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PRESENT STATUS AND PROSPECTS OF PULSE PRODUCTION IN NORTH EASTERN HILL REGION

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INTRODUCTION

The North Eastern Hill (NEH) Region comprising the states of Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura, lying between 21.5° N to 29.5° N latitude and 85.5° E to 97.5° E longitude, presents an unique geo-agroclimatic area. High mean annual rainfall varying from 800 to 4000 mm, high humidity and undulating hilly topography characterize NEH region. The agricultural production system in the region is mostly rain-fed, mono-cropped and at subsistence level. Slash and burn agriculture is still predominantly practiced in almost all the states except Sikkim on steep slopes. The cropping pattern in NEH Region with exception of Sikkim is characterized by predominance of rice as the food crop. Maize is the dominant crop in Sikkim. Food crops account for more than 80% of the gross cropped area and cereals occupy about 70% of that. This is suggestive of the subsistence agriculture and lack of crop diversification. Pulses are, however, grown in most of the states of this region as minor crops.

Pulses are the cheapest source of protein and, therefore, occupy an important position in balancing human dietary needs. Furthermore, pulses enrich soil fertility by adding nitrogen to the soil and also improve soil structure by their deep root system. Due to the plant type and ideal maturity duration, most of the pulses can be grown as intercrop. Newly developed short duration varieties of pulses fit in the multiple cropping system and thereby the cropping intensity can be increased manifolds. Besides grains, the green fodder of most of the pulses is also rich in protein and is palatable to the cattle. Thus, rich source of protein (ranging from 20-25%) and ability to fix atmospheric nitrogen, make the pulses an important crop in the agricultural system of India.

PULSES IN NEH REGION

An overview of growth rate of pulse production in the country shows that pulse production in the country has increased at much slower pace as compared to cereals. Consequently, per capita availability of pulses declined from 60.78 g/day in 1951 to 40.3 gm/day in 1991 and to 34 g/day in 1996. NEH region contributed only 0.28% (excluding Manipur owing to non-availability of data) to the national pool of pulses during 1996-97 (Anonymous, 1995). This clearly shows that despite immense importance of pulses in human and animal nutrition, production of pulses is on a very low key in the agricultural system of North-Eastern India. Area, production and productivity of total pulses in NEH region are presented in Fig. 1-

3. With the present level of production, per capita availability of pulses in NEH region is 20 g/ day as against 34 g/day at the national level during 1996. The low production of pulses in this region could be attributed to a number of biotic, abiotic, management, socio-economic and institutional factors. The region, however, has tremendous potential for production of pulses in low and mid altitude areas as evident from the favourable weather conditions prevailing in these areas. Statistics reveal that the average productivity of pulses in NEH region was higher (928 kg/ha) than the national average (623 kg/ha) during 1996-97. The total area under pulses during 1996-97, in this region, was 44,600 ha that produced 41,400 tonnes of pulses (excluding Manipur due to non-availability of the data). Within NEH region, Nagaland's production was the highest (13,800 tonnes) whereas Mizoram's productivity was the highest (1581 kg/ha) followed by that of Arunachal Pradesh (1000kg/ha), Nagaland (993 kg/ha), Sikkim (895 kg/ha), Meghalaya (758 kg/ha) and Tripura (571 kg/ha). The total area under pulses is maximum in Nagaland (13,800 ha) followed by Tripura (9,800 ha), Sikkim (6,700 ha) and Arunachal Pradesh (6,700 ha).

The growth scenario of pulse production in NEH region during 1990-91 to 1996-97 was a mixed one. Arunachal Pradesh and Tripura showed increase in area under pulses by 40% and 9.09% respectively. This was accompanied by increase in the productivity of these states by 30.39% and 3.72% respectively. In contrast, no significant change in area under pulses but productivity increased by 21.21% and 2.13% respectively. The situation were alarming in the states of Sikkim and Nagaland where area under pulses went down by 56.25% and 21.43% respectively and productivity declined by 3.04% and 13.38% respectively (Table 1).

MAJOR PULSES

The major pulses grown in the region are mung bean (*Vigna radiata*), urd bean (*Vigna mungo*), pigeon pea (*Cajanus cajan*), rice bean (*Vigna umbellata*) and cowpea (*Vigna unguiculata*) in *kharif* and french bean (*Phaseolus vulgaris*) and field pea (*Pisum sativum*) in *rabi*. In hills, various other beans such as faba bean (*Vicia faba*), adzuki bean (*Vigna angularis*), moth bean (*V. aconitifolia*) and broad bean (*Dolichos lablab*) are also grown and used as pulses. North Eastern India is a seat of diversity for several grain legumes, *viz.* urd bean (*Vigna mungo),* cowpea *(Vigna unguiculata)* and rice bean *(Vigna umbellata)*. Diverse genotypes of rice bean and different species of *Vigna* have been collected from various indigenous farming systems of the region. Wild forms of *V. aconitifolia, V. trilibata and V. capensis are* also found in NE Hills and sub-Himalayan tract.

MINOR PULSES

Adzukibean (*Vigna angularis)* more akin to rice bean has been collected from Bomdilla ranges of Arunachal Pradesh. Viny forms possessing thinner pods like mung bean with grain ranging from red, green to creamish colour prevail. Much variation in pod and grain size of broad bean (*Vicia faba)* has been observed. Local collections of moth bean (*Vigna acontifolia)* possess good variation in growth habit (spreading types predominant), leaf location, grain size, pod and seed colour. Local *khesari (Lathyrus sativus)* germplasm largely has a spreading growth habit and is well adapted to drought. *Vigna vaxillata* is another less known potential pulse-cum-tuber crop of NE region, resembling cowpea, produces both edible seeds and tubers. At younger stage the pods are used as vegetable and at maturity tribals use the seeds as *dal*. The tubers are also used as a substitute for tapioca in animal feed. Seeds and tubers both are very rich in protein. Out of 9 wild species of *Mucana* available in India, 7 species viz. *M. airopurpurea, M. bracteeta, M. capitata, M. nigicans, M. proriena, M. macrocarpa and M.monosparma* are found in the NE region.

DIVERSITY IN PULSES OF NEH REGION

Local collections of mung bean are semi-bushy to bushy types exhibiting much variation in leaf size, nature of inflorescence and pod type. Considerable variation prevails in grain colour (green, yellow, brown, black and mottled), the common colour being green (Sarma *et. al.,* 1981). Urd bean is one of the most extensively grown pulses in NE India especially in Assam. Local collections are semi-spreading type. Much variability in days to maturity occurs in medium to late maturity group. The indigenous types are observed to be photoperiod sensitive. Cowpea is rarely grown as a pulse crop in NE region. It is mostly grown for vegetable purpose. The native genetic resources possess much wider variability for growing in the plains, hills and even in stress environments. Good variation is exhibited in growth habit, photoperiodic and photothermic sensivity, seed size, pod shape and colour. Selection pressure has resulted in enriching the variability of grain, vegetable and fodder types of cowpea in NE region (Mehra and Arora, 1982). A wide array of diversity in *Atylosia sp.*, a wild relative of pigeon pea occurs in India with maximum concentration in the Western Ghat and in the North Eastern region. Out of 22 species of *Atylosia*, 4 species viz. *A. barbata, A. villosa, A voluibilis* and *A. scarabaraides* are often found in NE region. Perennial types of pigeon pea are commonly grown in Garo hills of Meghalaya and Karbi Anglong district of Assam. There are variations in seed size and colour in local perennial germplasm. Materials from districts of the north of the Brahmputra produced more yield on an average than that from the south of the river (Medhi *et. al.*, 1980). The *Phaseolus* group contains a number of important pulses. It is now generally agreed that the *Phaseolus* originated in the New World and that the Old World *Phaseolus* is designated as *Vigna. P. vulgaris* (known as common bean), haricot bean, navy bean, french bean, kidney bean etc. is generally grown as vegetable in NE region. Much variation occur in pod length, grain size and colour in this crop in both dwarf and pole types suited for vegetable or dal purpose (grain as *rajmash*). In higher elevations (2100-2700 meter above mean sea level) *P. coccineous* (runner or scarlet bean) is grown.

Rice bean assumes great importance as an underutilized and under exploited legume and has recently gained attention as a supplementary food crop with potential economic importance for the future. Rice bean possesses high nutritional quality and grain yield is also high. It has resistance to yellow mosaic virus and storage insects with rich genetic diversity. It is a hardy crop with wider adaptability. In addition to its use as a pulse crop, it finds usage as a forage crop. The seed protein of rice bean varies from 14-25%, the amino acid composition especially methionine and tryptophane is considerably high in rice bean compared to other *Vigna* species. It contains high quality of vitamins *viz.* thiamine, niacin and riboflavin. Phytin-Phosphorous content that generally inhibits the 'P' availability and lowers protein digestibility in most of the Asian pulses is low in rice bean. Genetic resources of rice bean have largely been collected from NE region. Enormous variability occurs in this less known pulse crop. More than 300 germplasm of rice bean have been collected from NEH region and elsewhere.

The germplasm were evaluated for 3 years and wide range of diversity in the collections was observed (Sarma et. al. 1995). Much information on the NE material on rice bean has now been available (Arora et. al., 1980; Chandel et. al., 1988; Sarma et. al. 1995). Chiefly viny types occur but some semi-bushy types have also been collected from Assam, Sikkim, Manipur and Meghalaya. Wide variability in pod length, growth habit, seed size and colour and maturity occur in NE materials. The materials are also found to be resistant to pod boring weevil (*Apion clavipes),* a major insect pest and rust *(Uromyces appendiculatus),* a major disease of rice bean (Sarma *et. al.,* 1991; 1995). In view of enormous variability, high yield, resistance to diseases and pests and wider adaptability, this under exploited legume, grown predominantly in mixed farming system, has great potential to become an important pulse crop of the region.

CONSTRAINTS IN PULSE PRODUCTION IN NEH REGION

While examining the causes of low acreage and resultant low production of pulses in the region, we find that apart from non-existence of economically rational and socially optimum cropping pattern and crop diversification; biotic factors play major role in limiting pulse production. Among the biotic stresses, diseases, insects-pests and weeds present enormous problems in rain-fed agriculture. The estimated loss due to diseases is around 25% whereas the loss due to insect pests is up to 20%. The region receives mean annual rainfall of more than 2000 mm and remains humid almost throughout the year. As a result, there exist serious disease problems. Survey revealed that leaf spot and powdery mildew are the major diseases of green gram as well as black gram whereas wilt and anthracnose are serious diseases of pigeon pea. Leaf spot, anthracnose rust, pod blight cause considerable yield loss in French bean. Powdery mildew and leaf blight are major diseases of pea whereas leaf spot is a serious disease of cowpea.

Insect-pests also pose serious problem and reduce the yield of pulses in NEH region. The climatic conditions favour multiplication of insect pests. Survey conducted in the different states of the region, varying from the foothills to high altitude areas revealed association of insect-pests with pulse crop. Several species of insect-pests attack pigeon pea from germination to maturity. The most important insect-pest of pigeonpea is pod-boring weevil (*Apion clavipes*). Apart from this, pigeon pea is attacked by pod borer (*Heliothis armigera* and *Etiella zinckenella*), pod-fly (*Angiomyza obtusa*), blister beetles (*Mylabris phalerata*, *M. Pustulata*), aphids (*Myzus persicae*) and flee beetles (*Chaetocnema basalis*). The pod-boring weevil is a new record in pigeon pea and rice bean and is a serious pest in Meghalaya. Termites (*Odontotermes sp.*) are serious pests in pigeonpea in uplands of Tripura . In Manipur and Arunachal Pradesh, pod-borer and weevil are major pests of pigeon pea causing 10-15% damage to the pods. Out of this, pod boring weevil alone causes 77% damage (Azad Thakur *et. al.,* 1995).

Conducive weather results in prolific growth of weeds that causes serious problems to the pulse crops of the region. Weeds assume an alarming proportion and are a major hindrance in crop production. Our experience shows that pre-emergence application of Butachlor (@ 1.5 kg a.i./ha) controls weeds to a great extent up to one month after sowing. The undulating land surface with large variation in slopes (0-100%), altitude variations and rainfall pattern causes a diversification of weed flora. High rainfall during April to September and sparse rainfall during winter is a major factor supporting diverse weed flora. Weeds compete with crop for nutrients and harbour insect-pests. Excessive rains during the cropping season makes it difficult to control weeds either manually or by spraying herbicides.

Soil, temperature, sunshine, solar radiation, rainfall and topography are some of the abiotic factors that limit pulse production in NEH region. About 95% of the soils of the region (except Nagaland having 77%) are acidic due to the presence of exchangeable Al^{3+} on the exchange complex. The acidic soils exhibit fixation capacity for water-soluble phosphate, leading to the deficiency in phosphorus. Low temperature decreases percent grain ripening and also absorption of phosphorous gets affected adversely at lower temperatures (Prasad *et al*, 1981). In view of high rainfall in the region, the number of days with bright sunshine is less as compared to rest of the country. Although there is plenty of rain, most of it is confined during May to September. Winter is almost dry with very low temperature, which is not conductive for *rabi* pulses in absence of irrigation. During *kharif*, excessive rainfall causes prolific growth of weeds and hampers inter-cultural operations. Soil erosion caused by rainwater run-off and other land and soil stresses are alarming in the region. Unlike plains, the undulating topography with steep slopes is another stress for cultivation of pulses in the region.

The crop management, institutional and socio-economic factors are equally responsible for limiting pulse production in this region. The farmers of NEH region give low priority to the pulses because of lack of general consumer acceptance and non-vegetarian food habit. Improved seeds of pulse crops are generally not available to the farmers in time. The poor extension machinery is also a constraint for popularization of pulses. Lastly, pulses being many in number do not find adequate attention to the extent other crops have received so far.

STRATEGIES FOR INCREASING PULSES PRODUCTION

India faces a deficit of around 3 million tonnes of pulses that can be met by horizontal as well as vertical expansion. North-Eastern region is one of the potential areas where pulse production could be increased. Although there are a number of factors that limit production of pulse in this region, yet the region offers vast scope for cultivation of different pulses. Table 2 shows the promising pulses that have been evaluated for three years and found suitable for different states of NEH region. Considering that pulses could be grown mixed with other crops and their feasibility for relay cropping; the area of pulses can be increased. In addition, intercropping covers the risk and gives a bonus yield of pulse crop in addition to the normal return of the main crop. Results of trials conducted under All India Co-ordinated Pulse Improvement Project in varying topography and locations of the region for the last 10 years, indicate that there is considerable scope for production of pulses under proper management practices. On the basis of the results of these trials, promising varieties of pulses identified for different states of the region have been collated in Table 3. In *Jhum* areas where productivity is normally low from 2nd year onwards, short duration variety of pigeonpea *viz.* ICPL 151 can be grown extensively. The use of shorter duration, high yielding varieties of efficient pulse crops and cropping systems is one of the means of minimizing the risks of biotic stresses. Use of varieties resistant to pests and diseases will be useful in combating biotic stresses. Seed is an important component, therefore, an efficient seed production technology is required for supply of adequate amount of quality seeds. National Pulse Development Programme

(NPDP) can provide funds for foundation seed production. Thus the non-availability of improved seeds of pulses can be overcome. Integrated pest management and rational chemical control should be carried out for minimizing the risk. Farmers should be forewarned about the outbreak of disease. Destruction of crop residues, clean cultivation or field sanitation, proper water management, practice of crop rotation, cultural practices, hand picking of insects are some of the approaches to save the pulse crops from different biotic stresses. Application of balanced fertilizers will help escape soil acidity and other soil related problems.

Trials conducted during pre-*rabi* of 1998-99 revealed that pulses like mung bean , urd bean or rajmash can be taken as 'catch crop' just after *kharif* maize on residual moisture as the maturity duration of 80-90 days fits well in this season. Moreover, the crop escapes heavy rain with minimum of diseases and pests. This helps in improving soil fertility and the farmer harvests an additional 8-10 q/ha of pulses instead of keeping the land fallow.

The use of pulses in the existing cropping system such as maize – soybean or maize – groundnut, rotation of maize + pulses or soybean + arhar or groundnut + pulses can lead to sustainable agriculture. Similarly, there is scope for growing pulses in the rice fallows which will help increase the acreage of pulses. Thus there is considerable potential for horizontal as well as vertical expansion of pulses in the region provided a well-planned strategy is adopted. Pulses can be made more productive through addition of higher inputs and adoption of improved technology. Collaboration with national as well as international organizations like IIPR, ICRISAT, ICARDA and AVRDC should be strengthened for augmentation of pulse research and development in the region.

ROLE OF BIOTECHNOLOGY IN AUGMENTING PULSE PRODUCTION

Plant breeding is a slow and painstaking process and the increase in productivity can not be sustained for long, therefore, in order to accelerate the pace of pulse improvement, research work on biotechnology which promises to supplement and complement the efforts in conventional breeding will prove rewarding. Pod borer (*Heliothis armigera)*, Weevil (*Apion claviceps)* and stored-grain pests are the major problems and there are no known source of resistance for many of these insects in pulses. Crystal protein genes of *Bacillus thuriengiensis* are known to control the Lepidopteran, Coleopteran and Dipteran insects. The immediate need is to develop efficient regeneration protocol that can, in turn, be coupled with transformation. This would lead to transfer of *cry* gene(s) in the important pulses which, in turn can become resistant/tolerant to these insects-pests. Apart from this, marker assisted selection can be used in making the breeding of pulses more efficient and precise. Presently, there is a need to undertake DNA fingerprinting of the pulse varieties that possess desirable traits.

NEH region of is one of the eight centres of mega-biodiversity that supports immense growth of plant biomass. It is either primary or secondary centre of origin for many crop plants; consequently, we get enormous diversity which is a pre-requisite for breeding varieties with desirable traits. The region has potential to become 'bean-bowl' of India but lags behind in pulse production. Concerted efforts in collection, evaluation, characterization and utilization of pulse germplasm with the aid of plant molecular biology and biotechnology will help in harnesing this production potential for meeting the future challenges of balanced human nutrition in India in general and North-Eastern Region in particular.

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Table 1. Area, Production and Productivity of Total Pulses* in NEH region (1996-97)

State	Area ('000ha)	Production ('000tonnes)	Productivity (kg/ha)
Arunachal Pradesh	7.0	7.0	1000
Meghalaya	3.0	2.0	766
Mizoram	4.0	8.0	2000
Nagaland	11.0	11.0	1000
Sikkim	7.0	6.0	850
Tripura	11.0	6.0	550
NEH Total (excluding Manipur)	43.0	40.0	1027.6
All India	25,000	14,500.0	580
Share of NEH	0.172%	0.20%	

*Pulses include greengram, blackgram, pigeonpea, gram, ricebean and other beans.

Table 2. Pulse production growth scenario in NEH region during 1996-97

State	%increase or decrease of area	%increase or decrease of productivity
Arunachal Pradesh	40.00	30.39
Tripura	9.09	3.72
Nagaland	21.43	13.38
Sikkim	56.25	3.04
Manipur	—	—
Mizoram	0	21.21
Meghalaya	0	2.13

Table 3. Promising pulses in different States of NEH region

States	Promising Pulses
Arunachal Pradesh	Field pea and Rajmash (low altitudes), Rajmash, Mung, Urd, fieldpea and pigeonpea (Mid-altitudes)
Manipur	Mung, Urd, Pigeonpea, Fieldpea
Meghalaya	Ricebean, Mungbean, Urdbean, Pigeonpea
Mizoram	Mung, Urd and pigeonpea (Kharif), lentil (Rabi)
Nagaland	Ricebean, Nagadal and pigeonpea
Sikkim	Rajmash, Urd(green seeded)
Tripura	Mung, Urd and pigeonpea (Kharif), fieldpea (Rabi)

Table 4. Promising varieties of pulses in NEH Region

Crop	Varieties	Yield (q/ha)	Maturity (days)	Altitude
Green gram	PDM54, PDM-II	8-10	70-80	L, M
Black gram	UG203, B3-8-8, PantU-19, UG301	10-12	75-85	L, M
Cow-pea	Amba, V385, C152, V271, V154	15-18	90-95	M
Pigeonpea	UPAS120, ICPL151	15-20	130-150	L, M
Rice-bean	RCRB1-6, RCRB6-10, PDRB1, RBL35, Bejiamah, Mansa	18-20	125-150	L, M
Field-pea	HUP4, KPMR85, PantA4, T163, DMR4, DMR7, Dentam, HUP1	15-20		
Lentil	PL639	8-10	120-130	L, M
Chick-pea	RSG116, BG240, BG315, BG316	12-15	115-125	L
Rajmash	HUR-120, HUR-137, HUR-91, HUR-15, VL-63	15-20	90-110	M

L: Low ; M: Medium

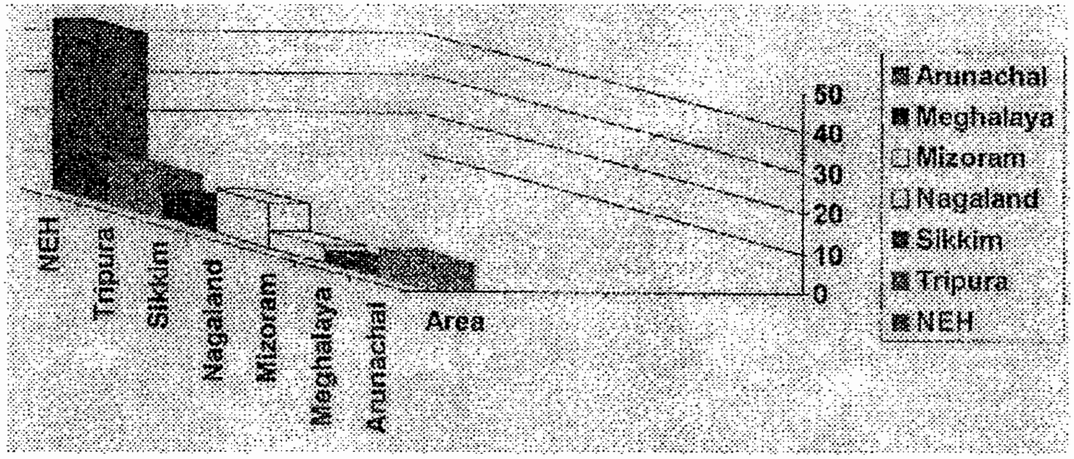

Fig. 1. Area ('000 ha) of total pulses in NEH region (1996-97)

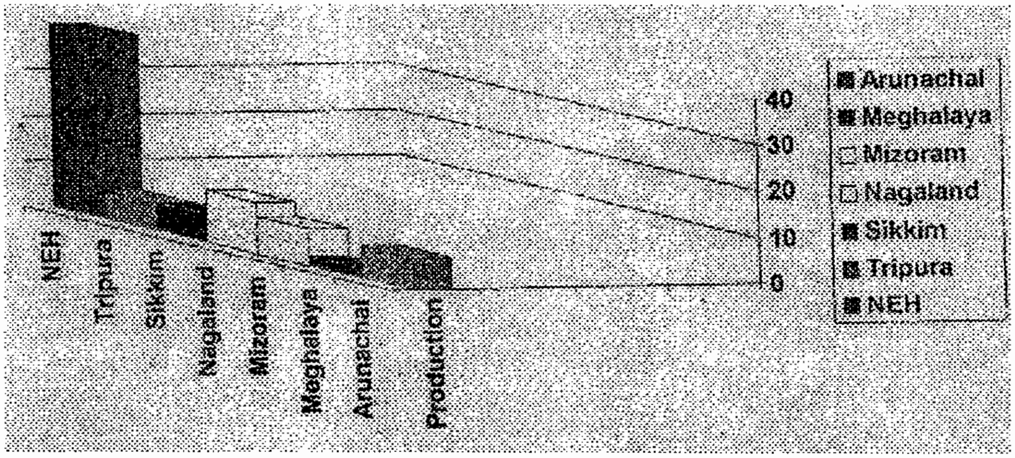

Fig. 2. Production ('000 tonnes) of total pulses in NEH region (1996-97)

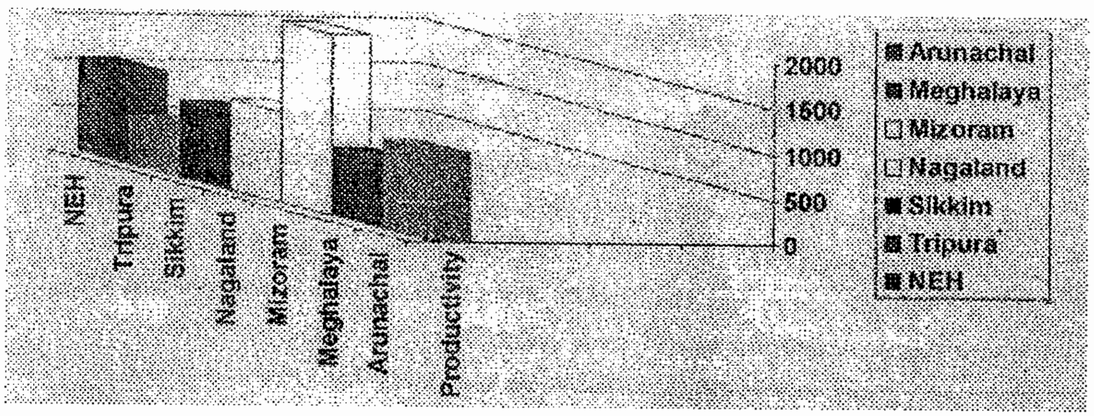

Fig. 3. Productivity (kg/ha) of total pulses in NEH region (1996-97)