security of food legumes and their prospects and constrains in north east hill regions. It also reports the phylogeny and particularly physiology of bacteria involved in these associations, as well as the relative agronomic importance of the different systems.

Key words: Food legumes, North East, Prospects and constraints, Pulse productivity, Significance in soil fertility

Pulses, the food legumes, have been grown since millennia and have been a vital ingredient of the human diet in India. Even "balanced food" – as defined over 1000 years ago – consisted of pulses, besides cereals, vegetables and fruits, and milk products (Ayachit 2002). Even today, pulses and milk provide the full complement of proteins to people who avoid eating meat. Pulses belong to the family leguminaceae (COPR 1981). The family leguminaceae is made up of many species which are cultivated all over the world (Rubatzky and Yamaguchi 1997). Pulses are the second most important group of crops after cereals. In 2009, the global pulses production was 61.5 million tonnes from an area of 70.6 million ha with an average yield of 871 kg/ha (IIPR 2011). Dry beans contributed about 32% to global pulses production followed by dry peas (17%), chickpea (15.9%), broad beans (7.5%), lentils (5.7%), cowpeas (6%) and pigeonpea (4.0%) (IIPR, 2011). The latest triennium (2007-09) average of 61.2 million tonnes production shows a positive annual growth of 0.7% per annum over 55.03 million tonnes recorded in 1997 (IIPR 2011). Comparative data for the eighties reveal phenomenal annual growth of 2.85% mainly attributed to positive growth of 0.87% in area and 1.83% in productivity (IIPR 2011). Developing countries contribute about 74% to the global pulses production and the remaining comes from developed countries. India, China, Brazil, Canada, Myanmar and Australia are the major pulse producing countries with relative share of 25%, 10%, 5%, 5% and 4%, respectively (Anonymous 2011). Countries recording annual production growth of more than 4% are

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Myanmar (11.5%), Canada (10.8%), Germany (8.3%), Sudan (8.1%), Spain (7.4%), Ethiopia (4.92%), China (4.7%) and Syria (4.1%) (IIPR 2011).

India produces a quarter of the world's pulses, accounting for one third of the total acreage under pulses. Indians consume 30% of the world's pulses, but domestic production of pulses has not kept pace with population growth. Pulses production has grown at only a 1% current agriculture growth rate from 1951–2008, compared to a population growth of about 2% during the same period (GOI 2008). The productivity of pulses has been very low in India, with 45% cumulative growth between 1951–2008, compared to the productivities of wheat and rice, which have grown manifold, at 320 and 230%, respectively, during the same period (GOI 2008). Also, the area under pulses has grown at 25% during this period, a much lower rate than that for other foodgrains.

If India's pulses productivity has to rise sufficiently to meet the nation's demand for pulses, then one route is to increase the amount of land used for cultivating pulses. In India, farming is mostly a pattern driven by the onset and intensity of the monsoon, and the timing of the *kharif* and *rabi* crops. The farming community can also increase productivity through adoption of improved technology on a much larger area. The Department of Agriculture and Cooperation has proposed a strategy for increasing production and productivity of pulses that involves a thrust on non-conventional cropping systems, such as: Intercropping of pigeonpea, greengram and blackgram with maize, cotton, groundnut, soybean, etc. (Amarteifio *et al.* 2002).

Potential for substantially increasing the legume production in the North Eastern Region of the country exists. The growth scenario of pulses and oilseeds production is a mixed one. The region produces 111.7 thousand tonnes of pulses and 239.1 thousand tonnes of oilseeds from 176.1 thousand ha and 424 thousand ha with an average yield of 634 kg/ha and 563 kg/ha respectively during 1998-99. Non-availability of adequate quantity of quality seeds of improved varieties and lack of use of inputs like fertiliser, weed control and disease and pests protection are major constraints in pulses and oilseeds production in the region. The total area under pulses in seven hill states in only 46 300 ha and that of oilseeds is only 93 800 ha. However, the area under pulses and oilseeds showed a substantial increase from 11 000 ha in 1993-94 to 16 400 ha in 1997-98 and 21 000 ha in 1993-94 to 28 500 ha in 1997-1998 respectively.

Food legumes scenario in India

Grain legumes include all the pulse crops like chickpea, pigeonpea, greengram, lentil, peas, beans etc and also some major oilseed crops like groundnut and soybeans. These are important crops in terms of the daily diet, contribution to human nutrition (both protein and fats) and also in terms of their contribution to farmer's income. During the period of four decades (1971-2010), there is a marginal increase of approximately 10% in the area under pulse cultivation with a nominal gain of total production , however the yield of pulses has remained virtually stagnant for the last 20 years (580 kg/ha in 1990's to nearly 607 kg/ha during 2010). In terms of area, production chickpea contributes maximum among all major pulse crops, whereas dry pea excels in productivity which is evident in Fig 1. Further the consumption of pulses is increasing over the years as shown in Fig 2. This demands urgent need to increase the area and production to meet the increasing demand of the pulses for the present and future growing population.

During green revolution period from 1966 to 1980s, major cereal production increased significantly at the cost of pulses and oilseeds. For pulses, there is no significant technological breakthrough until now, due to peculiar problems like indeterminate plant type, low response to fertilizers and irrigation. The same is true for oilseeds also until mid-1980s. However, since mid-1980s due to TMOs, the growth rate of oilseeds increased mainly driven by introduction of new crops like soybean and sunflower and integrated approach to oilseeds development with multiagency approach. Due to renewed emphasis on edible oils and pulses through different government programmes since last decade, the consumption rates of edible oils and pulses increased (Fig 2). But to reduce the prices to affordable levels there is a need for increased investments in research and development with emphasis on low cost technologies to increase cost competitiveness.

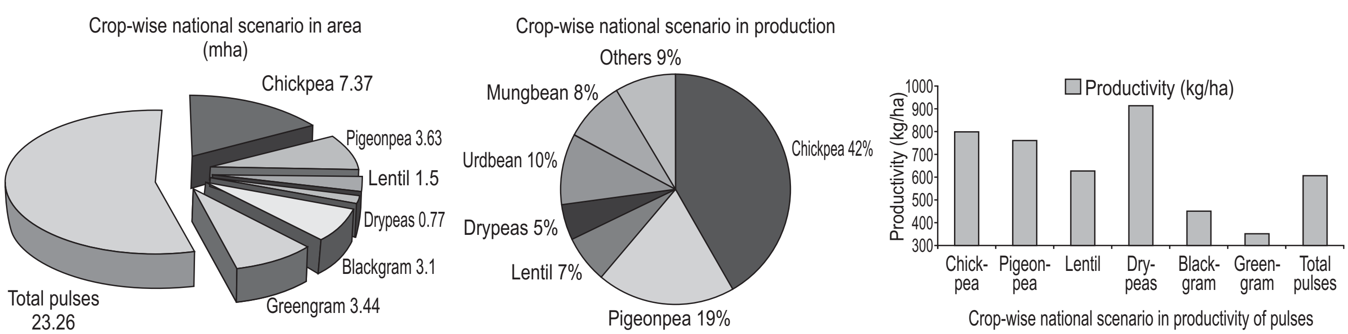

Fig 1 Crop-wise national scenario in area, production and productivity of pulses. Source: IIPR: Vision 2030 (2011)

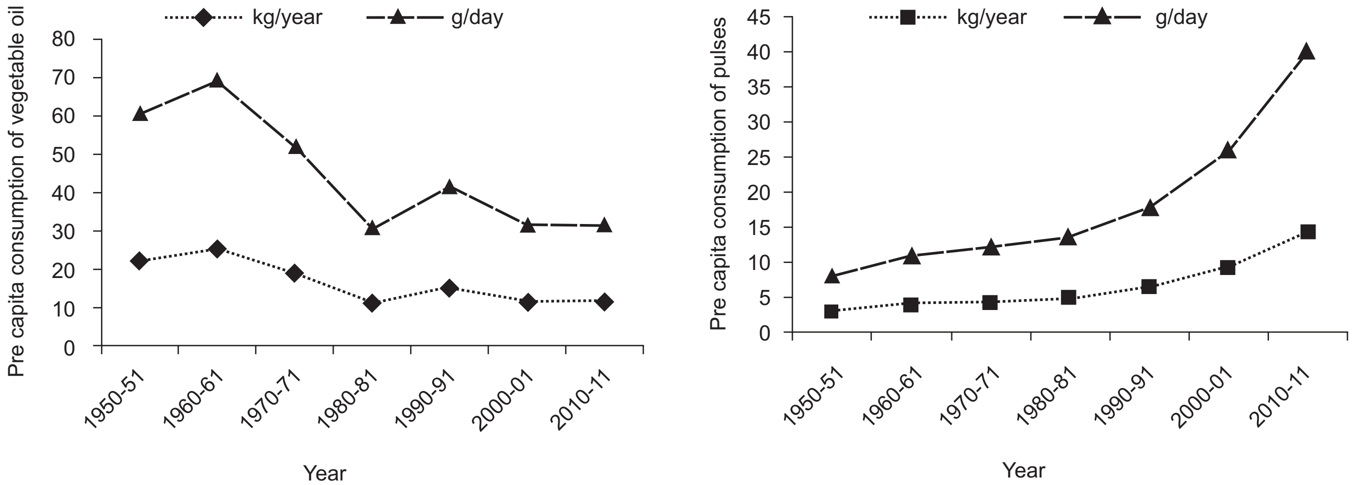

Fig 2 Consumption of vegetable oil and pulses over the years. Sources: Economic Survey 2011-12 and www.Indiastat.com/Ministry of Agriculture, Government of India, 2012.

Food legumes scenario in NE region

Pulses in India are mainly grown on marginal land under rainfed conditions with low or no inputs. The productivity of pulses in the region is around 800 kg/ha. However, we should not gloat over the fact that in term of productivity the region is ahead of the other parts of India. Still our productivity is very low as compared to developed countries. Rice is the dominant crop and occupied three-fourth area among the crops. Pulses are mostly grown under hilly regions. Beans, groundnut, pigeonpea, blackgram, lentil, pea, cowpea and rice bean are important legume crops of NE region. The productivity of *kharif* and *rabi* pulses of the region is shown in Fig 3 and 4.

In NE region, farming is predominantly rice based except Sikkim where maize is the dominant crop. Monocropping is prevalent; therefore, cropping intensity is low. There is ample scope for the introduction of pulses in the cropping system of the region. As compared to other states of India, the food legumes are not very much popular here because the diet of majority of the population is non-vegetarian. Farmers are growing pulses for better economic returns. This is evident from the area under *rabi* and *kharif* pulses in the NE states (Table 1 and 2).

Rice bean (*Vigna umbellata* L.) is an important underutilized crop of the region and its photo insensitive genotypes have been identified, therefore, it can be promoted in the region. It is regarded as a minor food and fodder crop and is often grown as intercrop or mixed crop with maize (*Zea mays*), or cowpea (*V. unguiculata*), as well as a sole crop in the uplands, on a very limited area. There is scope for increasing area under pulses such as rajmash in Sikkim, Nagaland, Mizoram and Manipur; pigeonpea and blackgram in Tripura. The region has a vast untapped agricultural potential. Concerted efforts have to be made to popularize cultivation of food legumes among the farming community of the region.

Cropping pattern and cropping system

In NEH Region, rice is the dominant crops in valley areas. In hilly areas mostly farmers are growing cereals, pulses and oilseeds in mixed farming. Intercropping of pulses and oilseeds is one of the ways to increase pulse and oilseed

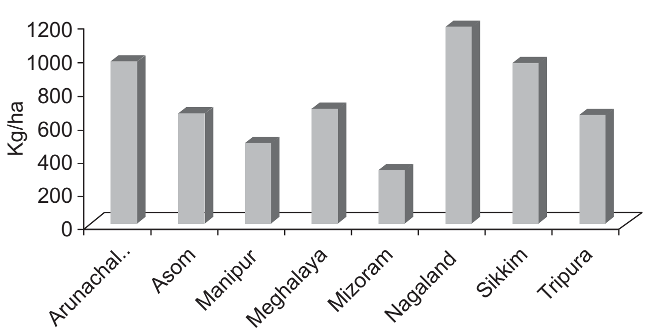

Fig 3 Productivity of *kharif* pulses in different NE states during 2007-08

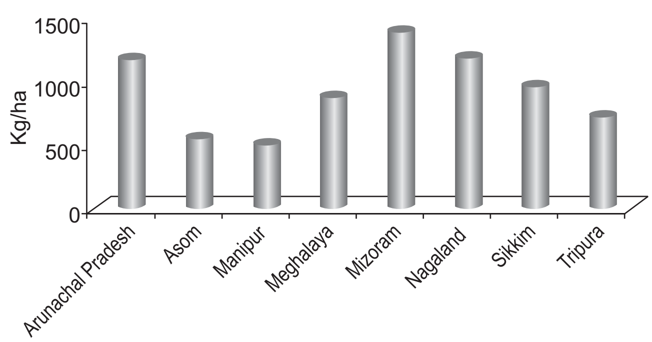

Fig 4 Productivity of *rabi* pulses in different NE states during 2007-08

Table 5 Area under *kharif* and *rabi* pulses in NE Region

State	Area ('000 ha)													
	2001-02		2002-03		2003-04		2004-05		2005-06		2006-07		2007-08	
	K	R	K	R	K	R	K	R	K	R	K	R	K	R
Arunachal Pradesh	4.7	2.1	3.6	3.7	3.4	3.4	3.8	2.7	3.7	4.0	3.7	4.0	3.7	4.0
Asom	7.0	110.8	7.0	104	7.0	108	6.7	100.9	6.5	94.0	7.0	99	6.0	107
Manipur	6.0	-	5.4	-	6.3	0	5.8	2.1	8.6	0	8.6	0	9.4	5.1
Meghalaya	2.1	2.6	2.0	2.6	2.1	2.6	2.1	0.5	2.1	2.7	1.3	2.6	1.3	2.7
Mizoram	1.8	0.9	2.5	2.1	2.6	2.6	2.4	1.3	4.6	1.9	2.9	2.1	4.1	1
Nagaland	17.0	18	14.0	16	18.5	15	15.9	15.7	14.6	16.4	19.5	18	20.0	15
Sikkim	0.4	8.52	0.4	9.40	0.4	9.55	0.3	939	0.4	891	0.4	891	6.1	891
Tripura	4.6	3.9	4.7	4.1	4.7	3.7	4.9	4	5.2	3.7	4.9	3.2	3.8	3

Table 6 Production of *kharif* and *rabi* pulses in NE Region

State	Production ('000 tonnes)													
	2001-02		2002-03		2003-04		2004-05		2005-06		2006-07		2007-08	
	K	R	K	R	K	R	K	R	K	R	K	R	K	R
Arunachal Pradesh	5.2	1.9	3.7	4.0	3.4	4.0	3.8	3.0	3.6	4.7	3.6	4.7	3.6	4.7
Asom	5.0	60.7	5.0	55.0	5.0	59.0	4.8	56.6	4.5	49.5	5.0	54.0	4.0	59.0
Manipur	3.1	NA	2.6	NA	3.2	NA	3.0	NA	4.5	NA	4.5	NA	4.6	2.6
Meghalaya	1.6	1.9	1.4	1.9	1.6	1.9	1.6	2.0	1.6	2.0	0.9	2.0	0.9	2.4
Mizoram	2.1	1.8	2.7	2.3	2.4	2.1	2.9	1.9	4.8	3.1	3.0	2.8	1.3	1.4
Nagaland	13.4	16.3	14.0	14.0	21.9	11.6	13.5	11.7	13.7	26.0	23.4	21.6	23.6	18.0
Sikkim	0.4	5.2	0.3	6.3	0.4	6.4	0.4	6.2	0.4	5.7	0.4	5.7	5.9	5.7
Tripura	3.1	2.4	3.0	2.5	2.9	2.3	3.1	2.4	3.3	2.3	3.1	2.2	2.5	2.2

Source: Government of India (2012), Ministry of Agriculture, K = *Kharif*, R = *Rabi*, NA = Not available

production as it is more advantageous than the sole cropping of both pulses and oilseeds (Lourduraj *et al.* 1998, Gangwar *et al*. 2006). Groundnut *(Archis hypogaea* L.) cultivation in some districts is also very popular among the farmers. These crops are grown as a sole or mixed in haphazard manner under rainfed conditions in less fertile soil during rainy season resulting in its low yield. Average size of holding in hill areas is very small. Intercropping can play a significant role to enhance the productivity and profitability per unit area and time through more efficient use of land, water and solar energy besides assuring insurance against crop failure due to failure of one or the other crop due to vagaries of weather or disease and pest epidemics in rainfed agriculture. Intercropping of pigeonpea with groundnut has been reported as one of the best combination (Sharma and Rajput 1996, Dwivedi and Bajpai 1997) because of their more suitability for better growth and development as pigeonpea is grown at a wider row distance and has slow growth in the early stages of development.

In NEH areas, less geographical area is utilized for cultivation of agricultural crops, however, there is a little scope to increase the area under cultivation of agricultural crops. More than 90% cultivated area is rainfed. This indicates that there is scope for diversification of food crops based on cropping systems approach under specific management. The agricultural practices in the region are broadly of two distinct types, viz. settled farming practiced in the plains, valley/foot hills and terraced slopes and shifting cultivation in the hill slopes. Depending upon the system of farming, food habits and climatic conditions, several crops are grown in the region.

Existing system in Manipur	
Valley region	Hill region
Farm ponds near home yard or within paddy field, fish + livestock + kitchen garden + vegetables + rice, use of farm-yard manure, compost, life saving irrigation with harvested water in pond	Maize, groundnut, soybean, upland rice, vegetables etc.

Cropping intensity (137 %)	
Alternate and viable system for Manipur	
Farming system (with all components)	Kharif – Maize, groundnut, soybean, upland rice, vegetables etc.
Kharif – Rice, horticultural crops vegetables and fruits	Rabi – Mustard, lentil, rabi maize, urdbean, mungbean, Lathyrus, pea, vegetables (radish, potato).
Rabi – Mustard, lentil, rabi maize, mung, lathyrus, pea, vegetables.	
Cropping intensity (> 200 %)	

Nitrogen fixation efficiency and nitrogen fertilization

Some legumes are better at fixing nitrogen than others (Dixon and Kahn 2004). Common beans (*Phaseolus vulgaris* L.) are poor fixers. Maximum economic yield for beans requires an additional 30-50 kg/ha of nitrogen fertilizer. However, if beans are not nodulated, yields often remain low, regardless of the amount of nitrogen applied. Nodules apparently help the plant use fertilizer nitrogen efficiently (Singh and Ahlawat 1998).

Other grain legumes such as peanuts, cowpeas, soybeans, and faba beans are good nitrogen fixers, and will fix all of their nitrogen needs other than that absorbed from the soil (Döbereiner 1992). These legumes may fix up to 120 kg of nitrogen per acre and are not usually fertilized. In fact, they usually don't respond to nitrogen fertilizer as long as they are capable of fixing nitrogen (Franche *et al.* 2009). Nitrogen fertilizer (@ 20 kg/ha) is applied at planting to these legumes when grown on jhum land of NEH region or low organic matter soils to supply nitrogen to the plant before nitrogen fixation starts. It is easier and less energy consuming for the plant to absorb nitrogen from the soil than to fix it from the air (Elmerich and Newton 2007). Other pulses can also grown in NEH region for exploiting more atmospheric N like perennial and forage legumes such as alfalfa, sweet clover, true clovers, and vetches may fix 125-250 kg of nitrogen per acre (Doyle and Luckow 2003). Like the grain legumes previously discussed, they are not normally fertilized with nitrogen. They occasionally respond to nitrogen fertilizer at planting or immediately after a cutting when the photosynthates supply is too low for adequate nitrogen fixation. The stalks, leaves, and roots of grain legumes such as soybeans and beans contain about the same concentration of nitrogen as found in non-legume crop residue (Pedrosa and Elmerich 2007). In fact, the residue from a corn crop contains more nitrogen than the residue from a bean crop, simply because the corn crop has more residues. A perennial or forage legume crop only adds significant nitrogen for the following crop if the entire biomass (stems, leaves, roots) is incorporated into the soil (Scagnozzi *et al*. 1997). If forage is cut and removed from the field, most of the nitrogen fixed by the forage is removed. Roots and crowns add little soil nitrogen, compared to the above ground biomass.

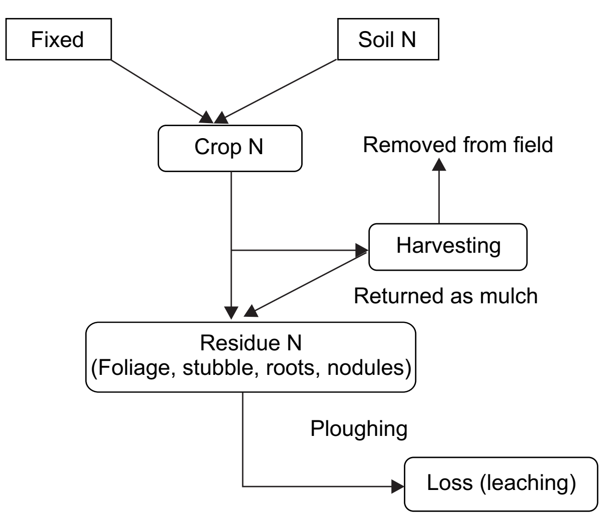

Fig 6 Nitrogen return into the soil after harvesting of crop as residue

Nitrogen fixation and crop productivity

Biological nitrogen fixation represents, annually, up to 100 million tonnes of N for terrestrial ecosystems, and from 30 to 300 million tonnes for marine ecosystems. In addition, 20 million tonnes result from chemical fixation due to atmospheric phenomena (Mosier 2002, Kumar and Singh 2004). The first industrial production of *Rhizobium* inoculants began by the end of the 19th century. However, to sustain production of cereal crops, legumes and other plants of agricultural importance, the supply of nitrogenous chemical fertilizers has been regularly increasing since the Second World War. According to an FAO report, production of N fertilizer for 2007 was 130 million tonnes of N, and this should further increase in the coming years (FAO 2008). This extensive use has certain drawbacks. A proportion of added fertilizer is lost as a result of denitrification and leaching of soil by rainfall and irrigation. In addition, leaching leads to water pollution caused by eutrophication. As a consequence, extending application of biological nitrogen fixation by any means is an important issue.

Nitrogen fixation problems in the field

Measurement of nitrogen fixation in the field is difficult. However, a grower can make some field observations that can help indicate if nitrogen fixation is adequate in some of the common legumes.

1. If a newly planted field is light green and slow growing, suspect insufficient nitrogen fixation. This is often seen with beans and alfalfa. In a new field, the poor fixation is often attributed to the lack of native *Rhizobium* to nodulate the legume, but the cause may also be poor plant nutrition or other plant stresses that inhibit nitrogen fixation. Small nodules should be present 2-3 weeks

after germination (Baldani and Baldani 2005, Sprent and James 2007). If no nodules are present, consider the following options.

A. Replant using seed inoculated with the correct *Rhizobium*.

B. Try to inoculate the plants in the field through the irrigation system or by other means. *Caution*: this technique often does not work and expert advice is needed.

C. Consider nitrogen fertilization to meet all of the plant's nitrogen needs. This may not be an option for a perennial legume such as alfalfa if the field is kept in alfalfa for several years. Also, some legumes use soil or fertilizer nitrogen more efficiently if nodules are present.

If young nodules are present, sufficient soil nitrogen may not be available for the young plant before nitrogen fixation starts. The plant usually grows out of this condition, or a small amount of nitrogen can be applied. Also, inefficient native *Rhizobium* may result in poor nitrogen fixation. Consider other soil stresses that may be inhibiting plant growth, especially plant nutrition and water stress.

2. If an established crop becomes nitrogen deficient in the middle of the growing season, when plant growth and nitrogen demands are greatest, poor or inefficient nitrogen fixation might be the cause (Beri *et al*. 2002). Nodules should be clearly evident, at about the size and number per plant as previously described, and pink or red in colour. If only a few nodules are present, insufficient *Rhizobium* numbers have limited nodulation, or plant stresses may be inhibiting nitrogen fixation. At this time, the grower may be able to remove a plant stress, but it is too late to inoculate if the nodules are mostly green, gray or white, the native may be inefficient nitrogen fixers. The only choice may be to apply nitrogen fertilizer on the present crop, and heavily inoculate the next crop.

Development of food legumes sector in NE states: Constraints and strategies

The soils and the environmental conditions prevailing in the region are conducive for pulses production in the region. However, the region has many constraints which hamper the production as well as popularization of food legumes.

Environmental constraints

- *Acidic soil:* Ninety five per cent of the soils of this region are acidic in nature and we don't have the varieties of pulses which are suitable for such soils.
- *Rainfall and humidity:* The rainfall varies from 1400 to 2000 mm. The average relative humidity of the region remains in the range of 60-80% for most part of the year. High humidity is an invitation for pests and diseases which take a heavy toll of crops (Ali *et al*. 2009). The rainfall in the region is erratic.
- *Climate change:* Jhum cultivation is the prevalent practice in north east states. However, climate change is a bitter reality. Under the vagaries of extreme temperature and heat wave the surface temperature is rising alarmingly.

Technical constraints

- *Seed and other inputs:* Seed is basic input in agriculture. The seed of improved varieties is not available to the farmers on time due to the landlocked state which depends mainly on road transport. The farmers in the remote areas do not get seeds and other agri-inputs.
- *Plant protection:* The farmers of NE region especially hill farmers have a mindset against the use of plant protection chemicals and fertilizers. Pesticides are a necessary evil and have to be used to offset the attack of pests and disease in pulse crops. The need for the use of pesticides is important because the region is very humid and the incidence of pests and diseases is high. The non-availability of pesticides and bio-control agents is a major constraint of the region.
- *Farm mechanization:* Vast of the area in the region is hilly. Farm mechanization is non-existent. As compared to other parts of the country, low cost farm machineries and implements for the hilly terrains are not available here.
- *Transfer of technology:* Knowledge is power. The farmers have to be empowered in terms of improved technology. Until now, the improved production package available for different food legumes has not been taken to the farmers' field. The farmers are cultivating the traditional varieties in their own way. However, some farmers have knowledge on production aspects but unable to procure the critical inputs because of poor input procuring capacity which is attributed to small and marginal farmers.

Physical constraints

The rugged terrain of the region hampers the delivery of various services to the farmers. The cost of cultivation is also high due to undulating lay of the land. Good roads and communication are key to development. The transport network in the region is in a poor shape. Procurement, processing, value addition and storage infrastructure is almost non-existent.

Economical constraints

Majority of the farming community is small and marginal. They do not have access to easy credit from the banking institutions, as a result of which they are compelled to continue with small scale household production system. Moreover, majority of the farmers have the farm size which is less than

1 ha and Northeastern agriculture is rainfed. This compels them to plant paddy for the consumption during kharif season and majority of the farmers keep the land fallow in the rabi season due to scarcity of water. Also, there is a lack of regulated market and retail chain to sell the produce at a profitable price. The farmers resort to distress sale of their produce.

Social constraints

Shifting cultivation is widely prevalent in the region. It is the most highly unscientific use of land which leads to land and environmental degradation. The productivity in such areas is very low. The farmers have to diversify to food legume cultivation to enhance their income. For this purpose, there has to be a proper land tenure system which inculcates among the farmers a sense of belongingness to the lands.

Future strategies

The existing technology is capable of increasing productivity by at least 30% as demonstrated by on farm trials. To achieve the objective of enhancing household food and nutritional security, the following strategies needs to be undertaken.

1. Collection, screening, genetic cataloguing, conservation and use of important food legumes through conventional and molecular means need to be undertaken.
2. There is need to develop agro-ecological zone specific varieties of different legume crops. Farmer's participation in technology and variety development has to be ensured in genetic enhancement program of pulse crops.
3. In India more than 550 high yielding disease resistant varieties of pulses for different agro-ecological regions have been developed. But the adoption rate of improved varieties is poor due to non-availability of quality seeds to farmers. Seed production of food legumes in a participatory mode through seed village programmes has to be promoted. Ensure that quality seed is available to the farmers.
4. Productivity of pulses in jhum areas is very low. Therefore, there is need to develop jhum specific varieties of legumes and also to develop alternative cropping system involving pulses.
5. The minimal amount of fertilizer is being used here as compared to other parts of the country. Sikkim and Mizoram have been declared organic states; incorporation of legume crops in the cropping sequence will enrich the soil through atmospheric N_2 fixation and reduce soil erosion from steep slopes. Organic farming package for different pulse crops needs to be standardized. In this way the region will have edge over other states of India.
6. Being forewarned is forearmed. Pest forecasting system needs to be developed to forewarn the farmers about the onset of diseases and insect pests of pulse crops in the region.
7. Rural connectivity and other infrastructure (processing unit, storage, marketing network etc.) need to be developed so that the farmers are easily able to sell their produce.
8. There is urgent need to make the various schemes of the banking sector farmer friendly so that small and marginal farmers are able to get crop loan without any hassle. Majority of the farmers do not know about the various schemes of the government such as crop insurance, Kisan Credit Card etc. A campaign needs to be launched to educate the farmers about these programmes. The government needs to take a policy decision to modify the present land tenure system.
9. Transfer of technology programmes (farmers trainings, front line demonstrations, sensitization programmes etc.) have to be organized to familiarize the farmers with the improved production technology of pulse crops and hammer home the point that yield will increase substantially if these crops are grown as per the recommended package of practices. Such programmes are very important to bridge the gap between actual and potential yield of legume crops.
10. Research programmes are required to be taken up urgently to study the impact of climate change on legume crops.
11. The North Eastern Region is one of the hot spots of biodiversity. Awareness programmes have to be taken up on IPR issues to protect the germplasm of legume crops.
12. The government must take up awareness programme to educate the stakeholders about the nutritional benefits of pulses.

CONCLUSIONS

In short, to increase area and production of pulse crops we need crop specific and region specific approaches, which should be adopted in the overall framework of systems approach. There is need to integrate the production technology, dissemination, utilization and support systems for transfer of improved technology to get the maximum production of legumes for the sustainable livelihood and food security in the region. There is urgent need of linkage between the public and private agencies to ensure the availability of latest technology, knowledge and empowerment of the stakeholders. Successful legume cultivation depends on the available resources and their proper utilization by the farming community to achieve maximum production and income from the landholding. The major thrust areas to be addressed are as follows (i) Incorporation of high-yielding varieties of pulses with cereal crops in the prevailing rice monocropping in cropping system under upland and lowland areas. (ii) Inclusion of short duration varieties of pulses as catch crop. (iii) Development of multiple disease and pest resistant varieties. (iv) Reducing storage loses and improving market information and infrastructure. (v) Linking MSP to market prices can bridge the gap between demand and supply. (vi) Developing high nitrogen fixing varieties, which will play a crucial role in sustainable agriculture, especially in jhum land and (vii) Coordination of research, extension and farmers to encourage farmer's participatory research.

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