# PROSPECT OF NORTHEAST AGRICULTURE IN POST COVID 19 SCENARIO


**ICAR- AGRICULTURAL TECHNOLOGY APPLICATION RESEARCH INSTITUTE (ATARI), UMIAM, MEGHALAYA –793103**

**(AN ISO 9001:2015 CERTIFIED ORGANIZATION)**

## Citation
**Prospects of Northeast Agriculture in post COVID 19 scenario**

## Concept
**Bidyut C. Deka**

## Chief Editor
Bidyut C. Deka

## Editors
A.K. Singha
Divya Parisa
Amrutha P.

## Cover design and interiors
Sumit Kumar Hajong

## Published by
ICAR- Agricultural Technology Application Research Institute, Umiam, Meghalaya –793103
Phone :0364-2950036(O), 0364-2950033(O)
Email : icarzcu3@gmail.com, ATARI.shillong@icar.gov.in
Website : http://www.icarzcu3.gov.in

**INDIAN COUNCIL OF AGRICULTURAL RESEARCH**
**KrishiAnusandhanBhawan, Pusa, New Delhi – 110 012**
**Ph.:91-11-25843277 (O), Fax : 91-11-25842968 E-mail: aksicar@gmail.com**

**Dr. A.K. Singh**
**Deputy Director General (Agricultural Extension)**

## FOREWORD

Agricultural Extension Division of ICAR, New Delhi through its 11 ATARIs has been popularizing the proven technologies in different micro agro ecological conditions across the country. The ICAR-ATARI, Umiam through its 43 KVKs have been trying very hard to improve the economic conditions of the farmers in the region by linking farmers with various flagship programmes of Govt. of India besides, implementing the mandated activities. In recent years, many KVKs of North Eastern Hill Region have shown their excellence despite of remoteness and poor connectivity. During nationwide lockdown due to COVID 19, ICAR-ATARI, Umiam and its KVKs quickly prepared the crop specific advisories and disseminated the same utilizing various ICT platforms. The scientists of ICAR-ATARI and KVKs were also actively engaged in bringing out various research publications, popular articles, case studies, book chapters and such other R&D activities taking the advantage of lockdown period.

I am happy to learn that ICAR-ATARI Umiam has effectively utilized the services of its scientists and project staffs during the lockdown period and bring out this eBook entitled "Prospect of Northeast Agriculture in Post COVID 19 Scenario" consisting of 16 chapters concerning various issues of North Eastern Hill Agriculture. I compliment the Director, ICAR-ATARI, Umiam and the entire team for their effort to bring out this valuable publication when the honourable Prime Minister of India has emphasized for Aatmanirbhar Bharat with a focal theme of local to vocal.

Dated : 03.06.2020

(A.K. Singh)
Deputy Director General (AE)

# PREFACE

**Greetings from ICAR- ATARI, Umiam !**

The bold decision for countrywide lockdown declared by Mr. Narendra Modi, the honourable Prime Minister of India on March 24, 2020 was very much timely and pragmatic to combat the situation arising out of COVID 19 in India. For a day or two, I along with my colleagues at ICAR-ATARI, Umiam were relaxed and enjoying the undeclared holidays following the instruction of Ministry of Home Affairs, Govt. of India. Sooner, my intuition instructed me to believe that this lockdown period is going to be extended at least for 2-3 months. I kept on thinking what best could be done during the lockdown period and accordingly few decisions were quickly taken to effectively utilize the valuable time of scientists, KVK personnel and project staff. Writing research articles, case studies on the success of the pilot project on doubling farmers' income, policy papers on problems and prospects of Agriculture in each of the districts of five NEH states, book chapters and publication of an eBook were some of the decisions. Subsequently, we at ATARI and KVKs were also busy preparing crop specific advisories as well as various reports, helping farmers to harvest and sell their produces, arranging seeds and planting materials for farmers, attending Webinar called by the Secretary, DARE & DG, ICAR, DDG (AE), IASRI and other ICAR Institutes.

At one point of time, I felt that the decisions we took to complete the above mentioned tasks might not be possible during the lockdown period, but that did not however deter me to continue the tempo to execute the decisions. Based on the expertise of the scientists, SMSs and project staffs, a topic was allotted to each one of them to write an article of 10-12 pages highlighting the importance of the topic in post COVID 19 scenario. Today, I am so happy that all the decisions that we took during last week of March, 2020 had been implemented including the eBook. This eBook entitled "Prospects of Northeast Agriculture in Post COVID 19 Scenario" contains a number of articles written by our scientists, SMSs and project staff during the lockdown period. The views expressed by the authors in the articles are their personal observation and wisdom. I sincerely compliment each one of them for devoting their energy and time in preparing the valuable articles. I express my sincere thanks and gratitude to Dr. T. Mohapatra, Secretary, DARE & DG, ICAR, Govt. of India and Dr. A.K. Singh, DDG (AE) for their constant encouragement, guidance and support during the countrywide lockdown. I wish to keep on record my sincere gratitude to Dr. A.K. Singha, Mrs. Dibya Parisa and Dr (Mrs) Amrutha P. for helping me in editing the articles. I would also like to thank Mr. Sumit Hajong, Office Assistant for designing the cover page and interiors of this book. I firmly believe that this eBook would not only give the readers an overview about the essence of agriculture development in the region, but would also remind them the lockdown reminiscences.

**May 31, 2020**

**Bidyut C. Deka**
Director

# Contents

# GROWTH IN AGRICULTURE AND ALLIED SECTORS IN NORTHEAST INDIA AND ITS PROSPECT

**Amrutha P. and Bidyut C. Deka**

North Eastern region of India is known for its diversified cultural heritage and biodiversity. The region comprises of eight states namely Arunachal Pradesh, Assam, Mizoram, Meghalaya, Nagaland, Tripura and Sikkim with a landmass of 2.6 million sq. km accounting for 7.9 per cent of India's total geographical area. About 5.3 million ha is under various crops while 1.67 million ha (NEDFi data bank, 2017-18) is under jhum (shifting) cultivation. The region is well endowed with natural resources and has unique and unparalleled features such as fertile land, water resources, dense forest, high rainfall (ranges between 1500 mm to 12000 mm), mega biodiversity and flora and fauna. The region has more than 98 per cent international border, sharing international boundaries with China in the North, Myanmar in the East, Bangladesh in the South West, Nepal in the West and Bhutan to the North West. The North-East region has a population of approximately 45 million people (Census, 2011) that accounts for 3.7 per cent of country's total population.

In spite of ample natural and human resources, the NE region of India is still lagging behind as compared to many states of India. The communities in the NE region are predominantly agrarian and practice subsistence agriculture. Majority of workforce (about 50 to 70 per cent across the states) are engaged in agriculture and allied sector for livelihood. The region produces merely 1.5 per cent of country's food grain production and continues to be a net importer of food grains even for its domestic consumption. The agricultural production system is characterized mainly by CDR (Complex diverse risk-prone) type, low cropping intensity, subsistence farming, undulating topography and defective land-use pattern with an annual soil loss of 46 tons/ha. In North Eastern states, the level of farm mechanization is extremely low mainly due to hilly topography, high transportation cost of farm equipment and socio-economic conditions of the farmers (Roy et al., 2015). The net sown area of the region is about four million hectares. Among the states, Assam (34.1 %) has highest net sown area, followed by Tripura (23.5%), while Arunachal Pradesh has lowest net sown area (2.1%). The cropping intensity of the NE region is around 135 per cent, highest in Tripura (185%) followed by Manipur (145 %).

The per cent utilization of cultivable area in the region (62.04%) is less than the national average (73.05%). About 80 per cent of the farmers in the region belong to small and marginal category. Moreover, with increase in population, the average size of land holding is gradually reducing over the years. This is primarily because hilly terrain constitutes nearly two third of the region's total geographical area and large size holding are not feasible. The average size of land holding in Northeast states (1.60 ha) is marginally higher than the all India (1.57 ha).

## Overview of economic status of Northeast India

The Gross State Domestic Product (GSDP) is showing increasing trend in North Eastern region. Assam has the lion share in NE GSDP and it accounts to around 60 per cent followed by Tripura and Meghalaya (Figure 1). The growth of GSDP of NE region showed an increasing trend at the rate of 8.00 per cent per annum between 2007-08 to 2017-18 period; though in absolute terms, Assam state has the highest GDP among NE states, but the highest growth in GSDP is observed in Mizoram state i.e. 12.69 per cent per annum followed by Tripura (9.86 %) and Sikkim (7.20%) and lowest growth rate is recorded in Meghalaya (3.36 %). In all NE region states, GSDP are showing positive decadal growth (Table. 1). The major contributor to the GSDP of NE region is tertiary sector but agriculture sector is also significantly contributing to GSDP of NE India.

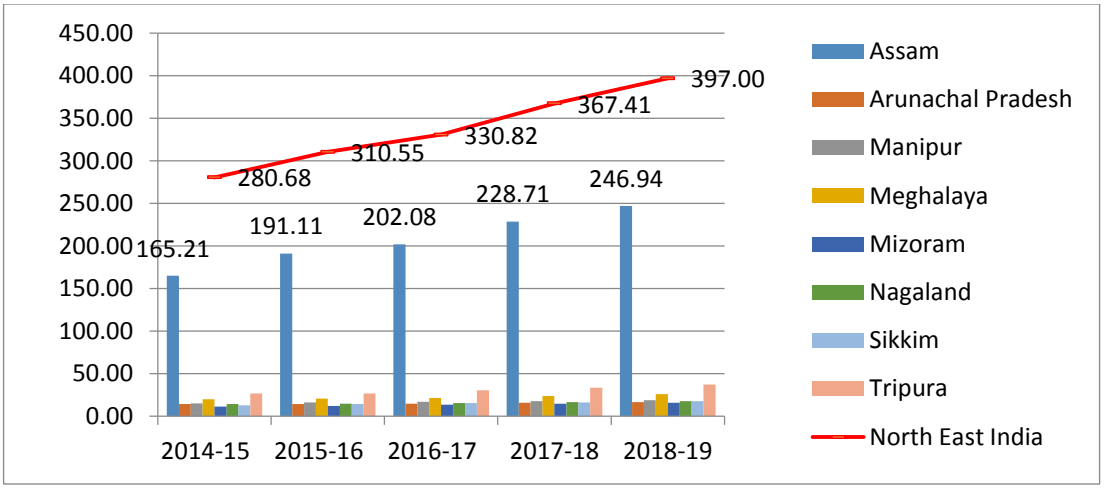



**Figure 1: Gross Domestic Product of North Eastern Region (in '000 crores)**

**Table 1: Compound annual growth rates of Gross State Domestic Product (2011 to 2017)**

| Arunachal Pradesh | Assam | Manipur | Meghalaya | Mizoram | Nagaland | Tripura | Sikkim | NE States |
|---|---|---|---|---|---|---|---|---|
| 6.28* | 8.64* | 5.96* | 3.36* | 12.69* | 5.17* | 9.86* | 7.20* | 8.01* |

Note: * indicates significant at 1% level of significance, NEH- North Eat Hilly Region

## Growth in agriculture and allied sectors in Northeast India

The area, production and productivity of major crops and other food items in Northeast India are presented in Table 2. The area under cereal crops is 3.80 million hectares with the total production of 7.82 million tones having the average productivity of 2058 Kg/ha during 2017-18. Cereals occupied the major share in total cropped area followed by vegetables (with area 0.56 million hectares and production 6.05 million tons), oilseeds (area 0.49 million hectares and production 0.38 million tons) and fruits (with area 0.46 million hectares and production 4.51 million tons). The region has produced 0.24 million tons of pulses from 0.27 million hectare area with an average productivity of 828 Kg/ ha during 2017-18. The NE region produced fish to the tune of 446.88 million tons during 2017-18.

**Table 2: Production and productivity of different food items in Northeast India (2017-18)**

| Particulars | Area (million ha) | Production (million tons) | Productivity (Kg/ha) |
|---|---|---|---|
| Cereal | 3.80 | 7.82 | 2058 |
| Pulses | 0.27 | 0.24 | 889 |
| Oilseeds | 0.49 | 0.38 | 776 |
| Fruits | 0.46 | 4.51 | 9804 |
| Vegetables | 0.56 | 6.05 | 10804 |
| Milk | - | 1.40 | - |
| Egg (in millions) | - | 1065.54 | - |
| Meat | - | 0.23 | - |
| Fish | - | 4.47 | - |

## 1. Growth in area, production and productivity of cereals across the states of Northeast

Rice is the principal cereal crop of the Northeast ecosystem and become the most dominant crop in *Kharif* season followed by maize and wheat in Rabi season. Among the crops, cereals occupied around 60 per cent of the total cropped area of the region and 3.7 per cent of the total cereals area in India, while its share in national cereals production is 3.2 per cent during 2017-18.

The data presented in table 3 revealed that the highest compound annual growth (2007-17) in cereal area is observed in Manipur (5.12 %) followed by Tripura (1.77 %) while negative growth is recorded in Mizoram (-3.92 %) and Sikkim states (-2.47 %). Though Mizoram recorded the negative growth in area but it has the highest positive growth in production (8.79 %) and productivity (13.21 %) of cereals. Except Sikkim, all other Northeast states accounted positive annual growth in production. High instability in cereals area is observed in Mizoram (19.62 %) followed by Manipur (14.08 %) and remaining other NE states showed lowest variability in area of cereal crops. Whereas, in production, the highest instability has been observed in Manipur with 24.24 per cent followed by Mizoram (20.61%), Nagaland (14.29%) and Arunachal Pradesh (11.18%) and all other states have less instability in production of cereals. Similar results are also observed in productivity of the cereal crops.

**Table 3: Compound annual growth rate and instability index in area, production and productivity of cereal crops in NE region of India (2007 to 2017)**

| Compound Annual Growth Rate | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Particulars | **Arunachal Pradesh** | **Assam** | **Manipur** | **Meghalaya** | **Mizoram** | **Nagaland** | **Sikkim** | **Tripura** | **NE states** |
| Area | **0.81**** | **-0.04** | **5.12*** | **0.48*** | **-3.92***** | **1.51*** | **-2.47*** | **1.77*** | **0.47***** |
| Production | **3.31**** | **3.53*** | **2.56** | **4.23*** | **8.79**** | **2.28** | **-1.02**** | **3.10*** | **3.31*** |
| Productivity | **2.48***** | **3.57*** | **-2.44** | **3.73**** | **13.21*** | **0.76** | **1.48*** | **1.30*** | **2.17*** |
| **Instability index** | | | | | | | | | |
| Area | **3.03** | **2.49** | **14.08** | **0.37** | **19.62** | **2.58** | **1.98** | **3.06** | **2.09** |
| Production | **11.18** | **6.83** | **24.24** | **11.86** | **20.61** | **14.29** | **3.43** | **2.56** | **5.50** |
| Productivity | **11.43** | **5.61** | **16.73** | **11.61** | **19.34** | **14.89** | **3.09** | **1.55** | **5.20** |

Note: *indicates significant at 1 per cent, ** indicates significant at 5 per cent, *** indicates significant at 10

## 2. Growth in area, production and productivity of pulses across the states of the region

Pulses are mainly grown in uplands in NE region of India. The major pulses grown in the region are greengram, blackgram, pigeonpea, rice bean and cowpea in *Kharif*, and French bean, chickpea, lentil, lathyrus, and pea in rabi season. In maize based cropping systems, the short duration pulses like blackgram, greengram, frenchbean are cultivated after the harvesting of maize as pre-rabi crop by utilizing residual soil moisture. The highest positive growth in pulses area has been recorded in Tripura (16.25 %) followed by Manipur, Meghalaya and Arunachal Pradesh with 9.59 per cent, 8.53 per cent and 7.88 per cent, respectively. The growth rates are significant at one per cent level. Sikkim (-9.88 %) recorded the highest negative annual growth in area under pulses. Assam is the only state recorded the lowest variability in area and the highest instability is observed in Tripura (27.18 %) followed by Meghalaya, Sikkim, Manipur and Nagaland. Except Assam (8.32 %) all other states showed high variability in production of pulses (Table 4).

**Table 4: Compound annual growth rate and instability index in area, production and productivity of Pulse crops in Northeast India (2007 to 2017)**

| Compound Annual Growth Rate | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Particulars** | **Arunachal Pradesh** | **Assam** | **Manipur** | **Meghalaya** | **Mizoram** | **Nagaland** | **Sikkim** | **Tripura** | **NE states** |
| **Area** | 7.88* | 3.47* | 9.59* | 8.53* | -2.44** | 3.86*** | -9.88* | 16.25* | 4.32* |
| **Production** | 7.84* | 7.50* | 17.94* | 16.16* | 3.34 | 4.42 | -9.70* | 17.46* | 7.24* |
| **Productivity** | -0.01 | 3.88* | 7.60* | 7.10* | 5.87*** | 0.55 | 0.23 | 1.06 | 2.99* |
| **Instability index** | | | | | | | | | |
| **Area** | 13.81 | 4.77 | 16.17 | 25.94 | 10.42 | 16.31 | 20.34 | 27.18 | 5.15 |
| **Production** | 15.87 | 8.32 | 23.63 | 34.19 | 23.80 | 19.56 | 21.48 | 37.69 | 7.52 |
| **Productivity** | 7.26 | 5.68 | 14.42 | 8.58 | 22.01 | 7.14 | 2.54 | 9.63 | 3.15 |

Note: *indicates significant at 1 per cent, ** indicates significant at 5 per cent, *** indicates significant at 10

## 2. Growth in area, production and productivity of oilseed crops across the Northeast states

The major oilseed crops grown in NE region are rapeseed, mustard, linseed, sesame, soybean and groundnut. CAGR and instability in area, production and productivity of oilseed crops in NE

region for the period 2007-08 to 2017-18 are presented in the Table 5. Manipur state witnessed annual growth rate of 44.78 per cent in area and 50.80 per cent in production of oilseed crops, which is highest among NE states and statistically significant at one per cent level. However, the growth in both area and production of oilseeds in Sikkim and Nagaland are negative. In oilseeds productivity, Mizoram showed highest positive annual growth rate of 8.98 per cent and is statistically significant at five per cent followed by Meghalaya, Manipur and Assam states. The data presented in the table 5 indicated that the oilseed area is highly unstable in states like Manipur (39.12 %) and Tripura (28.66 %), whereas, in Assam (3.32 %) the variability in oilseed area is very low. Similar trend is also observed in production of oilseeds, while, in productivity of oilseeds, Mizoram state has the highest variability and Arunachal Pradesh recorded the lowest variability.

**Table 5: Compound annual growth rate and instability index in area, production and productivity of Oilseed crops in NE region of India (2007 to 2017)**

| Compound Annual Growth Rate | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Particulars** | **Arunachal Pradesh** | **Assam** | **Manipur** | **Meghalaya** | **Mizoram** | **Nagaland** | **Sikkim** | **Tripura** | **NE states** |
| **Area** | **2.29*** | **2.28*** | **44.78*** | **4.63*** | **-4.32*** | **-1.60** | **-3.96*** | **18.39*** | **2.61*** |
| **Production** | **3.31*** | **5.03*** | **50.80*** | **10.97*** | **4.32** | **-0.57** | **-3.02*** | **20.15*** | **4.71*** |
| **Productivity** | **1.00**** | **2.68*** | **4.14**** | **6.09*** | **8.98**** | **1.06** | **0.97** | **1.50** | **2.86*** |
| **Instability index** | | | | | | | | | |
| **Area** | **3.34** | **3.32** | **39.12** | **8.63** | **12.60** | **15.13** | **6.83** | **28.66** | **3.13** |
| **Production** | **5.00** | **6.37** | **34.50** | **17.74** | **28.17** | **7.01** | **8.66** | **33.36** | **3.54** |
| **Productivity** | **3.82** | **4.53** | **11.16** | **9.82** | **21.64** | **7.58** | **5.24** | **10.33** | **4.73** |

Note: * indicates significant at 1 per cent, ** indicates significant at 5 per cent, *** indicates significant at 10

## 3. Growth in area, production and productivity of horticultural crops across the Northeast states

Presently horticultural crops account only 18.60 per cent of total cultivated area in Northeast India. This share is highest in Sikkim followed by Manipur, Arunachal Pradesh, Meghalaya, Tripura, Mizoram, Assam and Nagaland (Lakshman, 2017). The major fruits cultivated in the region are citrus fruits, banana, mango, pineapple, plum, peach and strawberry etc. During the period 2007 to 2017, Mizoram recorded the highest growth in area (12%) under fruits production per annum followed by Nagaland and Tripura. While in fruit production Nagaland has the highest growth rate i.e. 17 per cent per annum followed by Manipur (14%) and are significant at five per cent level. The highest variability or instability in area and production of fruits is observed in Sikkim followed by Arunachal Pradesh. The average annual growth in area and production of vegetables is highest in Nagaland state followed by Mizoram and Manipur. Where, variability in area and production of vegetable crops is highest in Arunachal Pradesh and lowest in Meghalaya and Tripura (Table 6).

**Table 6: Compound annual growth rate and instability index in area, production and productivity of horticultural crops in Northeast India (2007 to 2017)**

| Fruits | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Compound Annual Growth Rate | | | | | | | | | |
| Particulars | Arunachal Pradesh | Assam | Manipur | Meghalaya | Mizoram | Nagaland | Sikkim | Tripura | NE states |
| Area | -1.99 | 2.68* | 0.79* | 2.05* | 12.11* | 10.79* | -7.03 | 6.85* | 3.51* |
| Production | 6.32 | 3.93* | 14.34** | 5.10* | 4.55** | 16.66* | -4.94 | 1.50 | 5.02* |
| Productivity | 8.48*** | 1.22*** | 13.44** | 2.99* | -6.74* | 5.29* | 2.26 | -5.01* | 1.46** |
| Instability index | | | | | | | | | |
| Area | 20.90 | 6.87 | 18.65 | 5.57 | 11.46 | 20.00 | 38.25 | 17.44 | 8.61 |
| Production | 48.45 | 5.20 | 26.85 | 12.13 | 13.26 | 22.59 | 50.13 | 16.28 | 10.28 |
| Productivity | 31.79 | 5.82 | 29.74 | 6.83 | 16.67 | 12.95 | 23.33 | 7.70 | 5.87 |

| Vegetables | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Compound Annual Growth Rate** | | | | | | | | | |
| **Area** | **-8.56** | **0.98** | **12.58*** | **1.64**** | **13.98*#** | **20.42*** | **2.51** | **5.57*** | **3.48*** |
| **Production** | **-10.03** | **-1.04** | **8.51*** | **4.60*** | **3.44***#** | **29.90*** | **2.51** | **7.50*** | **5.67** |
| **Productivity** | **-1.61** | **-2.05** | **-4.78*** | **2.69**** | **-9.25**** | **7.72*** | **-1.13** | **0.74** | **-1.61** |
| **Instability index** | | | | | | | | | |
| **Area** | **43.84** | **8.06** | **24.99** | **5.29** | **28.25** | **17.76** | **16.82** | **9.89** | **5.81** |
| **Production** | **42.43** | **17.72** | **12.79** | **8.68** | **26.65** | **23.25** | **28.93** | **8.77** | **12.54** |
| **Productivity** | **56.17** | **17.46** | **9.04** | **8.67** | **39.80** | **14.68** | **24.06** | **4.31** | **12.70** |

Note: * indicates significant at 1 per cent, ** indicates significant at 5 per cent, *** indicates significant at 10 per cent. # indicates the data used from 2008 to 2017 for analysis.

## 4. Growth of livestock and poultry sector across the states of Northeast India

Livestock rearing is an integral component of hill farming system and plays a significant role in rural economy by providing year round employment, particularly to the small and marginal farmers and agricultural labour. The data in table 7 revealed that Arunachal Pradesh has the highest annual growth in milk production to the tune of 10.68 per cent followed by Mizoram and Tripura with 8.63 and 7.16 per cent, respectively between 2008 to 2018. Manipur state recorded the lowest average annual growth in milk production among NE states. Tripura has the highest positive growth and Manipur recorded the negative annual growth in egg production during 2008-2018. The highest variability or instability in egg production is recorded in Arunachal Pradesh followed by Mizoram while low variability has been observed in Meghalaya and Assam states. The meat production is highly recognized sector in NE region. Nagaland recorded the highest negative growth in meat production and the highest growth has been recorded in Sikkim and Tripura states (Table 7).

**Table 7: Compound annual growth rate and instability index in livestock and poultry sector in NE India (2008 to 2018)**

| Particulars | Arunachal Pradesh | Assam | Manipur | Meghalaya | Mizoram | Nagaland | Sikkim | Tripura | NE states |
|---|---|---|---|---|---|---|---|---|---|
| **Milk Production** | | | | | | | | | |
| CAGR | 10.68* | 1.62* | 0.65** | 1.11* | 8.63* | 1.28 | 4.32* | 7.16* | 2.51* |
| Instability index | 14.76 | 0.67 | 2.13 | 0.41 | 14.53 | 9.35 | 9.44 | 3.36 | 0.87 |
| **Egg Production** | | | | | | | | | |
| CAGR | 4.23* | 0.60* | -1.14** | 0.92* | 0.82 | -9.03* | -9.89* | 7.29* | 1.17* |
| Instability index | 7.82 | 1.32 | 4.15 | 0.45 | 5.71 | 22.90 | 18.18 | 6.35 | 2.80 |
| **Meat Production** | | | | | | | | | |
| CAGR | 0.36 | 5.46* | 1.88* | 1.86* | 3.99* | -8.66* | 10.64** | 9.63* | 1.22** |
| Instability index | 7.10 | 2.40 | 1.47 | 1.86 | 8.56 | 20.08 | 25.34 | 3.93 | 3.90 |

Note: * indicates significant at 1 per cent, ** indicates significant at 5 per cent, *** indicates significant at 10

## 5. Growth in production of fishery sector across Northeast states

NE region is considered as one of the hot spots of freshwater fish diversity in the world. This region is ideal for inland and freshwater pisciculture. The growth and variability in fish production for NE region is presented in Table 8. The data revealed that the highest annual growth in fish production is observed in Meghalaya followed by Sikkim and Tripura. The lowest growth in fish production is recorded in Nagaland with 4.61 per cent per annum. The highest variability or instability in fish production has been seen in Sikkim followed by Meghalaya. The North Eastern States have enormous untapped potential for fisheries in terms of rivers, streams, floodplain, wetlands, lakes, ponds and large areas under rice fish culture system.

**Table 8: Compound annual growth rate and instability index in fishery sector in NE region of India (2008 to 2018)**

| Fish Production | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Particulars** | **Arunachal Pradesh** | **Assam** | **Manipur** | **Meghalaya** | **Mizoram** | **Nagaland** | **Sikkim** | **Tripura** | **NE states** |
| **CAGR** | **5.28*** | **5.26*** | **6.75*** | **14.82*#** | **12.52*** | **4.61*** | **10.46*** | **7.99*** | **5.72*** |
| **Instability index** | **3.94** | **1.75** | **5.92** | **21.35** | **12.89** | **2.55** | **23.56** | **2.51** | **4.41** |

Note: * indicates significant at 1 per cent, ** indicates significant at 5 per cent, *** indicates significant at 10, # indicates data taken for analysis from 2008-2018

## Dynamics of food grains production *vis-a-vis* requirement in NE region

By and large the North Eastern region of India is deficit in food grains production and this is the cause of concern of all policy makers and technologists. The rough estimates prepared as per ICMR recommendation clearly indicates that the region would require an approximately 80.78 lakh tons of cereals, 4.43 lakh tons of pulses, 6.06 lakh tons of oilseeds, 6.05 lakh tons of fruits and 20.20 lakh tons of vegetables for its projected population of 55.33 million in 2030 (Population Projections for India and States 2011-2036). Over the years the demand for food grains has shown increasing trend with the increasing population. Assam state has the largest population in NE region and requires around 69 per cent of total cereals demand followed by Tripura, Meghalaya, Manipur, Nagaland, Arunachal Pradesh and Sikkim during 2030. Similar trend is observed for all the field crops including horticultural crops, fishery, livestock and poultry sector.

The supply projection of field crops, horticulture, livestock, poultry and fishery sector for the period 2030 is presented in Table 9. As per the projections, cereals produced during 2030 in NE region would be around 95.58 lakh ton which is 15.48 percent more than the requirement. Oilseeds, pulses and vegetables have however showed substantial deficit in their production in contrast to fruits production, which has shown strong growth in the next decade. Livestock products such as milk, meat and eggs may become deficit as per the ICMR recommendation for the anticipated population as per the present trend of the growth. Only fish production is expected to meet its requirement in coming

decade. The deficit in pulse production in NE region of India is around 82 per cent against its requirements as per ICMR recommendation (Roy *et. al*., 2017).

**Table 9: Production and requirement of food grains in Northeast India for 2030**

| North East Hill region | Demand (lakh tons) | Supply (lakh tons) | Deficit/Surplus (lakh tons) | Share of deficit/surplus in projected supply (%) |
|---|---|---|---|---|
| **Cereals** | **80.78** | **95.58** | **14.79** | **15.48** |
| **Pulses** | **4.43** | **3.12** | **-1.31** | **-42.05** |
| **Oilseeds** | **6.06** | **4.55** | **-1.51** | **-33.06** |
| **Fruits** | **25.14** | **52.86** | **+27.72** | **52.44** |
| **Vegetables** | **62.53** | **73.90** | **+11.37** | **15.39** |
| **Milk** | **27.67** | **16.89** | **-10.78** | **-63.82** |
| **Fish** | **2.88** | **6.84** | **3.96** | **57.92** |
| **Meat** | **6.06** | **3.26** | **-2.80** | **-85.87** |
| **Egg (lakh No.)** | **99594** | **13547** | **-86047** | **-635.17** |

Source: ICMR RDA 2010: Per capita consumption: Milk-50kg/yr ; meat:10.95kg/yr; egg:180 nos/yr; pulses:8kg/yr; ; vegetables:300g/day; oils:30g; fruits:120g; cereals: 400g/day; Fish:100g/week.

## Comprehensive roadmap for Northeast Agriculture

The NE region has untapped potential to enhance the income of the farming population by promotion of location specific crops, horticultural and plantation crops, fisheries and livestock production by using appropriate technologies and suitable strategies for diverse agro-climatic conditions of the region. The implementation of various programmes like Food Security Mission, RKVY, Mission for Integrated Development in Horticulture, Livestock Mission, Blue revolution, MOVCDNER (Mission Organic Value Chain Development in North Eastern Region) and such other initiatives of govt. of India along with the recently declared packages under Aatmanirbhar Bharat would help the region in achieving the much needed growth in Agriculture sector in next few years. However, the following issues/ areas need immediate attention from the policy makers and other stakeholders.

- Though the region would be self sufficient in cereal crops in next few years, there is an urgent need to improve the productivity of rice, maize and millets by increasing the seed replacement ratio with high yielding varieties and hybrids. The region also need to strengthen its R&D capabilities so as to utilize the vast biodiversity for development of bio-fortified crop varieties meeting the requirement of food habits/ taste of local people with a vision of local to vocal.
- Utilization of rice/ maize fallow to promote double/ triple cropping should get top priority and a mission mode programme for promotion of double cropping may be launched at regional level encompassing entire Northeast India with an objective of complementary and supplementary benefits. Cluster based production system for pulses and oil seeds utilizing the rice/ maize fallow would not only increase the production and productivity of pulses and oilseeds in the region, but would also open lot of windows for secondary agriculture and value addition, thereby reducing the unemployment problem in rural and peri-urban areas to a great extent.
- Organic Agriculture with appropriate budget provision may be promoted in niche areas. While emphasizing to convert the entire agriculture of the region into organic production system, a comprehensive regional plan for production and marketing of inputs like seeds, bio-fertilizers, bio-pesticides, bio-growth promoters etc with appropriate value chain and branding should be prepared with a focus to export the surplus to South East Asia and beyond.
- The region is very rich in different horticultural crops and the production and productivity of the same have been increased in last few years even though the region has failed so far to tap its potential due to a number of reasons. To harness the potentiality, mission mode approach for development of citrus and spices should be adopted by all the states of the region with appropriate measures for post harvest management and value addition in cluster approach. R&D programmes for promotion of indigenous fruits, vegetables, medicinal and aromatic plants of the region should immediately be initiated.
- The NE region has vast potential in livestock production due to the availability of fodder as a form of extensive grasslands, waste land and feasible climatic conditions to manifest a way for sustainable livestock farming and yet the production of meat, milk and eggs are very meager in the region. For promotion of the sector, the respective state govt. should emphasis for

popularization of improve breeds of cattle, pig, goat etc through AI couple with appropriate measures for local production of Feed and fodder on a Mission mode. Backyard poultry for both meat and egg has lot of prospects in the region. Promotion of backyard poultry and duck has the potentiality to uplift the economic condition of marginal and landless farmers in Northeast India by investing very small capital.

- Fish production is expected to meet the demand of the region in near future. However, initiative for taking up fishery on commercial lines on PPP mode should be taken by the state government. Appropriate policy interventions from respective state governments for proper maintenance and management of water bodies and rivers, revamping of fishery extension service etc are equally important to promote the sector in the region.
- Strengthening of post harvest value chain including storage and transportation for seamless marketing utilizing e-NAM platform and other regional markets along with appropriate product branding would help the region in increasing the producer share in consumer rupee.
- Extending support for formation of farmer's associations, producer's organization and cooperatives etc besides helping the farmers in production enhancement and marketing to fetch better returns is very much needed. The KVKs and ATMA of the region need to be strengthened with all required logistics and infrastructure.

## Conclusion

NE region is predominantly agrarian and practice subsistence agriculture. Majority of the workforce are engaged in agriculture and allied sector for livelihood. In recent years, due to appropriate policy initiatives by the government, the progress in Agriculture in the region is visible and few states like Assam, Manipur, Nagaland and Tripura are now self sufficient in rice production. Likewise, the annual growth in Fishery sector in the region in terms of production is more than 5 % during 2008-18. Moreover, by 2030, the region would have surplus production in cereals, fruits and fish even though it would be deficient in production of pulses, oilseeds, milk, meet and egg etc. The potentiality of agriculture in the region is very vast and with appropriate market let production system planning coupled with technology injection and participation of young educated people, the agriculture in the region would grow substantially to bridge the gap between production and demand in next few

years. It is expected that in this fiscal, the share of agriculture in state GDP in the region would increase due to the favorable rainfall pattern as indicted by IMD coupled with the much needed measures announced by Govt. of India through its Aatmanirbhar Bharat initiative.

## References

1. Anirudh Roy, D. S. Dhkar, Anil Kumar Tripathi and NongmaithemUttam Singh, 2014, Growth Performance of Agriculture and Allied Sectors in the North East India, *Economic Affairs*, **59**, pp: 783-795.
2. Anirudh Roy, N.U. Singh, D.S. Dkhar, A.K. Mohanty, S.B. Singh and A.K. Tripathi, 2015, Food Security in North-East Region of India — A State-wise Analysis, Agricultural *Economics Research Review*, **28**, pp: 259-266.
3. Barah, B. C., 2007, Strategies for Agricultural Development in the North-East India: Challenges and Emerging Opportunities, *Indian Journal of Agricultural Economics*, **62**(1), pp: 13-31.
4. Chikkathimme Gowda, H. R., Amrutha, T., Ragavendra, K. J. and Shivkumar, 2019, Millets Production and Prospects in India: An Economic Overview, Green Farming, **10**(3), pp: 35-39.
5. Joseph Koireng, P.S. Rolling Anal , Kalyan Jana and K.H. Priya Devi, Prospects of Sustainable Livestock Farming in NEH Region of India, *International Journal of Current Microbiology and Applied Sciences*, **7**(1):1285-1292.
6. Konwar, Paranan., 2015, Socio-economic conditions, inequality and deprivation in North East India. MPRA Paper No. 65407.
7. Lakshman Chandra De, 2017, Horticulture Scenario in NE region of India, *International Journal of Agricultural Science and Research*, **7**(2): 243-254.
8. National Commission on Population, 2019, Population projections for India and States 2011-2036.

# IMPACT OF COVID19 IN NORTHEAST AGRICULTURE AND POSSIBLE OPPORTUNITIES

**Bidyut C. Deka**

North Eastern region of India is known for its diversified cultural heritage and biodiversity. The region comprises of eight states namely Arunachal Pradesh, Assam, Mizoram, Meghalaya, Nagaland, Tripura and Sikkim with a landmass of 2.6 million Sq. km accounting for 7.9 per cent of India's total geographical area. About 5.3 million ha is under various crops while 1.47 million ha (NEC, 2015) is under jhum (shifting) cultivation. Northeast India has a population of about 45 million (Census, 2011), which accounts for 3.7 per cent of country's total population. The communities in the region are predominantly agrarian and practice subsistence agriculture. The economy of the region is by and large dependent on agriculture contributing 16-20 % in state GDP of the region.

The countrywide lockdown on account of COVID 19 pandemic during March 24 to May 31 in four different phases had a great impact in the agriculture sector of the region. To understand the impact of COVID 19 in Agriculture and allied sector, a quick survey was conducted by the KVKs of the Manipur, Meghalaya, Mizoram, Nagaland and Tripura during April 9-10 utilizing the ICT tools like Whats App and Facebook. The following are some of the impacts of COVID 19 in the states as reported by the KVKs.

## Impact of COID 19 on Agriculture and allied sector

- The rough estimates suggest that the harvesting of around 10 to 17 per cent of vegetables, 0.80 per cent of *rabi* oilseed and 6 per cent of pulse crops are affected due to lockdown in the region.
- Floriculture sector is hampered to a great extent as these commodities are usually marketed within and outside the region for religious and social ceremonies.
- Sowing of spices like ginger and turmeric is delayed as it coincided with the lockdown period. Delayed sowing will affect growth and yield of spices.
- Sowing is delayed to the tune of 10 to 20 per cent under *jhum* cultivation of the region.

- Due to restriction of labour movement, shortage of agricultural labourers for harvesting and post harvesting operations for *rabi* crops is experienced in few districts of the region which resulted rise in wage rate.
- Delayed/Non supply of agricultural inputs in time is going to affect the *kharif* season crops. Availability of hybrid seeds and other farm inputs from outside the states might be adversely affected.
- Due to lockdown, agriculture supply chain is disturbed to a great extent with no or less facilities for transportation, leading to shortage of essential goods and rise in the price of perishable commodities in most of the states of the region.
- Farming communities have incurred loss and realized low returns (low price) due to restriction in the movement of vehicle carrying agricultural produces. This situation compels the consumers to pay higher prices due to shortage in the market leading to producer-consumer paradox.
- Animal sectors especially commercial broiler farmers have incurred more than 60 per cent loss, as the supply of feed for poultry sector is predominantly dependent on outside supply, more particularly on Kolkata and Hyderabad. Likewise, the pig sector has also suffered a lot.
- Milk supply chain is severely affected due to close down of hotels, bakeries and sweet shops.
- Lack of proper communication in rural areas has hindered the information dissemination to a great extent.

To mitigate the situation, ICAR-ATARI, Umiam through its KVKs of the region analyzed the ground realities and devised the following strategies/ measures so as to minimize the loss of farmers and bring them back to cultivation taking the advantage of the relaxation given by the respective state govt. in phase II of the lockdown. The following are some of the measures devised by the KVKs in consultation with ICAR-ATARI, Umiam, farmers club, NGOs, progressive farmers and other stakeholders.

## Measures taken for short term mitigation

- The KVKs of the region have quickly prepared and distributed face masks to farming communities by utilizing the facilities available with the KVKs and make the farmers understand about the importance of social distancing at all the stages of production and distribution.
- The KVKs along with other central and state government Departments have taken up all possible measures to disseminate the crop-specific advisories to farmers through personal calls and whatsApp messages and also advising them to follow safety measures such as wearing masks, washing hands regularly and maintaining social distance during sowing, harvesting, post-harvest operations, storage and marketing etc.
- Some of the KVKs and line departments of various state govt. of the region have started distributing the available seeds of maize, paddy, vegetables etc and feeds for livestock and fishes through contact farmers. During the period, 537. 21 q of rice seed and 88.55 q of maize seed have been distributed to the farmers across the states by the KVKs.
- The states of Meghalaya, Manipur and Mizoram through different Apps have started selling fruits, vegetables, fishes etc at consumer doorstep in reasonable rate involving FPOs, Farmer clubs and various line departments including NGOs.
- Since the farm activities are now exempted from the purview of the lockdown period by most of the states, the farmers are geared up for cultivation of *Kharif* crops and marketing of the produces in the nearby markets.
- All the KVKs are in constant touch with the farmers through various ICT tools and motivating them to continue their farm operations by following all measures to combat COVID19.

## Initiatives of Govt. of India to rejuvenate the farm sector

The lockdown declared by the honorable Prime Minister of India on March 24, 2020 to mitigate the situation arising out of COVID 19 pandemic has badly affected the agriculture of the region at a time when many of the educated young people started looking agriculture as a lucrative vocation for them. Some educated young people started different agricultural activities like pig

farming, poultry farming, integrated/ composite fish farming, organic farming, cluster based vegetable production, protected cultivation, IFS etc by availing bank loan/ personal loan with a hope that they would earn their livelihood besides generating lot of employment and few of them were very successful in their endeavor. The COVID 19 pandemic coupled with African Swine fever, post effect of AMPHAN, flood in many parts of Assam and such other natural calamities have further discouraged many of them. However, the launching of "Aatmanirbhar Bharat" initiative of Govt. of India with a slogan of "local to vocal" has brought a ray of hope to revitalize the enterprises of the young people in the region. The people of the region by and large feel that the scheme is very much timely for empowering agrarian India and ancillary industries to build self-reliant India. However, the success of the programme will depend on its implementation by the respective state governments and other stakeholders like banks, NABARD, regulatory bodies including farmers and their groups. For effective implementation of the programme, the Ministry of Agriculture & FW and other Ministry should immediately issue the implementable guidelines so that the activities in the ground can start within a month time.

In order to take the advantage of Aatmanirbhar Bharat programme, the KVKs of the regions were mobilized to identify few sectors looking into the strength of the region and according all the KVKs put forwarded their opinions. Based on the observation and opinions of the Sr. Scientists & Head of the KVKs of the region, the following strategies/ action points against each of eight (8) areas were identified and suggested. The respective state govt. of Northeast India should immediately prepare few projects to get the major share of the total outlay announced by the honorable Finance Minister, Govt. of India.

### 1. Agri infrastructure fund for Farm Gate infrastructure for farmers- Total outlay: Rs. 1.00 lakh crore

- Establishment of ware house and cold storage having 3-4 no. of chambers per cold storage with different temperature and relative humidity controller for safe storage of perishable commodities in production catchment area. These facilities may be linked to the nearest railway station/ airport with appropriate cold chain logistics.

- For promotion of inter-state movement of perishable commodities like fruits, vegetables, Indian Railway may be requested to arrange minimum 2-3 refrigerated wagons/ compartments in every long distant passenger train in PPP mode.
- Establishment of 4-5 nos. of Custom Hiring Center (CHC) with tractor, power tiller, dal mill, paddy/ wheat/ maize thresher, solar drier, pump set, power sprayer, mobile pick-up van etc in each of the Development blocks of the region. They may be operated based on requisition through a mobile based portal like UBER/ OLA.
- Good amount of fund may be kept for Entrepreneurship Development programme for rural youths (Capacity Building for Start-Up including one time start-up grant) in DFI (Doubling Farmers' Income) villages adopted by KVKs. The line Department may be made responsible for implementation of this programme in convergence with KVKs and ATMA.
- 10-15% of the outlay should be utilized for strengthening the KVK infrastructure.

## 2. Formation of micro-food enterprises-Total outlay: Rs. 10000 crore

- Setting up of one processing and packaging facilities on PPP mode for value added products in production catchment area per district.
- Budgetary provision for establishment of pilot processing facilities for training and demonstration for value addition in select KVKs having SMSs in Home Science/ Agriculture Engineering may be made.
- Promotion of SHGs in profit oriented agri-bussiness enterprises such as Micro-food Processing Industries/Cottage Industries for popularization of area specific and indigenous crops/products like pineapple, Assam lemon, Ginger, Turmeic, Large, cardamom, king chilli, bamboo-shoots, bamboo based industrial products, piggery unit, egg production unit, composite fish culture, honey production, handloom & handicraft etc. including branding, certification for safety standards etc with appropriate skill up-gradation programme. Establishment of 2-3 meat processing unit per state in PPP mode would encourage the livestock sector.

### 3. Pradhan Mantri Matsya Sampada Yojana-Total outlay: Rs. 20000 crore

- Promotion of Integrated farming System (Fishery cum Livestock + Agriculture + horticulture) to enhance production per unit area for improvement of rural economy. Paddy cum fish culture needs to be taken up on large scale, promotion of Paddy cum Fish culture through establishment and adoption of 'Refuge Pond System' as shallow pool of paddy cultivation etc are essentially required for small and marginal farmers. Popularization of fish culture in tank using bio-flock technology may be another option for landless laborers.
- Establishment of minimum one (1) commercial aqua hatchery per 2-3 districts for supply of quality fingerlings to enhance fish production in the country. Establishment of Mini Ice Plant for producing ice blocks and provisioning of refrigerated vans in identified potential villages for improvement of market chain.
- Organization of capacity development programme on fish production, marketing and value addition etc and providing bank loan to the successful trainee immediately after the training based on the recommendation of the concerned organizers at minimum interest rate with flexible repayment mode.

### 4. National Animal Disease Control Programme-Total outlay: Rs. 13343 crore

- Establishment of 4-5 vaccine banks per state for livestock, poultry etc. ICAR/ SAU facilities may be utilized on leased basis in PPP mode with one time capital and revenue grant.
- Organization of village level animal health and vaccination camp twice in a year against minimum payment by farmers in convergence mode.
- Establishment of well-equipped quarantine facilities to check the outbreak of diseases due to interstate/ international movement of animals. Well equip Animal disease diagnostic laboratory in each state may be established on a priority basis.
- Popularization of rapid taste kit against different animal diseases, more particularly the diseases of virus origin for adopting timely control measures.
- KVKs having scientists in Animal Science may be made the nodal officer to execute the vaccination programme in the district.

## 5. Animal Husbandry Infrastructure Development Fund-Total outlay: Rs. 15000 crore

- Create facilities for semen collection and storage of all livestock in each of the districts for promotion of Artificial Insemination (AI) in a big way.
- Setting up of 4-5 nos. of commercial egg production units in PPP mode per state. Likewise, for promotion of backyard poultry, establishment of Poultry Hatchery in each of the districts of the NE states is essential so that the farmers can get adequate number of improved variety of poultry chicks at a lower price and reduce the gap between demand and supply of egg in the region.
- Establishment of Livestock Feed processing unitin each district to formulate balanced ration incorporating locally available feed resources for reduction of feed cost. Like, FCI, a Regional/national level Animal and Fish Feed Corporation may be established with all logistic arrangement like ware house, feed tasting lab in select locations across the states of the region to regulate the regular supply of feed ration to the farmers at minimal rate.
- Establishment of slaughter house in each of the blocks for promotion of safe and clean meat.

## 6. Promotion of cultivation of medicinal plants-Total outlay: Rs. 4000 crore

- Formation of 5-6 of clusters of different medicinal plants per state along with processing, distillation, packaging and marketing facilities. KVKs may be given the responsibility for promotion of medicinal cluster through CFLD programme like oilseeds and pulses.
- Formation of 5-6 of clusters of different medicinal plants per state along with processing, distillation and packaging facilities. Such clusters may be linked with companies like Patanjali with the involvement of AYUSH Ministry.
- A startup fund may be created for exploring the possibilities for development of organic value added products utilizing various mix of medicinal and aromatic plants with honey as well as mustard oil.

### 7. Beekeeping activities-Total outlay: Rs. 500 crore

- Formation of minimum one cluster for bee keeping as pollinators to various crops per district to increase yield of crops and quality honey. Processing and packaging facilities in PPP mode may be established. MSP may be fixed for the honey.
- Organization of regular hands on training on bee keeping and processing including bee wax and such other products.

### 8. To extent operation "TOP" to all vegetables-Total outlay: Rs. 500 crore

- A mobile App may be launched for home delivery of quality vegetable seeds recommended by ICAR/SAUs/ KVK/ Line Department for timely delivery of seeds to farmers against indene.
- Establishment of facilities for collection, sorting and grading in each of the wholesale market of the block. Facilities should also be created for farm level minimal processing facilities as backup plan for processing industries.
- Promotion of micro irrigation system in vegetables in a big way linking with the programme of Ministry of Jal Shakti.
- Low cost storage structure for short term storage of vegetables may be promoted for small and marginal farmers.
- Promotion of on-farm drying technology for production of dehydrated vegetables in cluster approach by FPOs, CIG etc.

## Way forward

As per the latest analysis made by a number of economists in the country and elsewhere, the GDP of most of the countries in the world will either be (-) 2-3% or little over 1 % in this fiscal and India is no exception to that. The situation in the North Eastern states would be much more alarming due to its poor revenue collection that results too much dependence on funding/ grant from central govt. Moreover, the recent home coming of workers from different parts of the country to their home states coupled with the existing unemployment scenario has further aggravated the already deplorable economic condition in the region. Under such circumstances, the respective state govt. in the region

will have to seek opportunities in this adversity the way the *jugaad* innovators do in such a situation by being quick to act in response to the situation. In order to bring back the growth in our economy to the modest tune of 3-4 % in this fiscal, the agriculture has to play a very proactive role by taking the advantage of the favorable rainfall pattern as indicted by IMD coupled with the much desired measures announced by Govt. of India through its Aatmanirbhar Bharat initiative. The following are some of the random thoughts, which I believe would help in bringing back the momentum in agriculture sector in the region with a target of 6-8 % growth in this fiscal.

- Immediate release of compensation in cash or kinds to those farmers who could not sell their perishable commodities due to lockdown and otherwise.
- The government should immediately ensure the supply of critical agricultural inputs at farmer door steps for the *kharif* crops and livestock including poultry and fishery.
- Arranging KCC or such other loan in minimum interest rate having one year of moratorium on repayment to revitalize the existing farm enterprises. The same facility should also be extended to the migrant workers having strong desire to take agriculture as their vocation. The govt. should make sure that the respective bank releases the loan amount to the farmers within 7-10 days of their duly submitted application vetted by the concerned line Departments or KVKs in the district.
- Mission double/ triple cropping, self sufficiency in poultry egg production, milk production with processing facilities in cluster mode should be implemented through contract farming involving the interested migrant workers based on their skill.
- FPO's, Cooperatives, Societies and SHGs registered with the state government may be utilized for aggregator based services in agriculture to resolve the problem of transportation of the farmers. Such organization may also be mobilized for promotion of secondary agriculture with appropriate hand holding and financial support by the respective state govt. for installing the required infrastructure for value addition and marketing.
- eNAM in each of the states of the region should be implemented at a much faster pace to eliminate the role of middle men and mitigate such situation in future.

- Lesson learnt from the recent outbreak of African Swine fever indicates that every state should install quarantine facilities equip with the required equipments and bio-safety tools including the staff in select locations for planting materials/ animals.
- A mandatory fodder bank in each of the revenue villages may be thought under the Ministry of Animal husbandry and Veterinary. Hydroponics for such purposes is the need of the hour.
- The govt. may seriously think to include Agriculture in concurrent list of the constitution of India so as to tide over such situation in future.

# GENESIS AND GROWTH OF AGRICULTURAL TECHNOLOGY APPLICATION RESEARCH INSTITUTE (ATARI) AND KRISHI VIGYAN KENDRA (KVK) IN NE REGION

**Dr. A.K. Singha**

The agriculture and its allied sectors are critical to the sustainable growth and development of the country. The issue of growth in agriculture has assumed a global concern in view of meeting the sustainable development goals of producing enough food to end hunger, achieving food and nutritional security and promoting sustainable agriculture for a rapidly growing world population. In this context, the role of such agricultural technologies which could be integrated into the existing farming systems under different agro-ecological situations for boosting production of various commodities and in turn increasing income of the farmers assumes significance. At present, there are challenges like doubling of farmers' income by optimal and eco-friendly resources-land, labour, capital and management, producing 'more from less-for more' with agriculture becoming more and more knowledge demanding.

There is a continuous need for development and transfer of location specific technologies which are economically viable and socially desirable. In order to provide technologies with location-specific focus, ICAR established Krishi Vigyan Kendra (KVK) in every district of the country. Innovations, assessment & refinement and diffusion of improved and traditional technologies are some of the core activities of KVKs. Time and again, there were empirical evidences to prove that the KVK system has positively impacted the quality of life of farming community in terms of income and yield level by optimal utilization of farm resources. It also has made a tangible impact in the areas of integrated farming, crop diversification, value addition, biodiversity, organic farming, horticulture, dairying, veterinary & animal husbandry, fisheries etc. However, the inter-state diversities due to agro-climatic conditions, non-uniform agrarian dynamics of each district, dissimilar institutional framework are few reasons for non-uniform outcomes and efficacies from each KVK in the country.

Over a period of four decades, since the set-up of first KVK system in NE region in Kolasib district of Mizoram during 1979 at grass-root level, the spectrum of the mandated and core functions of

KVKs are enlarged to address all the day-to-day issues of farming community in a seamless manner. The KVKs at present have grown as the largest vibrant network in the region with a quantum jump in number reaching to 89.Currently, the KVKs in the region are performing multi-dimensional roles, starting from core activities such as technology backstopping, resource-conservation methods, introduction of cutting-edge techniques, and up-scaling at one end, and envisioning entrepreneurial opportunities in rural areas, providing vocational/skill training to rural youth, women folks on the other end. These Institutions are also effectively using the latest tools of ICT in dissemination of information for extended reach with richness. KVKs are solely responsible to Agricultural Technology Application Research Institute (ATARI), which in turns is accountable for the successful performance of KVKs through effective coordination and monitoring mechanism with physical and financial supports.

## Genesis and Growth of ATARI, Umiam

The erstwhile Zonal Coordinating Unit (ZCU), Zone-III, Umiam began its journey from the office attached to ICAR Research Complex for NEH Region, Umiam with administrative and financial management under its control. On the eve of golden jubilee celebration of Indian Council of Agricultural Research (ICAR), New Delhi, the ZCU, Zone-III was established in 1979 at Umiam, Meghalaya as one of the 8 (eight) units across the country with staff strength of 6 (six) for implementation of Lab-to-Land programme (LLP) with financial support from the Cess Fund of ICAR. The unit started functioning with the joining of Dr. D.J. Roy as the Zonal Coordinator since September 14, 1979. Subsequently, the ICAR decided that the Krishi Vigyan Kendra (KVK) project would be monitored by this unit and hence, increased the staff strength to 8 (eight) for monitoring and reviewing the technology assessment, refinement, demonstration, training programmes and other extension activities conducted by KVKs in North Eastern Region, which comprises of eight states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. During the VIIIth Plan (1992-1997), when the total number of KVKs was 261 in India, the ICAR revised the staff strength of Zonal Coordinating Unit to 15 (fifteen). In XI$^{th}$ Plan, on an average, each Zonal Coordinating Unit had to handle and manage an annual budget of about Rs. 55crores with increased number of KVKs. Thus, the Zonal Coordinating Units in India were upgraded to the status of Project Directorate, called Zonal Project Directorate (ZPD) with total sanctioned staff strength of 17 with effect from March 19, 2009 for proper financial management as well as effective monitoring, coordinating and reviewing of activities of large number of KVKs. The ZPD again was subsequently elevated to the level of research institute called Agricultural Technology Application Research Institute

(ATARI) with effect from August 11, 2015 keeping in view of its revised mandates. In view of overriding responsibilities of the institute besides effective monitoring, coordinating and reviewing the activities of increased number of KVKs, the ICAR-ATARI, Umiam was further bifurcated into two zones namely; ICAR-ATARI, Zone-VI, Guwahati with 3 states viz;. Assam Arunachal Pradesh and Sikkim under its jurisdiction and ICAR-ATARI, Zone-VII, Umiam with the remaining 5 states, viz. Manipur, Meghalaya, Mizoram, Nagaland and Tripura of the region with the administrative approval of the ICAR, New Delhi.

## Mandate of ATARI

- Coordination and monitoring of technology application and frontline extension education programmes, and
- Strengthening agricultural extension research and knowledge management.

## Functions

The major functions of ICAR-ATARI, Umiam include-

- Planning, formulating, monitoring, guiding and reviewing the activities of KVKs of the zone;
- Identify, prioritize and implement various activities related to technology integration and dissemination;
- Coordinating with SAUs, ICAR institutes/organizations, host institutes, line departments and voluntary organizations in the zone for implementation of KVK mandated activities;
- Partnering with Directorate of Extension Education of CAU in assured technological backstopping to KVKs and appropriate overseeing of KVK activities.
- Strengthening the Directorates of Extension Education of CAU with financial support.
- Implementing special projects and programmes of ICAR like NICRA, CFLD, ARYA, NEMA, Farmer FIRST, DAMU and others.
- Facilitating financial and infrastructural support to KVKs for effective functioning.
- Maintaining close liaison with ICAR headquarters particularly with Division of Agricultural Extension for preparing reports, write ups and other important documents.

## Organisational Structure of ICAR-Agricultural Technology Application Research Institute (ATARI)

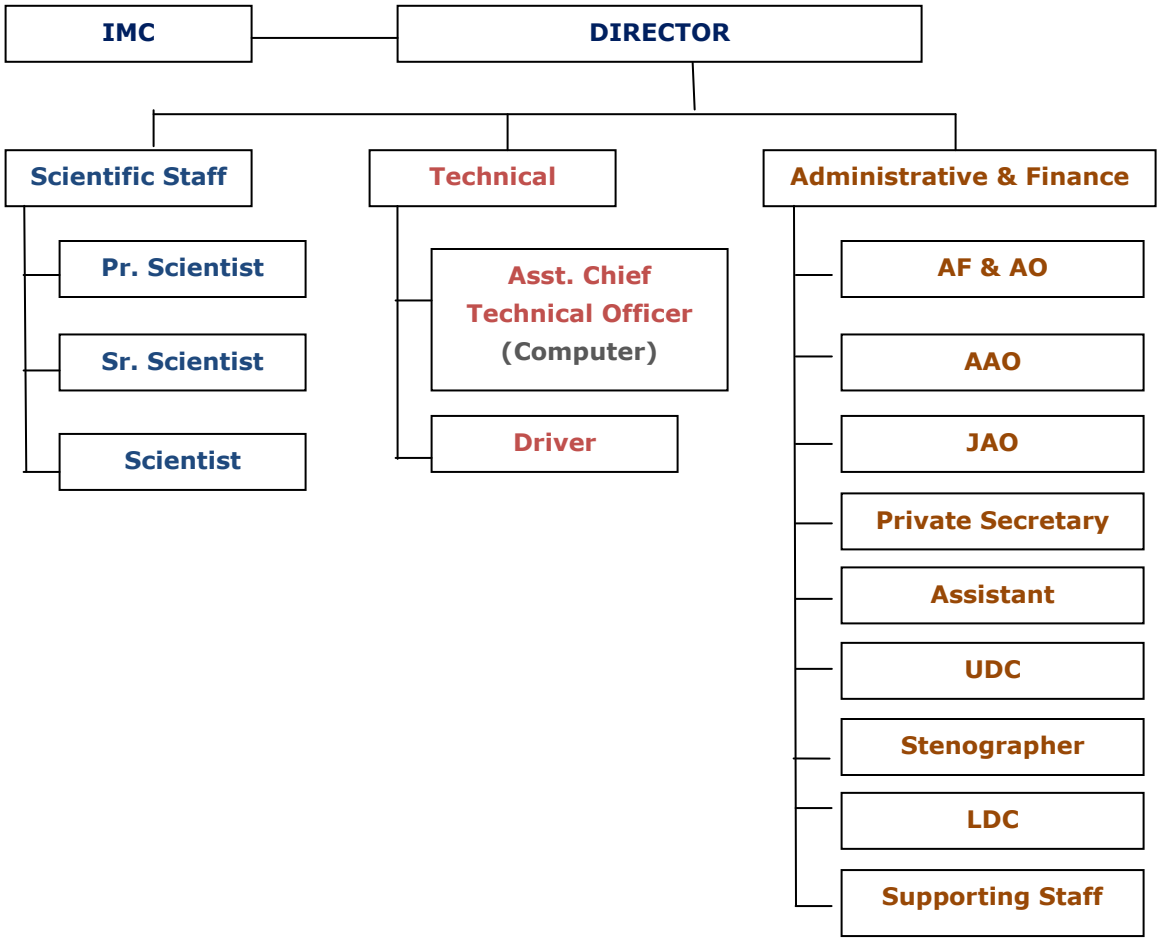



Fig 1: Organizational Structure of ICAR-ATARI, Umiam

## Genesis, Origin and Growth of Krishi Vigyan Kendra (KVK)

As the number of unskilled rural youth was fast increasing, the Education Commission (1964-66) recommended that a vigorous effort be made to establish specialized institutions to provide vocational education in agriculture and allied fields at the pre- and post-matriculate levels to cater to the training needs of a large number of boys and girls of rural areas. Further, it was suggested that such institutions be named as Agricultural Polytechnics. The recommendations of the Commission were thoroughly discussed during 1966-72 in the inter-ministerial meetings including Ministry of Education, Ministry of Agriculture, Planning Commission, ICAR and other allied institutions. Finally, the ICAR mooted the idea of establishing Krishi Vigyan Kendras (KVKs) as innovative institutions for imparting vocational training to the practicing farmers, school drop-outs and field level extension functionaries. The ICAR Standing Committee on Agricultural Extension, in its meeting held in August 1973, observed that since the establishment of KVKs was of national importance which would help in accelerating the agricultural production and also in improving the socio-economic conditions of the farming community, the assistance of all related institutions should be taken to implement this scheme. The ICAR therefore, constituted a committee in 1973 headed by Dr. Mohan Singh Mehta of Seva Mandir, Udaipur (Rajasthan) for working out a detailed plan. The Committee submitted its report in 1974 and as part of the report, the first KVK on a pilot basis was established in 1974 at Pondicherry (now Puducherry) under the administrative control of the Tamil Nadu Agricultural University (TNAU), Coimbatore.

## Concept of KVK

KVKs are grass root level organizations meant for application of technology through assessment, and demonstration of proven technologies under different 'micro farming' situations in a district. With this in mind, transfer of technology *per se* is not the primary function of KVKs, but field extension activities are carried out to facilitate on-farm assessment of the newly released technologies, demonstrate the proven ones and train farmers and extension functionaries on the same. The purpose is to develop models of different cost effective farming systems which could be upscaled by the State Extension Services.

## KVK in NE Region

The first KVK in NE region was established in Kolasib district of Mizoram in February, 1979 to impart training to equip the farmers with skill and knowledge required for practicing advanced agricultural and allied practices. Gradually with the increase in number, the sphere of KVKs also widened to shoulder other responsibilities like conducting front line demonstrations, on-farm trials, providing trainings to other stakeholders etc. During the IX the plan, the region had only 13 KVKs with most of them were under ICAR administration. Presently the region has 89 KVKs with 46 under Zone-VI, Guwahati and 43 under Zone-VII, Umiam across the 8 states of the region. Under Zone-VII, Umiam, the process of establishing KVKs in 14 new districts will be taken up once the official approval for the same is issued from the Council. These new districts are Kakching, Kangpokpi, Noney, Tengnoupal, Jiribam, Pherzawl and Kamjong in Manipur (7), North Garo Hills, South West Garo Hills, East Jaintia Hills and South West Khasi Hills in Meghalaya (4) and Hnahthial, Saitual and Khawzawl in Mizoram (3). Over a period of time, the Vision, Mission, Mandate, Staff set-up etc. of KVKs have undergone many changes to make it more demand driven. At present, the Vision, Mission and Mandate of KVK are as follows:

### Vision

Science and technology-led growth leading to enhanced productivity, profitability and sustainability of agriculture.

### Mission

Farmer-centric growth in agriculture and allied sectors through application of appropriate technologies in specific agro-ecosystem perspective

### Mandate

The mandate of KVK is Technology Assessment and Demonstration for its Application and to enhance Capacity development (TADA-CD).

## Major activities

To implement the mandate effectively through creation of awareness about the improved agricultural technologies, the following activities are defined for each KVK:

- On-farm testing to assess the location specificity of agricultural technologies under various farming systems,
- Out-scaling of farm innovations through frontline demonstration to showcase the specific benefits/worth of technologies on farmers' fields,
- Capacity development of farmers and extension personnel to update their knowledge and skills in modern agricultural technologies and enterprises,
- Work as Knowledge and Resource Centre for improving the overall agricultural economy in the operational area,
- Conduct frontline extension programmes and provide farm advisories,
- Using ICT and other media on varied subjects of interest to farmers and
- Data documentation, characterization and strategic planning of farming practices.

KVKs are also required to produce quality technology related inputs/products (seeds, planting materials, bio-agents, livestock, fingerlings etc.) and make them available to farmers, besides identifying and documenting selected farmer-led innovations and converging with the ongoing schemes and programmes within the mandate of KVK.

## Growth of KVKs in NE Region

The KVK Scheme of ICAR is implemented through different host organizations under their administrative control. The first KVK in the region was established in Kolasib district of Mizoram in February, 1979 during rolling year (1978-1980). Presently in North East Region, KVKs are functioning under 18 different host organisations namely; ICAR Research Complex for NEH Region, Umiam (20), Assam Agricultural University, Jorhat (23), Central Agricultural University, Imphal (6), Department of Agriculture, Govt. of Arunachal Pradesh (9), Department of Agriculture, Govt. of Manipur (1), Department of Agriculture, Govt. of Meghalaya (3), Department of Agriculture, Govt. of Nagaland (4), Department of Agriculture (Research & Education), Govt. of Mizoram (7), Dept. of Agriculture and Farmers Welfare, Govt. of Tripura (4), Dept. of Food Security & Agricultural Development, Govt. of Sikkim (3), Department of Veterinary & A.H., Govt. of Arunachal Pradesh (1), State Horticulture Research & Development Institute, Dept. of Horticulture, Govt. of Arunachal

Pradesh (1), National Research Centre (NRC) for Pig, Rani (1), Keshav Smarak Nyas, Haflong (1), NRC on Mithun, Jharnapani, Nagaland (1), Nagaland University, Kohima (1), Joint Farming Cum Pisciculture Co-operative Society, Bishnupur, Manipur (1), Foundation for Environment & Economic Development Services (FEEDS), Senapati, Manipur (1) and Sri Ramakrishna Seva Kendra, Kolkata, West Bengal (1). The plan-wise growth of KVKs in the region is given below in figure.

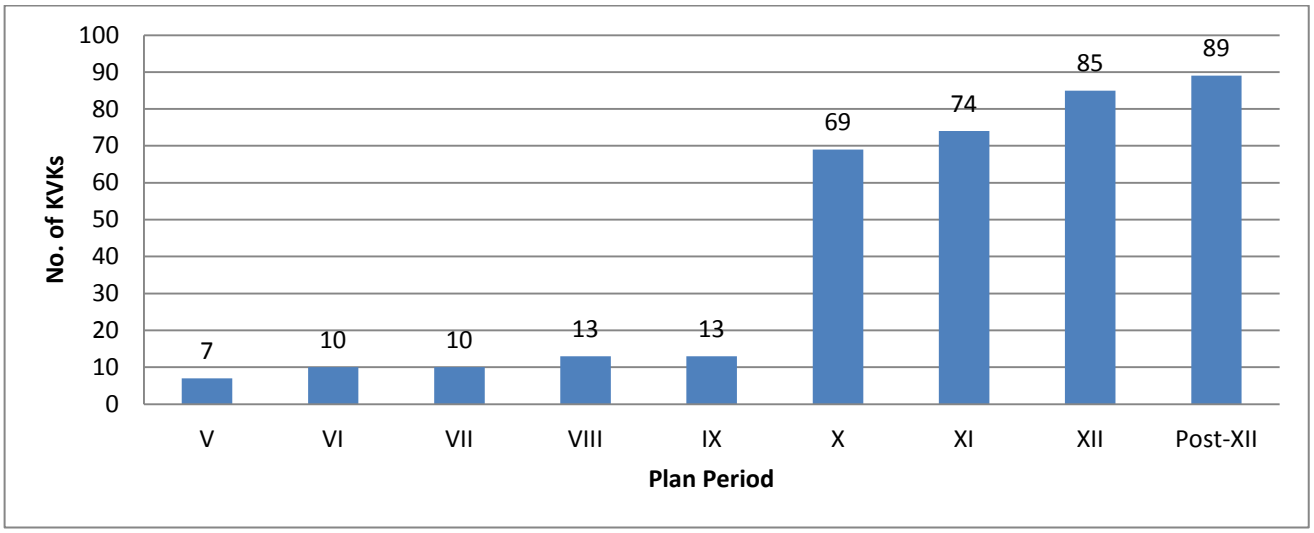



Fig 2. Growth of KVKs over five year plans in North East

## Achievements of KVKs at a glance during 2011-12 to 2018-19 in NE Region

In general, KVKs in North East India are performing not only their mandated activities as per action plans, they are also implementing different special programmes and activities duly assigned by Central government and other developmental organisations from time to time for benefit of farming community in the region with strong support from Agricultural Technology Application Research Institute (ATARI). KVKs, while acting as a single window Agricultural Technology Information Centre (ATIC), are also producing quality technology related inputs/products (seeds, planting materials, bio-agents, livestock, fingerlings etc,) and make them available to farmers. Besides, KVKs identify and document selected farmer-led innovations and converge with ongoing schemes and programmes within the mandate of KVK. The table below presents brief achievements of KVKs in NE region during 2011-12 to 2018-19.

**Table: Year-wise achievements of KVKs under Zone-VI & VII during 2011-12 to 2018-19**

| Activity | Year | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | 2011-12 | 2012-13 | 2013-14 | 2014-15 | 2015-16 | 2016-17 | 2017-18 | 2018-19 | |
| On Farm Trials (No. of technologies) | 287 | 226 | 255 | 233 | 397 | 920 | 966 | 974 | 4258 |
| Front Line Demonstration (No) | 7536 | 10720 | 10697 | 7075 | 12123 | 12478 | 3926 | 5688 | 70243 |
| Training of Farmers (No. of participants | 85445 | 100689 | 103932 | 72752 | 116738 | 108760 | 100456 | 187635 | 876407 |
| Training of Rural youths (No. of participants) | 15926 | 18630 | 19327 | 16961 | 28250 | 21908 | 20427 | 28818 | 170247 |
| Training of Extension Personnel (No. of participants) | 6714 | 5538 | 5177 | 5346 | 6727 | 6777 | 7595 | 10506 | 54380 |
| Extension Activities (No. of participants) | 169001 | 301035 | 380275 | 263420 | 302016 | 526574 | 553953 | 674025 | 3170299 |
| Production of seeds ( in tonne) | 1079.62 | 249.03 | 3078.79 | 1144.69 | 167.48 | 1975.31 | 1331.61 | 2106.66 | 11133.19 |
| Planting materials (in lakh) | 8.56 | 10.03 | 6.32 | 13.20 | 24.62 | 6.57 | 37.71 | 53.37 | 160.38 |
| Livestock strains/Fingerlings (in Lakh | 3.67 | 3.99 | 4.6 | 7.00 | 4.49 | 6.25 | 22.494 | 11.318 | 63.812 |
| Soil and Water Testing (No. of samples | 5332 | 8280 | 3430 | 2293 | 62344 | 63179 | 69477 | 107059 | 321394 |
| Soil Health Card Distributed (Nos.) | - | - | - | - | 19500 | 25242 | 36892 | 83577 | 165211 |
| Kisan Mobile Advisory (KMA) (No. of farmers benefitted (in lakh) | 0.22 | 0.50 | 0.98 | 1.41 | 5.26 | 9.87 | 11.57 | 12.41 | 42.22 |

## Conclusion

At present, the region faces several formidable challenges including technology fatigue, shrinking land base, dwindling water resources, the adverse impact of climate change, emergence of new generation pests, low investment in agricultural research and development, less reach of agriculture technology to farmers, shortage of farm labour, increasing costs of inputs and poor marketing channels etc besides natural calamities like flood, drought and unprecedented situation like COVID 19. In recent years, however, many changes have taken place in agriculture in terms of technological interventions, use of improved farm machinery, implements and equipments etc. for enhancing agricultural productivity and farm income of farmers in the region with the help of KVKs as the key-players. However, factors such as sub-division and fragmentation of landholdings, natural calamities, increasing input costs, poor marketing channels, limited warehousing facilities, varied food demands, challenge of producing more from less continue to pose a major threat. Hence, all these call for a need to reorient the research and development in agriculture sector as well as KVK system in their primary and secondary responsibilities towards developing and promoting those technologies that raise agricultural income and ensure more rural employment opportunities to farmers in the region.

# PULSES FOR NUTRITIONAL SECURITY IN NORTH-EAST INDIA

Careen Nongrum

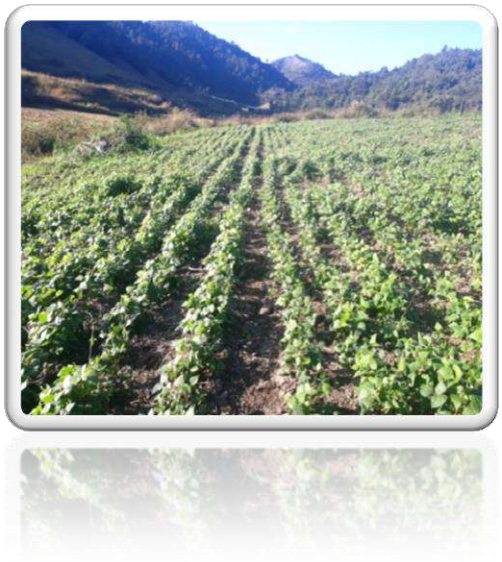
Malnutrition is one of the major problems in India with prevailing child malnutrition of 37% of the child in the country. As per NFHS-3 (2005-06) survey, 30.5% children in Northeast India are malnourished in which Meghalaya has the highest malnourished children under (6-39 months) with 48.8%.Protein-energy malnutrition as well as micronutrient deficiencies can be addressed by increasing the consumption of pulses which are a rich source of proteins, minerals, iron and fibre. The UN declared 2016 as the International Year of Pulses to focus attention on the production and consumption of these nutrient-dense crops.

Pulses possess several other qualities besides being the rich source in protein,it improves soil fertility and physical structure, fits in mixed/inter-cropping system, crop rotations and dry farming and provides green pods for vegetable and nutritious fodder for cattle as well.

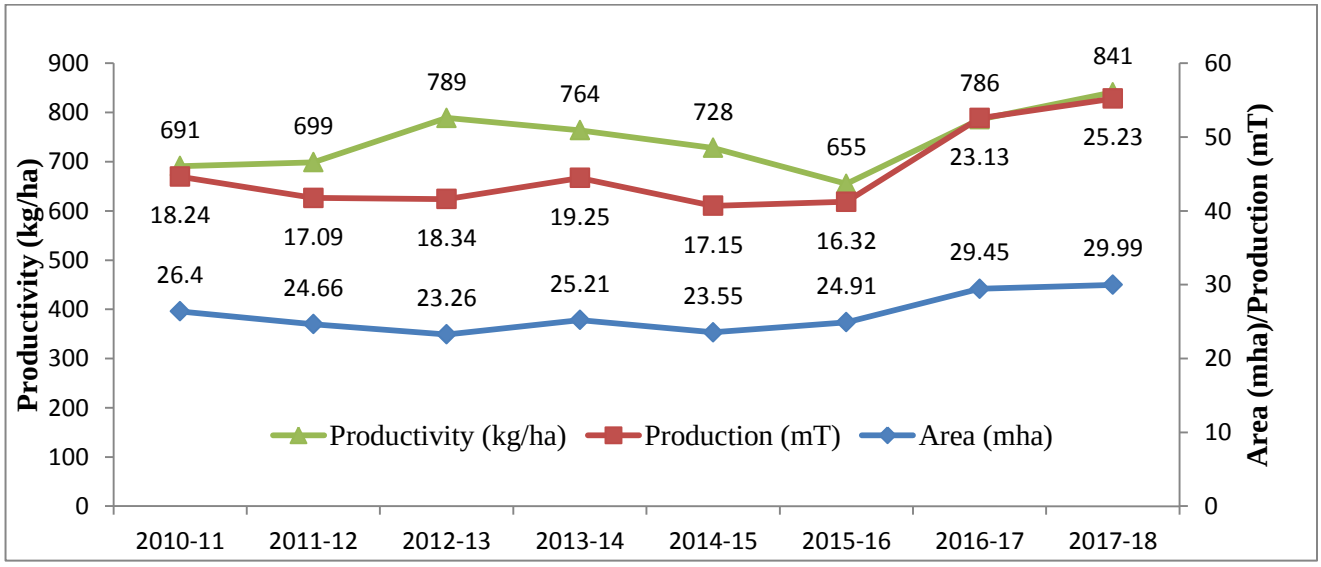
To increase area, production and productivity of pulses in Northeast region, there is need for cropspecific approaches, which should be adopted in the overall framework of systems approach like inclusion of short duration varieties of pulses as inter and/or catch crop especially in rice/ maize fallow areas, development of multiple disease-pest resistant and high biological N fixation varieties (Das *et al*, 2016*)*.Government of India has been implementing through State Governments, the National Food Security Mission (NFSM)-Pulses since 2007-08. The funds under the umbrella scheme of NFSM are allocated for promoting cultivation of pulses. Since 2014-15, NFSM-Pulses is being implemented in 622 districts of 27 States including all districts of North-Eastern and hill States by KVKs (Minister of State for Agriculture & Farmers Welfare, 2016).

## Area, Production and Productivity

The growth rate of pulses production in the country has increased but at a slower rate compared to other food grains like rice, wheat and nutri-cereals. The area, production and productivity of Pulses in India from 2010-11 to 2017-18 are represented in Fig.2



In 2016-17, the area under Pulses is 29.45 mha of which 2.71 lakh hectares is contributed by Northeast India. The average productivity of Pulse in the year 2016-17 in India is 786 kg/ha. However, the average productivity in Northeast India in the year 2016-17 is 888.52 kg/ha (Table 1) which is more than the National's average productivity of pulses. It can be seen that Northeast India has a huge potential in Pulse production. Table 1 highlights that the area, production and productivity of pulses contributed by the North-eastern states of India in the year 2016-17. Among the states, Meghalaya has recorded the highest productivity (1446 kg/ha) followed by Mizoram with 1352 kg/ha.




*Source: Directorate of Economics & Statistics*

**Fig 2: All India Area, Production and Productivity of Pulses**

**Table 1: Area, production and productivity of Total Pulses in NEH region during 2016-17**

| State | Area (Lakh ha) | Production (Lakh Tonnes) | Productivity (kg/ha) |
|---|---|---|---|
| Arunachal Pradesh | 0.13 | 0.131 | 1011 |
| Assam | 1.464 | 1.075 | 735 |
| Manipur | 0.311 | 0.303 | 973 |
| Meghalaya | 0.082 | 0.118 | 1446 |
| Mizoram | 0.035 | 0.048 | 1352 |
| Nagaland | 0.387 | 0.445 | 1151 |
| Sikkim | 0.057 | 0.055 | 961 |
| Tripura | 0.243 | 0.232 | 952 |
| Total | 2.709 | 2.407 | 888.52 |

*'Source: Directorate of Economics & Statistics, M/A, GoI*

## Contribution of Pulses to Nutritional Security in area, production and productivity

The major Pulses grown in Northeast India are Pigeonpea, Gram, Lentil, Peas & beans, Moong and Urad. Table 2 shows that the area, production and productivity (2016-17) under Pulses in Northeast India. Under individual crop category, Urad (Blackgram) recorded the highest productivity of 1134.83 kg/ha followed by Pigeonpea (950.43 kg/ha).

**Table 2: Major Pulses grown in Northeast India (2016-17)**

| Pulses | Area (Lakh ha) | Production (Lakh Tonnes) | Productivity (kg/ha) |
|---|---|---|---|
| Tur/Pigeonpea | 0.172 | 0.146 | 950.43 |
| Gram | 0.062 | 0.051 | 854.40 |
| Lentil | 0.308 | 0.208 | 717.00 |
| Peas and Beans | 0.502 | 0.462 | 912.00 |
| Moong | 0.159 | 0.112 | 836.75 |
| Urad | 0.627 | 0.438 | 1134.83 |

*Source- Directorate of Economics & Statistics, M/A, GoI*

The State-wise area, production and productivity of different pulses are given in tables below:

**Table 3: Area, production and productivity of Pigeonpea in Northeast India**

| Tur/ Pigeonpea | 2014-15 | | | 2015-16 | | | 2016-17 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Area (Lakh ha) | Production (Lakh Tonnes) | Productivity (kg/ha) | Area (Lakh ha) | Production (Lakh Tonnes) | Productivity (kg/ha) | Area (Lakh ha) | Production (Lakh Tonnes) | Productivity (kg/ha) |
| Arunachal Pradesh | 0.006 | 0.006 | 1091 | 0.006 | 0.006 | 905 | 0.008 | 0.006 | 814 |
| Assam | 0.061 | 0.057 | 941 | 0.064 | 0.056 | 880 | 0.057 | 0.049 | 858 |
| Manipur | 0.005 | 0.005 | 989 | 0.005 | 0.006 | 1094 | 0.006 | 0.006 | 1109 |
| Meghalaya | 0.012 | 0.015 | 1278 | 0.012 | 0.015 | 1295 | 0.012 | 0.015 | 1299 |
| Mizoram | - | - | - | - | - | - | 0.003 | 0.003 | 965 |
| Nagaland | 0.03 | 0.027 | 900 | 0.031 | 0.028 | 902 | 0.032 | 0.029 | 903 |
| Tripura | 0.025 | 0.018 | 722 | 0.042 | 0.029 | 687 | 0.054 | 0.038 | 705 |
| Total NE | 0.139 | 0.128 | 986.83 | 0.16 | 0.14 | 960.5 | 0.172 | 0.146 | 950.43 |

**Table 4: Area, production and productivity of Gram in Northeast India**

| Gram | 2014-15 | | | 2015-16 | | | 2016-17 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Area (Lakh ha) | Production (Lakh Tonnes) | Productivity (kg/ha) | Area (Lakh ha) | Production (Lakh Tonnes) | Productivity (kg/ha) | Area (Lakh ha) | Production (Lakh Tonnes) | Productivity (kg/ha) |
| Assam | 0.021 | 0.02 | 938 | 0.022 | 0.015 | 704 | 0.024 | 0.016 | 651 |
| Manipur | 0.007 | 0.006 | 838 | 0.008 | 0.007 | 922 | 0.008 | 0.007 | 949 |
| Meghalaya | 0.018 | 0.019 | 1033 | 0.018 | 0.019 | 1059 | 0.019 | 0.02 | 1065 |
| Nagaland | 0.008 | 0.006 | 842 | 0.008 | 0.007 | 844 | 0.008 | 0.006 | 827 |
| Tripura | 0.002 | 0.001 | 750 | 0.003 | 0.002 | 780 | 0.003 | 0.002 | 780 |
| Total NE | 0.056 | 0.052 | 880.2 | 0.059 | 0.05 | 861.8 | 0.062 | 0.051 | 854.4 |

## Table 5: Area, production and productivity of Lentil in Northeast India

| Lentil | 2014-15 | | | 2015-16 | | | 2016-17 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Area (Lakh ha) | Production (Lakh Tonnes) | Productivity (kg/ha) | Area (Lakh ha) | Production (Lakh Tonnes) | Productivity (kg/ha) | Area (Lakh ha) | Production (Lakh Tonnes) | Productivity (kg/ha) |
| Arunachal Pradesh | - | - | - | - | - | - | 0.004 | 0.002 | 500 |
| Assam | 0.291 | 0.225 | 775 | 0.283 | 0.196 | 693 | 0.238 | 0.157 | 658 |
| Manipur | - | - | - | - | - | - | 0.007 | 0.007 | 943 |
| Nagaland | - | - | - | - | - | - | 0.021 | 0.017 | 817 |
| Tripura | 0.025 | 0.017 | 699 | - | - | - | 0.038 | 0.025 | 667 |
| Total NE | 0.316 | 0.242 | 737 | 0.283 | 0.196 | 693 | 0.308 | 0.208 | 717 ↑ |

## Table 6: Area, production and productivity of Peas and beans in Northeast India

| Peas and Beans | 2014-15 | | | 2015-16 | | | 2016-17 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Area (Lakh ha) | Production (Lakh Tonnes) | Productivity (kg/ha) | Area (Lakh ha) | Production (Lakh Tonnes) | Productivity (kg/ha) | Area (Lakh ha) | Production (Lakh Tonnes) | Productivity (kg/ha) |
| Assam | 0.3 | 0.277 | 924 | 0.157 | 0.141 | 901 | 0.287 | 0.26 | 907 |
| Manipur | 2.061 | 2.292 | 1112 | 0.183 | 0.172 | 940 | 0.183 | 0.174 | 949 |
| Tripura | 0.02 | 0.018 | 882 | - | - | - | 0.032 | 0.028 | 880 |
| Total NE | 2.381 | 2.587 | 972.67 | 0.34 | 0.31 | 920.5 | 0.502 | 0.462 | 912 ↓ |

**Table 7: Area, production and productivity of Moong in Northeast India**

| Moong | 2014-15 | | | 2015-16 | | | 2016-17 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Area (Lakh ha) | Production (Lakh Tonnes) | Productivity (kg/ha) | Area (Lakh ha) | Production (Lakh Tonnes) | Productivity (kg/ha) | Area (Lakh ha) | Production (Lakh Tonnes) | Productivity (kg/ha) |
| Arunachal Pradesh | 0.011 | 0.014 | 1273 | 0.012 | 0.013 | 1030 | 0.013 | 0.013 | 992 |
| Assam | 0.113 | 0.078 | 687 | 0.108 | 0.073 | 677 | 0.107 | 0.074 | 694 |
| Manipur | 0.005 | 0.004 | 956 | 0.005 | 0.005 | 1000 | 0.005 | 0.005 | 1087 |
| Tripura | 0.012 | 0.006 | 530 | 0.032 | 0.017 | 519 | 0.034 | 0.02 | 574 |
| Total NE | 0.141 | 0.102 | 861.5 | 0.157 | 0.108 | 806.5 | 0.159 | 0.112 | 836.75 ↑ |

**Table 8: Area, production and productivity of Urad in Northeast India**

| Urad | 2014-15 | | | 2015-16 | | | 2016-17 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Area (Lakh ha) | Production (Lakh Tonnes) | Productivity (kg/ha) | Area (Lakh ha) | Production (Lakh Tonnes) | Productivity (kg/ha) | Area (Lakh ha) | Production (Lakh Tonnes) | Productivity (kg/ha) |
| Arunachal Pradesh | 0.023 | 0.024 | 1067 | 0.025 | 0.022 | 863 | 0.025 | 0.022 | 871 |
| Assam | 0.528 | 0.342 | 648 | 0.516 | 0.339 | 658 | 0.574 | 0.389 | 677 |
| Manipur | 0.014 | 0.017 | 1182 | 0.014 | 0.016 | 1143 | 0.015 | 0.016 | 1116 |
| Nagaland | 0.011 | 0.01 | 868 | 0.012 | 0.011 | 884 | 0.013 | 0.011 | 890 |
| Sikkim | 0.032 | 0.029 | 901 | 0.029 | 0.027 | 931 | 0.029 | 0.027 | 935 |
| Tripura | 0.013 | 0.008 | 595 | 0.036 | 0.023 | 636 | 0.038 | 0.089 | 2320 |
| Total NE | 0.621 | 0.43 | 876.8333333 | 0.632 | 0.438 | 852.5 | 0.694 | 0.554 | 1134.83 ↑ |

*Source- Directorate of Economics & Statistics, M/A, GoI*

Under State-wise category, Meghalaya recorded a highest productivity of 1299kg/ha followed by Manipur with a productivity of 1109 kg/ha for Pigeonpea (Table 3). States contributing in gram production are Assam (651 kg/ha), Manipur (949 kg/ha), Meghalaya (1065 kg/ha), Nagaland (827 kg/ha), Tripura (780 kg/ha) (Table4). In the year 2016-17, many Northeastern states have contributed in the production of the Lentil. Area-wise contribution are Arunachal Pradesh (0.004 lakh ha), Assam (0.238 lakh ha), Manipur (0.007 lakh ha), Nagaland (0.021 lakh ha) and Tripura (0.038 lakh ha), Manipur having the highest productivity of 943 kg/ha followed by Nagaland with a productivity of 817 kg/ha (Table 5)**.** Three states viz. Assam, Manipur and Tripura contributed in the production of peas and beans having a total area of 0.502 lakh ha and an average productivity of 912 kg/ha. Moong is one of the important pulses cultivated in the region for many years, the major states contributing in the cultivation of this crops are Arunachal Pradesh, Assam, Manipur and Tripura with a total area of 0.159 lakh ha and highest productivity of this particular pulse was contributed by Manipur (1087 kg/ha) in the year 2016-17 as depicted in Table 7. The total area of cultivation of urad bean or blackgram in the Northeastern states *viz*. Arunachal Pradesh, Assam, Manipur and Nagaland, Sikkim and Tripura is 0.694 lakh ha with an average productivity of 1134.83 kg/ha in the year 2016-17 (Table 8).

## Scenario of Pulses in Northeast India


The per capita availability of pulses has increased considerably in last few years.In conformity to FSA- 2013 to ensure nutritional security to vegetarian population, the per capita per day availability of pulses which dwindled down to a provisional level of 41-42 g (15-16 kg/annum) in 2011-2013, is now attend at the level of 53 g per head/day *i.e* >19kg/annum/person (GoI, Directorate of Pulses Development. Annual Report: 2017-18).The same trend is followed in the North-eastern states. The requirement and deficit of pulses for NE region, considering per capita consumption at 19 kg per annum has been worked out and is presented in Table 9.The requirement of pulses per annum has a deficit of 74.93% in the Northeast region as a whole. In order to increase production of pulses in the

country, Government of India has been implementing the National Food Security Mission (NFSM)-Pulses through State Governments.

**Table 9: Requirement, deficient/ surplus of pulses in NE region (computed considering per caput requirement of 19 kg/annum/person).*P**

| States | Population (2018) | Production 2016-17 ('000 tonnes) | Requirement as per 2018 population ('000 tonnes) | Deficit/Surplus (000 tonnes) | Deficit/Surplus (%) |
|---|---|---|---|---|---|
| Arunachal Pradesh | 15,28,296 | 13.1 | 29.04 | -15.94 | -54.89 |
| Assam | 3,45,86,234 | 107.5 | 657.14 | -549.64 | -83.64 |
| Manipur | 30,08,546 | 30.3 | 57.16 | -26.86 | -46.99 |
| Meghalaya | 32,76,323 | 11.8 | 62.25 | -50.45 | -81.04 |
| Mizoram | 12,05,974 | 4.8 | 22.91 | -18.11 | -79.05 |
| Nagaland | 21,89,297 | 44.5 | 41.60 | 2.90 | 6.98 |
| Sikkim | 6,71,720 | 5.5 | 12.76 | -7.26 | -56.91 |
| Tripura | 40,57,847 | 23.2 | 77.10 | -53.90 | -69.91 |
| Total NER | 5,05,24,237 | 240.7 | 959.96 | -719.26 | -74.93 |

*P* - Provisional figures are based on IIIrd Advance Estimates of production for 2017-18,*
*Source: Press Information Bureau, Ministry of Agriculture & Farmers Welfare. http://www.populationu.com/india-population*

Enhancing nutrition with pulses into human diets has the potential in contributing to nutritional adequacy. Pulses which are a high-protein, micronutrient-rich caloric values offer a great opportunity for eradicating malnutrition. Pulses are Smart Food as these are critical for food basket (dal-roti, dal-chawal), rich source of protein *i.e.* 20-25 *per cent* which is double the protein content of wheat and thrice that of rice and help address obesity, diabetes malnutrition etc (GoI, Directorate of Pulses Development. Annual Report: 2017-18). Pulse-wise nutritional level shows the Nutritional contents of various Pulses (table 10).

**Table 10: Nutritional labels of various Pulses** (Unit mg/100g)

| Nutrients/Minerals | Tur | Gram | Lentil | Peas | Moong | Urd |
|---|---|---|---|---|---|---|
| **Protein (%)** | **22** | **20** | **25** | **22** | **25** | **24** |
| **Vit. A (I.U.)** | **220** | **316** | **450** | **31** | **83** | **64** |
| **Vit. C** | **-** | **3** | **-** | **-** | **-** | **-** |
| **Vit.K** | **-** | **0.29** | **0.25** | **-** | **-** | **0.19** |
| **Thiamine** | **0.45** | **0.3** | **0.45** | **0.47** | **0.72** | **0.41** |
| **Riboflavin** | **0.51** | **0.51** | **0.49** | **0.21** | **0.15** | **0.37** |
| **Nicotinic acid** | **2.6** | **2.1** | **1.5** | **3.5** | **2.4** | **2** |
| **Biotin (g/100g)** | **7.6** | **10** | **13.2** | **-** | **-** | **7.5** |
| **Choline** | **183** | **194** | **299** | **-** | **-** | **206** |
| **Folic-acid (g/100g)** | **83** | **125** | **107** | **-** | **-** | **144** |
| **Inositol** | **100** | **240** | **130** | **-** | **-** | **90** |
| **Pantothemic acid** | **1.5** | **1.3** | **1.6** | **-** | **-** | **3.5** |
| **Total No. of Vitamin/ Minerals** | **10** | **12** | **11** | **5** | **5** | **11** |

*Source: Indian Council of Medical Research (ICMR), Hyderabad, 2012.*

Pulses are gluten-free, promote bone health and have a low glycemic index, low fat and high fibre content which is suitable for people with diabetes. In fact, the protein obtained from pulses is significantly less expensive compared to animal foods. Additionally, the iron absorption of pulses and the protein quality of the diet are enhanced when pulses are eaten with cereals and vitamin C rich foods (Fidler *et al*. 2004).

Pulses are also rich in complex carbohydrates, micronutrients, protein and B-vitamins, which are vital parts of a healthy diet. Low in fat and rich in fibre, pulses are excellent for managing cholesterol, digestive health and regulating energy levels. Pulses are also particularly rich in folate, iron, calcium, magnesium, zinc and potassium (FAO, 2016).

## Impact of Technologies on Pulse production

To increase area, production and productivity of pulses in region, there is need for crop specific approaches, like inclusion of short duration varieties of pulses as inter and/or catch crop especially in rice/ maize fallow areas, development of multiple disease-pest resistant and high biological N fixation varieties. (Das *et al).* The Ministry of Agriculture and Farmers' Welfare, Govt. of India had initiated a nationwide cluster frontline demonstration programme on Pulses under National Food Security Mission-Pulses (NFSM-Pulses). The NFSM aimed at increasing production of rice, wheat and pulses through area expansion and productivity enhancement; restoring soil fertility and productivity; creating employment opportunities; and enhancing farm level economy to restore confidence of farmers of targeted districts.

The basic strategies of NFSM-Pulses programmes were implementation of interventions in a mission mode through active engagement of all the stakeholders at various levels including KVKs. These interventions include promotion and extension of improved technologies i.e., Seed, Integrated Nutrient Management (micro-nutrient, soil amendments), IPM and resource conservation technologies (RCTs) along with capacity building of farmers. (GoI, Directorate of Pulses Development, Annual Report: 2015-16). Institutional and policy support are required for enhancing area under pulses, development of HYVs, supply of quality inputs (Kumar *et al.* and Singh *et al.* 2012), intercropping (Sankaranarayanan *et al.* 2011), proper extension of production technologies (Tomar*et al.* 2009), development of value chain etc. Popularizing low cost technology of production, promotion of high yielding varieties and marketing related issues will be more effective using ICT. Considering the fact like wide spread malnutrition prevailing among children and women in India, there is need to promote consumption of pulses by linking to programme like mid-day meal and rural health mission by incorporating either free distribution of pulses or by subsidizing the food (Roy *et al.* 2017).

Government has initiated National Level Cluster Frontline Demonstrations on pulses, through Krishi Vigyan Kendra under 11 Agricultural Technology Application Research Institute (ATARIs) involving 549 KVKs throughout the country to demonstrate the production potential of new varieties and the related technologies. Under ICAR-ATARI, Umiam, 21 KVKs have been involved in CFLD programme for increasing production through area expansion and productivity enhancement in a sustainable manner in the identified clusters in each of the districts in the region. The transfer of

technology through CFLDs has increased yield levels over local check and normal yield. Crop-wise technology demonstrated during 2015-16 to 2018-19 is given in Table11.

**Table 11: Technology Demonstrated through CFLD in Northeast Region during the year 2015-16 to 2018-19**

| Improved Technologies | Blackgram (*Vigna mungo)* | Greengram (*Vigna radiata*) | Rajma (*Phaseolus vulgaris*) | Pigeonpea (*Cajanus cajan)* |
|---|---|---|---|---|
| **Improved varieties** | PU-31, Tripura Maskolai, IPU-94-1 | IPM-2-3, Pratap, PDC-3 and Tripura Mung 1 | Ambar (IIPR 96-4), Uday (PDR-14), Utkarsh and Jwala | UPAS-120. |
| **Nutritive components** | Highly nutritive and contains high proportion of digestible protein with many essential amino acids, minerals and vitamins | 25% protein content, iron, zinc and calcium | Seeds are protein rich (23%), calcium, phosphorus and iron | rich in iron, iodine, essential amino acids like lycine, tyrocene, cystine and arginine |
| **Planting season** | Kharif (August-September), Rabi (September-November) and Zaid (February-March) under rainfed conditions | Kharif (July-September) and Zaid (February-April) under rainfed and irrigated conditions | Late Kharif (August-September) and Rabi (November-December) | Kharif (June), due to delay monsoon in NE, sowing beyond second fortnight of August |
| **Seed Rate** | 25 kg/ha | 20-25 kg/ha | 50kg/ha | 12-15 kg/ha |
| **Days of Maturity** | 75-85 days | 65-72 days | 120-140 days | 125-150 days |
| **Seed Treatment** | Rhizobium culture and Phosphate Solubilising Bacteria @ 50 g/kg seed, *Trichoderma viride* @ 5 g/kg seed | Rhizobium culture and Phosphate Solubilising Bacteria @50 g/kg seed. | Rhizobium culture and Phosphate Solubilising Bacteria @200 g/10 kg seed. | *Trichoderma viride* @ 4g/kg seed. |
| **Cropping System** | Rice-pulse based cropping system | Rice-pulse based cropping system | Rice-pulse based cropping system | Rice/Maize-Pulse based |
| **Nutrient Management** | Soil quality was enhanced by application of vermicompost @ 1.5 t/ha and 65.5 kg/ha of lime as soil amendment. Integrated Nutrient Management with 25 kg N, 50 kg P2O5 and 25 kg K2O. | 25 kg N, 50 kg P2O5 and 25 kg K2O, application of vermicompost @ 1.0 t/ha and 13.1 q of lime as soil amendment. | Application of 66 kg/ha Urea, 250 kg/ha of SSP, 34 kg/ha of MOP. | Integrated Pest Management by application of monocrotophos @ 2 – 2.5 ml/l and Pheromonone trap @ 6 nos/ha (helilure). |

| | | | | |
|---|---|---|---|---|
| **Pest and Disease Management** | Seed treatment with Mancozeb and Carbendazim @2 g/kg. Spraying with Chloropyriphos 20 EC against infestation of leaf eating caterpillar. | Chloropyriphos @ 2.5 ml/l of water for controlling caterpillar attack at vegetative stage, use of Neembicidine @ 3 ml/l against sucking pests. | Application of Neembicidine @ 3 ml/l against sucking pests. Seed treatment with Captan @ 3 g/kg. | Release *Trichogrammachilonis* twice at weekly intervals @65000/ha |

*Contd.*

| **Improved Technologies** | **Lathyrus (*Lathyrus sativus*)** | **Lentil (*Lens esculanta*)** | **Fieldpea (*Pisum sativum)*** |
|---|---|---|---|
| **Improved varieties** | Ratan | HUL-57, Moitree (WBL-77) and KLS-218 | Aman, Prakash, VL Matar-42, Rachna, HUP-2, HUDP-15, V-10 |
| **Nutritive components** | Grasspea contains 34% protein and other essential micro-nutrients | It is rich in calcium (560 ppm), iron, and niacin | rich in protein, fibre, calcium, magnesium, phosphorus, potassium, Sodium, Sulphur |
| **Planting season** | Rabi (November) under rainfed conditions and as a relay crop | Rabi (November) under rainfed conditions | Rabi (November-December) under rainfed conditions |
| **Seed Rate** | 40-60 kg | 80kg/ha | 70kg/ha. |
| **Days of Maturity** | 108-116 days | 117-130 days | 94-134 days |
| **Seed Treatment** | Azotobacter and Phosphate Solubilising Bacteria @ 50g/kg of seed. | Rhizobium culture and Phosphate Solubilising Bacteria @50 g/kg seed, *Trichoderma viride* @ 5 g/kg seed, Seed Priming in lentil. | Seed treatment with rhizobium culture @50 g/kg seed, Bavistin @ 2.0 g/kg seed and *Trichoderm viride* @ 4 g/kg seed. |
| **Cropping System** | Rice-uteralathyrus system | Rice-pulse cropping system | Rice-pulse cropping system |
| **Nutrient Management** | Application of 45 kg/ha Urea and Vipul granules @ 500 kg. | Application of NPK @ 10:35:0 kg/ha along with application of micronutrient mixture @ 7.5 kg/ha, Neem oil @ 2.6 lt. /ha and nutrient complex Tricontanol (Vipul) @ 52.5 lt. /ha. | Application of vermicompost @ 1q/bigha, 65.5 kg/ha of lime as soil amendment, nutrient complex Tricontanol @ 0.75 l/ha and Borax @ 10kg/ha. Basal fertilizer application viz. 25 kg N, 50 kg P2O5 and 25 kg K2O. |

| | | | |
|---|---|---|---|
| **Pest and Disease Management** | Seed treated with sodium molybdate @ 0.5 g/kg seed and two times foliar spray of NPK (19:19:19) @ 0.5% at branching and 15 days after1st spray harvest | Seed treatment with Carbendazim @ 2 g/kg. | Seed treatment with Carbendazim @ 2 g/kg against infestation of powdery mildew. |

*Source: Training Manual, Technologies for Enhancing Productivity of Pulse and Oilseed, Crops in NEH* Region. *ICAR-Agricultural Technology Application Research Institute, Zone-VII, Umiam*

**Table 12: Performance of Pulses under Cluster frontline demonstration and farmers practice (FP) (check) during from 2015-16 to 2017-18under ICAR-ATARI, Zone VII, Umiam**

| Lentil | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Variety | Area (ha) | No. of Demo | Yield (q/ha) | | % increase over FP | B:C ratio | | Potential Yield (q/ha) | Technology gap | Technology Index (%) |
| | | | | FP | CFLD | | FP | Demo | | | |
| 2015-16 | K-75, HUL-57, WBL-77 | 388 | 1129 | 3.87 | 6.76 | 74.75 | 2.03 | 2.5 | 14 | 7.24 | 51.69 |
| 2016-17 | HUL-57, Moitree, KLS-218 | 775 | 1966 | 5.75 | 6.72 | 16.93 | 1.73 | 2.01 | 14 | 7.28 | 51.98 |
| 2017-18* | WBL-77, HUL-57 | 158.2 | 294 | 5.00 | 7.46 | 49.1 | 1.87 | 2.07 | 14 | 6.55 | 46.75 |

| Fieldpea | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Variety | Area (ha) | No. of Demo | Yield (q/ha) | | % increase over FP | B:C ratio | | Potential Yield (q/ha) | Technology gap | Technology Index (%) |
| | | | | FP | CFLD | | FP | Demo | | | |
| 2015-16 | TRCP -8, HUDP-15, Rachna, Prakash and Aparna | 1459.4 | 3705 | 4.87 | 6.98 | 43.24 | 2.06 | 2.4 | 22 | 15.01 | 68.27 |
| 2016-17 | Prakash, Rachna, HUDP-15, VL-42, V-10, Aman | 607 | 1507 | 10.90 | 12.70 | 16.51 | 1.71 | 2.39 | 22 | 9.29 | 42.27 |
| 2017-18* | Prakash, Aman, HUDP-15 | 285 | 553 | 8.23 | 10.88 | 32.15 | 2.11 | 2.59 | 22 | 11.12 | 50.55 |

| Rajma | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Variety | Area (ha) | No. of Demo | Yield (q/ha) | | % increase over FP | B:C ratio | | Potential Yield (q/ha) | Technology gap | Technology Index (%) |
| | | | | FP | CFLD | | FP | Demo | | | |
| 2015-16 | Jwala, Anupam K-5 | 20 | 29 | 11.79 | 11.88 | 0.76 | 6.08 | 5.67 | 18 | 6.12 | 34.00 |
| 2016-17 | Ambar, PDR-14, Utkarsh, Jwala | 190 | 492 | 13.90 | 16.73 | 20.36 | 1.76 | 2.23 | 18 | 1.27 | 7.06 |
| 2017-18* | Utkarsh, HUR-301, Dhansri | 58 | 143 | 11.98 | 13.02 | 8.73 | 1.04 | 1.45 | 18 | 4.98 | 27.67 |

| Blackgram | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Variety | Area (ha) | No. of Demo | Yield (q/ha) | | % increase over FP | B:C ratio | | Potential Yield (q/ha) | Technology gap | Technology Index (%) |
| | | | | FP | CFLD | | FP | Demo | | | |
| 2015-16 | Tripura Maskolai, PU-31, IPU-94-1 | 130 | 281 | 5.68 | 7.01 | 23.33 | 2 | 2.54 | 9 | 2.00 | 22.17 |
| 2016-17 | PU-31 | 480 | 1305 | 5.46 | 8.15 | 49.27 | 1.52 | 2.07 | 9 | 0.85 | 9.44 |
| 2017-18* | Tripura Maskolai, PU-31 | 160 | 351 | 6.02 | 8.08 | 34.22 | 1.71 | 2.27 | 9 | 0.92 | 10.22 |

| Greengram | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Variety | Area (ha) | No. of Demo | Yield (q/ha) | | % increase over FP | B:C ratio | | Potential Yield (q/ha) | Technology gap | Technology Index (%) |
| | | | | FP | CFLD | | FP | Demo | | | |
| 2015-16 | Pratap | 70 | 185 | | 6.98 | | 2.06 | 2.38 | 8.12 | 1.14 | 14.04 |
| 2016-17 | Pratap, IPM-2-3, Tripura Mung 1 | 270 | 654 | 5.69 | 7.35 | 29.13 | 1.74 | 2.2 | 8.12 | 0.7725 | 9.51 |
| 2017-18* | IPM2-3, Tripura Mung-1, PusaVisahal | 30 | 51 | 5.43 | 7.93 | 46.18 | 1.7 | 2.43 | 8.12 | 0.19 | 2.34 |

| Ricebean | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Variety | Area (ha) | No. of Demo | Yield (q/ha) | | % increase over FP | B:C ratio | | Potential Yield (q/ha) | Technology gap | Technology Index |
| | | | | FP | CFLD | | FP | Demo | | | |
| 2017-18* | Local | 32 | 76 | 5.46 | 7.74 | 41.76 | 1.33 | 1.49 | 10 | 2.26 | 22.60 |

| Pigeonpea | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Variety | Area (ha) | No. of Demo | Yield (q/ha) | | % increase over FP | B:C ratio | |
| | | | | FP | CFLD | | FP | Demo |
| 2016-17 | UPAS-120 | 30 | 80 | 6.90 | 11.40 | 65.22 | 2.94 | 2.1 |

| Chickpea | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Variety | Area (ha) | No. of Demo | Yield (q/ha) | | % increase over FP | B:C ratio | |
| | | | | FP | CFLD | | FP | Demo |
| 2015-16 | JG-16, AP-1 | 30 | 70 | 9.00 | 12.83 | 42.59 | 2.11 | 3.5 |

| Frenchbean | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Variety | Area (ha) | No. of Demo | Yield (q/ha) | | % increase over FP | B:C ratio | |
| | | | | FP | CFLD | | FP | Demo |
| 2015-16 | S-9 | 10 | 31 | 9.87 | 17.65 | 78.82 | 2.32 | 3.94 |
| 2017-18* | Anupam | 10 | 24 | 8.60 | 12.50 | 45.34 | 2.73 | 4.55 |

**2017-18 Arunachal Pradesh, Assam and Sikkim under ICAR-ATARI, Zone-VII, Guwahati.*
*Source: CFLD Report 2015-16 to 2018-19, ICAR-ATARI, Zone VII, Umiam*

## Impact of Technologies over the years (2015-16 to 2018-19) under CFLD

### Integrated Nutrient Management of Lentil (Tripura)

| Name of the Technology | Crop | Variety | Area (ha) | No. of farmers | Demo Yield (q/ha) | FP Yield (q/ha) | % increase |
|---|---|---|---|---|---|---|---|
| • Urea-43 kg<br>• SSP-250 kg<br>• MOP-33 kg | Lentil | HUL-57 | 10 | 37 | 8.7 | 6 | 45.0 |

## Organic cultivation of Fieldpea (Assam)

| Name of the Technology | Crop | Variety | Area (ha) | No. of farmers | Demo Yield (q/ha) | FP Yield (q/ha) | % increase |
|---|---|---|---|---|---|---|---|
| • FYM @1015 Kg/ha | Fieldpea | Prakash | 10 | 32 | 12.21 | 84 | 45.35 |

## Organic production technology of field pea in rice-fallow (Sikkim)

| Name of the Technology | Crop | Variety | Area (ha) | No. of farmers | Demo Yield (q/ha) | FP Yield (q/ha) | Net income (Rs/ha) | B:C ratio |
|---|---|---|---|---|---|---|---|---|
| • FYM (2.5 t/ha) + Neem cake (200 kg/ha), Biofertilizer- Nalpak (5 kg/ha).<br>• Phytoneem @ 4 ml/l, Sulfex @ 2g/l, COC @ 2g/l | Fielpea | Prakash | 3.0 | 12 | 17.3 | Preferred vegetable pea to fieldpea | 28660 | 1.89 |

## Plant protection and stacking in Rajma (Nagaland)

| Name of the Technology | Crop | Variety | Area (ha) | No. of farmers | Demo Yield (q/ha) | FP Yield (q/ha) | % increase |
|---|---|---|---|---|---|---|---|
| • Seed treatment with Thiram- 4 kg<br>• Plant protection: Carbofuron- 5 kg/ha &Bavistin- 5 kg | Rajma | AnupamK-5 | 2 | 1 | 13.5 | 11.79 | 14.5 |

## Integrated Nutrient Management in Blackgram (Manipur)

| Name of the Technology | Crop | Variety | Area (ha) | No. of farmers | Demo Yield (q/ha) | FP Yield (q/ha) | % increase |
|---|---|---|---|---|---|---|---|
| • INM- INM- NPK @ 10:20:15 along with FYM 1t/ha as basal<br>• Seed innoculation with Rhizobium & PSB @ 50g/kg of seed | Blackgram | PU-31 | 10 | 25 | 8.25 | 5.73 | 44 |

## Varietal Performance of Rajma var. Arun (Mizoram)

| Name of the Technology | Crop | Variety | Area (ha) | No. of farmers | Demo Yield (q/ha) | FP Yield (q/ha) | % increase |
|---|---|---|---|---|---|---|---|
| • Arun variety was used and the crop was also cultivated in line planting and applied with Fertilizers. | Rajma | Arun | 20 | 30 | 16 | 13 | 23.07 |

## Organic cultivation of Frenchbean (Arunachal Pradesh)

| Name of the Technology | Crop | Variety | Area (ha) | No. of farmers | Demo Yield (q/ha) | FP Yield (q/ha) | % increase |
|---|---|---|---|---|---|---|---|
| • FYM/Cow dung @1000 Kg/ha from farmers side | Frenchbean | S-9 | 10 | 31 | 17.65 | 9.87 | 78.82 |

*Source: CFLD Report 2015-16 to 2018-19, ICAR-ATARI, Zone VII, Umiam, Demonstrational Performance of Pulses in India: Experiences of KVKs under NFSM 2015-16, Division of Agricultural Extension, Indian Council of Agriculture Research New Delhi.*

## Outcome

The technology demonstrated through CFLD over the years shows a huge impact in the cultivation of pulses. Yield recorded for every pulse crops shows an increase over the farmer's practice implying CFLD programme as an effective tool for increasing productivity of pulses and changing the knowledge, attitude and skill of farmers on the adoption of improved technologies

## Discussion

As per Table 1, the pulse productivity of Northeast is higher than the national average (more than 10q); whereas the individual pulse crop productivity is comparatively lesser than 10 q in almost all crops. The information obtained from Directorate of Economics & Statistics, M/A, GoI reflected some pulses crops over the year 2014-15 to 2016-17. CFLD was implemented in the North-eastern states in the year 2015-16. Table 1 represented the area, production and productivity of Total pulses in North-east India whereas from Table 2 to Table 8 only major crops were shown implying CFLD programme was not included as other pulse crops were not reflected.

The requirement of pulses per annum has a deficit of 74.93% in the Northeast region as a whole. Although Nagaland shows a sufficiency of 6%, this is comparatively very less. Other states show a deficient ranging from 46.99% to 83.64%. To reduce the demand-supply gap, Government of India has launched various programmes like integrated scheme of oilseed, pulses, oil palm and maize (ISOPOM), national food security mission (NFSM) and front-line demonstrations (FLD) programme in pulses. Still, prime attention is required in pulse production to meet the challenges of increasing population. It is prime time to create the awareness about the improved crop-management practices to scale-up productivity of pulses and highlight future research priorities with the prime objective of sustaining pulse production in NER (Das *et al*, 2016).

## Conclusion

The deficiency of protein in human diet often leads to malnutrition. With the increase in population, it is challenging to meet their demands. Although, the production of pulses is at a slower rate compared to foodgrains, the productivity of pulses in Northeast region has a great potential. As Agriculture growth is limited, imports may help improve the supply situation in the short term whereas, the long term measures would need to focus on sustainable production system. To increase area, production and productivity of pulses in region and henceforth sustainable agriculture, there is need for improved technologies and crop specific approaches, which should be adopted like inclusion of short duration varieties of pulses as inter and/or catch crop especially in rice/ maize fallow areas, development of multiple disease-pest resistant and high biological N fixation varieties. Substantial area under shifting cultivation may slowly be diverted for production of pulses and other crops following principles of conservation agriculture, which would help in conserving soil and improving its health. Even, if 30% rice–fallow area becomes available, the region may become self-sufficient in pulse production. No-till has very good potential for pulses cultivation in rice and maize fallow areas that would save time, labour and other resources. Pulses like rice bean, urd bean etc. serve multiple purposes of food, feed, cover crops and builds soil fertility. Coordination of research, extension and farmers to encourage farmer's participatory research and mass awareness programme are required to educate farmers on scientific storage along to check the post-harvest losses and increase the shelf-life of pulses. Subsidy for critical inputs, easy- and low-interest credits and farmers' friendly crop

insurance policies can help the farmers to grow pulses with minimum risk and in turn contribute to well being of the Nation (Das *et al.*, 2016). With the intervention of Cluster frontline demonstration in different districts of the North-eastern states under ICAR, ATARIs, various training programmes were organized during Kharif, Rabi and Summer Season. Trainings were conducted to impart knowhow on Integrated Nutrient Management, Production technology and bio-control of pests, Package & practices, Integrated Pest Management and other awareness programmes aimed at Integrated farming approaches for livelihood and nutritional security.

## References:

1. Das. A,Babu. S, Yadav G.S., Ansari M.A., Singh R., Baishya L.K., Rajkhowa D.J. and NgachanS.V. 2016. Status and strategies for pulses production for food and nutritional security in north eastern region of India. *Indian Journal of Agronomy* **61** (Special issue): 43-57.
2. Demonstrational Performance of Pulses in India: Experiences of KVKs under NFSM 2015-16, Division of Agricultural Extension, Indian Council of Agriculture Research New Delhi.
3. Fidler MC; Davidsson L; Zeder C; Hurrell RF (2004). Erythorbic acid is a potent enhancer of nonheme-iron absorption. American Journal of Clinical Nutrition 79:99–102.
4. Food and Agriculture Organization of the United Nations. 2016. Nutritional Benifits of Pulses. International Year of Pulses. fao.org/pulses-2016.
5. Kumar R, Singh S K, Purushottam and Sah Uma. 2012. Dissemination of pulse production technologies in Uttar Pradesh: A micro-level analysis. Journal of Food Legumes. **25**(4): 340-343.
6. Government of India. Ministry of Agriculture & Farmers Welfare. 2016. Per Capita, Per Day Net Availability of Pulses.
7. Government of India Ministry of Agriculture & Farmers Welfare Department of Agriculture, Cooperation & Farmers Welfare. Directorate of Economics & Statistics. Pocket Book of Agricultural Statistics 2018.
8. Government of India Ministry of Agriculture & Farmers Welfare Department of Agriculture, Cooperation & Farmers Welfare. Directorate of Pulses Development. Annual Report: 2015-16.

9. Government of India Ministry of Agriculture & Farmers Welfare Department of Agriculture, Cooperation & Farmers Welfare. Directorate of Pulses Development. Annual Report: 2017-18
10. Government of India Ministry of Agriculture & Farmers Welfare Department of Agriculture, Cooperation & Farmers Welfare. Directorate of Pulses Development. 2018. Pulses in India: Retrospect and Prospects.
11. Government of India. Ministry of Women and Child Development. PoshanSamvaad. 2019. *https://icds-wcd.nic.in/nnm/Newsletter.htm*
12. Government of India. Ministry of Women and Child Development. 2013. Statewise Details on Malnutrition.
13. Roy A., Singh N.U., Tripathi A.K., Yumnam A., Sinha P.K., Kumar B.and Das S.K. 2017. Dynamics of Pulse Production in North-East Region of India- A State-wise Analysis. Economic Affairs, Vol. 62, No. 4, pp. 655-662.
14. Sankaranarayanan K, Praharaj C S, Nalayini P and Gopalakrishnan N. 2011. Grain legume as a doable remunerative intercrop in rainfed cotton. Journal of Food Legumes 24(1):18-22.
15. Shalendra, GummagolmathKarabasayya, Sharma Purushottam. 2013. Role of pulses in the food and nutritional security in India. Journal of Food Legumes 26(3 & 4): 124-129.
16. Tomar R K S, Sahu B L, Singh Rupendra K and Prajapati R K. 2009. Productivity enhancement of blackgram*(Vignamungo*L.) through improved production technologies in farmers' Held. Journal of Food Legumes. 22(3):202-204.

# OILSEED PRODUCTION AND PRODUCTIVITY-ITS PROBLEMS AND PROSPECTS IN NORTH EAST INDIA

**Emika K. Kyndiah**

India is blessed with diverse agro-ecological conditions which is suited for growing oilseed crops. The vegetable oilseed economy of India is the fourth largest in the world next to USA, China and Brazil. Oilseeds constitute the principal commercial crop of India. Oilseed crops play the second important role in the Indian agricultural economy next to food grains in terms of area and production. Currently, India accounts for 6.8% of the oilseed production, 5.9% of the oilseed export, 6.1% of the vegetable oil export and 9.3 % of the edible oil consumption of the world (Sonnad *et al*., 2011). Oilseed crops has attained annual growth rate of 2.44%, 5.47% and 2.96% at area, production and yield respectively during the last decade (1999-2009) (Ghosh *et al*., 2018). Oilseeds are important components in tropical agriculture as they provide easily available and highly nutritious food to human beings and animals. The oilseeds contain 20 to 60 % oil, which is chiefly consumed as food and energy source. They are energy rich and cash value crops. Oils and fats, apart from forming an essential part of human diet, serve as important raw materials for the manufacture of soaps, paints and varnishes, lubricants, etc. Oilseed crops can be used as pasture, cover and green manure crops. They are also used as fodder and for silage. The oilseed cake which has 40-60% protein is used in animal feed and organic manure. Unlike food crops, oilseed crops are grown under low management situation. The oilseed crops primarily grown in North East India are groundnut, rapeseed-mustard, soybean, sesamum and linseed. Among them, soybean and rapeseed-mustard are the two oilseeds that dominate the edible oil economy of the country.

## Area, production and yield of oilseed crops

The area, production and yield of oilseeds in India from the year 2011-12 to 2018-19 are given in the Table 1.

**Table-1: Status of Oilseed Production, Productivity and Area in India**

| Item | Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2011-12 | 2012-13 | 2013-14 | 2014-15 | 2015-16 | 2016-17 | 2017-18 | 2018-19 |
| Productivity (kg/ha) | 1133 | 1168 | 1168 | 1075 | 968 | 1195 | 1284 | 1265 |
| Area (mha) | 26.31 | 26.48 | 28.05 | 25.6 | 26.09 | 26.18 | 24.51 | 25.5 |
| Production (mt) | 29.8 | 30.94 | 32.75 | 27.51 | 25.25 | 31.28 | 31.46 | 32.26 |

**Source**: *Pocket book of Agricultural Statistics 2018: Directorate of Economics & Statistics*

Area, production and yield of oilseed crops in North East Region have shown a slight increase in growth rate from the year 2013-14 to 2015-16. The data presented in Table 2 indicated that the area under oilseed crops has increased from 4.58 lakh ha in the year 2013-14 to to 4.72 lakhs ha in 2015-16. The production of oilseeds has also increased from 3.38 lakh tonnes in 2013-14 to 3.78 lakh tonnes in 2015-16. The yield of oilseed crops has increased from 926.17 kg/ha (2013-14) to 928.84 kg/ha in the year 2015-16.

**Table-2: Area, production and yield of oilseed crops grown in North East Region**

| State | 2013-14 | | | 2015-16 | | |
|---|---|---|---|---|---|---|
| | Area (lakh ha) | Production (lakh tonnes) | Yield (kg/ha) | Area (lakh ha) | Production (lakh tonnes) | Yield (kg/ha) |
| Arunachal Pradesh | 0.326 | 0.313 | 974.8 | 0.343 | 0.361 | 956 |
| Assam | 2.969 | 1.815 | 678 | 3.028 | 2.108 | 673 |
| Manipur | 0.369 | 0.311 | 839.25 | 0.375 | 0.318 | 852.25 |
| Meghalaya | 0.136 | 0.141 | 1145.5 | 0.137 | 0.151 | 1220 |
| Mizoram | 0.021 | 0.024 | 1105 | 0.027 | 0.03 | 1036 |
| Nagaland | 0.623 | 0.663 | 946 | 0.627 | 0.668 | 946 |
| Tripura | 0.057 | 0.042 | 832.75 | 0.108 | 0.081 | 835 |
| Sikkim | 0.08 | 0.071 | 888 | 0.07 | 0.063 | 912.5 |
| Total | 4.58 | 3.38 | 926.17 | 4.72 | 3.78 | 928.84 |

The productivity of major oilseed crops grown in the North East Region *ie.*, state-wise in the year 2015-16 are shown in the given figures below:

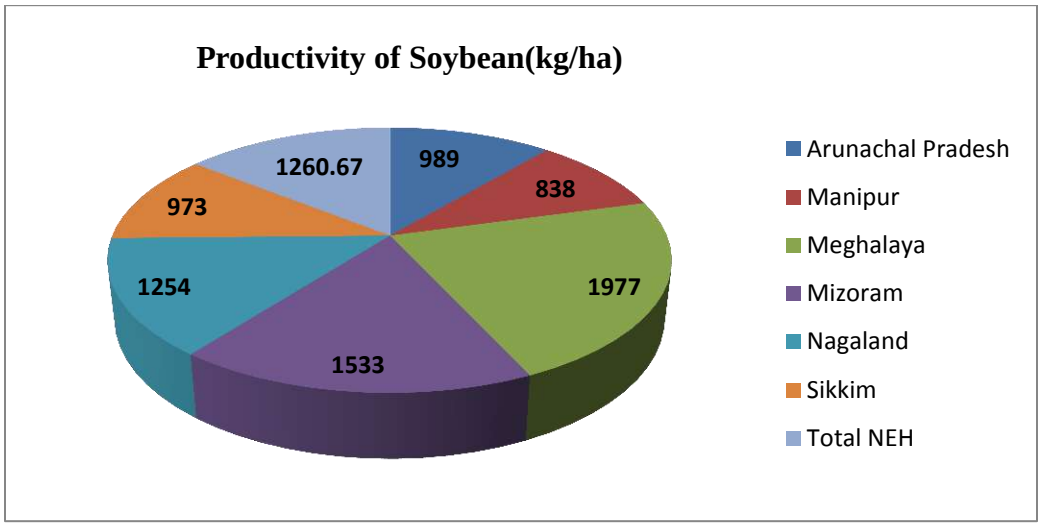



**Fig 1: Productivity (kg/ha) of Soybean in the NEH region**

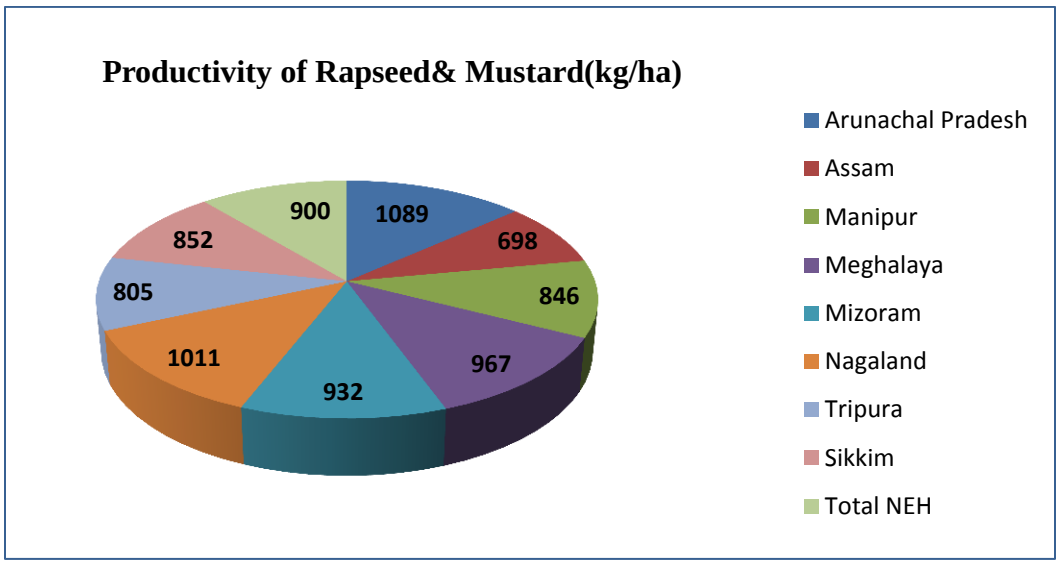



**Fig 2: Productivity (kg/ha) of Groundnut in the NEH region**

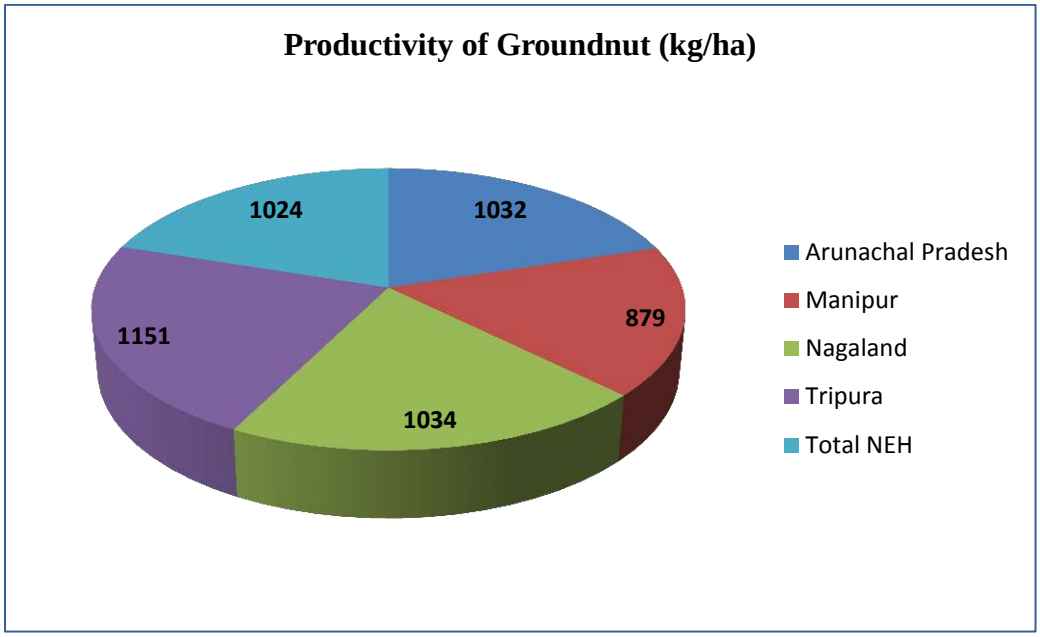



**Fig 3: Productivity (kg/ha) of Rapeseed & Mustard in the NEH region**

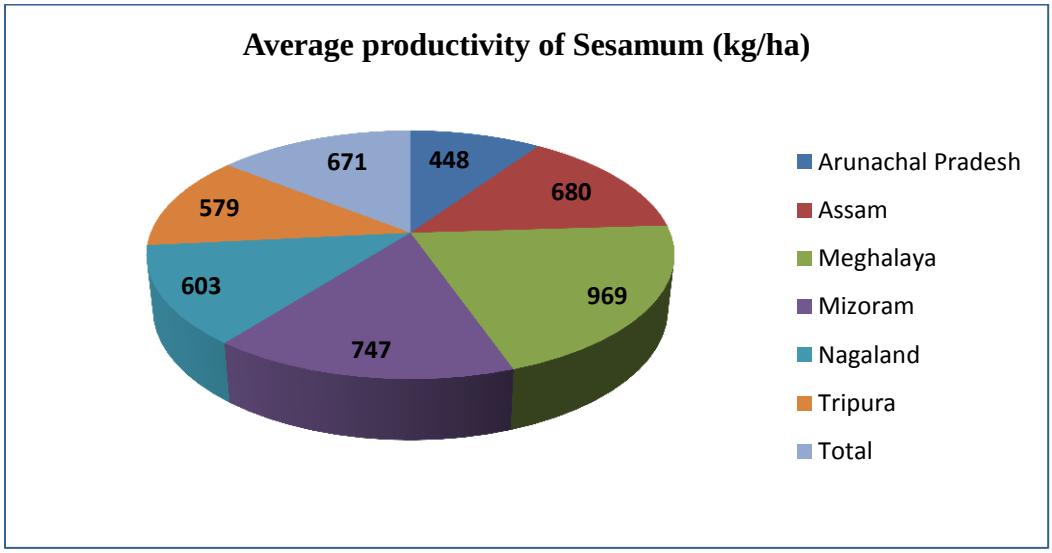



**Fig 4: Productivity (kg/ha) of Sesamum in the NEH region**

**Table-3: Trends of growth in oilseed crops in the North East Region**

| Area, production and yield of Soybean in Northeast India | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013-14 | | | 2014-15 | | | 2015-16 | | |
| State | Area (Lakh ha) | Production (Lakh tonnes) | Yield (kg/ha) | Area (Lakh ha) | Production (Lakh tonnes) | Yield (kg/ha) | Area (Lakh ha) | Production (Lakh tonnes) | Yield (kg/ha) |
| Arunachal Pradesh | 0.028 | 0.035 | 1273 | 0.028 | 0.026 | 923 | 0.028 | 0.028 | 989 |
| Manipur | 0.052 | 0.046 | 878 | 0.053 | 0.046 | 868 | 0.051 | 0.043 | 838 |
| Meghalaya | 0.016 | 0.029 | 1820 | 0.017 | 0.033 | 1947 | 0.017 | 0.034 | 1977 |
| Mizoram | 0.01 | 0.015 | 1480 | 0.01 | 0.015 | 1413 | 0.011 | 0.016 | 1533 |
| Nagaland | 0.248 | 0.311 | 1255 | 0.248 | 0.311 | 1254 | 0.249 | 0.312 | 1254 |
| Sikkim | 0.039 | 0.037 | 946 | 0.041 | 0.039 | 948 | 0.033 | 0.032 | 973 |
| Total | 0.393 | 0.473 | 1275.333 | 0.397 | 0.47 | 1225.5 | 0.389 | 0.465 | 1260.667 |

**Table- 4: Area, production and yield of Groundnut in Northeast India**

| State | Area, production and yield of Groundnut in Northeast India | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013-14 | | | 2014-15 | | | 2015-16 | | |
| | Area (Lakh ha) | Production (Lakh tonnes) | Yield (kg/ha) | Area (Lakh ha) | Production (Lakh tonnes) | Yield (kg/ha) | Area (Lakh ha) | Production (Lakh tonnes) | Yield (kg/ha) |
| Arunachal Pradesh | 0.006 | 0.006 | 949 | 0.006 | 0.006 | 1000 | 0.006 | 0.007 | 1032 |
| Manipur | 0.032 | 0.026 | 805 | 0.031 | 0.025 | 819 | 0.034 | 0.03 | 879 |
| Nagaland | 0.009 | 0.009 | 1023 | 0.009 | 0.009 | 1023 | 0.009 | 0.009 | 1034 |
| Tripura | 0.003 | 0.003 | 1077 | 0.003 | 0.003 | 1080 | 0.005 | 0.006 | 1151 |
| Total | 0.05 | 0.044 | 963.5 | 0.049 | 0.043 | 980.5 | 0.054 | 0.052 | 1024 |

**Table- 5: Area, production and yield of Linseed in Northeast India**

| State | Area, production and yield of Linseed in Northeast India | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013-14 | | | 2014-15 | | | 2015-16 | | |
| | Area (Lakh hectare) | Production (Lakh tonnes) | Yield (kg/ha) | Area (Lakh hectare) | Production (Lakh tonnes) | Yield (kg/ha) | Area (Lakh hectare) | Production (Lakh tonnes) | Yield (kg/ha) |
| Assam | 0.06 | 0.039 | 643 | 0.056 | 0.04 | 703 | 0.053 | 0.033 | 634 |
| Nagaland | 0.058 | 0.046 | 803 | 0.058 | 0.047 | 808 | 0.058 | 0.047 | 808 |
| Total | 0.118 | 0.085 | 723 | 0.114 | 0.087 | 755.5 | 0.111 | 0.08 | 721 |

**Table -6: Area, production and yield of Sesame in Northeast India**

| State | Area, production and yield of Sesame in Northeast India | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013-14 | | | 2014-15 | | | 2015-16 | | |
| | Area (Lakh ha) | Production (Lakh tonnes) | Yield (kg/ha) | Area (Lakh ha) | Production (Lakh tonnes) | Yield (kg/ha) | Area (Lakh ha) | Production (Lakh tonnes) | Yield (kg/ha) |
| Arunachal Pradesh | 0.016 | 0.013 | 819 | 0.017 | 0.007 | 413 | 0.017 | 0.008 | 448 |
| Assam | 0.117 | 0.086 | 732 | 0.122 | 0.092 | 758 | 0.118 | 0.08 | 680 |
| Meghalaya | 0.022 | 0.02 | 886 | 0.022 | 0.021 | 932 | 0.022 | 0.022 | 969 |
| Mizoram | 0.008 | 0.006 | 740 | 0.008 | 0.006 | 769 | 0.009 | 0.007 | 747 |
| Nagaland | 0.036 | 0.022 | 602 | 0.036 | 0.022 | 602 | 0.036 | 0.022 | 603 |
| Tripura | 0.028 | 0.017 | 606 | 0.025 | 0.015 | 623 | 0.039 | 0.023 | 579 |
| Total | 0.227 | 0.164 | 730.83 | 0.23 | 0.163 | 682.83 | 0.241 | 0.162 | 671 |

**Table- 7: Area, production and yield of Rapseed-Mustard in Northeast India**

| State | Area, production and yield of Rapseed-Mustard in Northeast India | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013-14 | | | 2014-15 | | | 2015-16 | | |
| | Area (Lakh ha) | Production (Lakh tonnes) | Yield (kg/ha) | Area (Lakh ha) | Production (Lakh tonnes) | Yield (kg/ha) | Area (Lakh ha) | Production (Lakh tonnes) | Yield (kg/ha) |
| Arunachal Pradesh | 0.276 | 0.259 | 936 | 0.292 | 0.297 | 1016 | 0.292 | 0.318 | 1089 |
| Assam | 2.792 | 1.69 | 605 | 2.81 | 1.875 | 667 | 2.857 | 1.995 | 698 |
| Manipur | 0.285 | 0.239 | 837 | 0.298 | 0.245 | 867 | 0.29 | 0.245 | 846 |
| Meghalaya | 0.098 | 0.092 | 938 | 0.098 | 0.094 | 956 | 0.098 | 0.095 | 967 |
| Mizoram | 0.003 | 0.003 | 1100 | 0.003 | 0.003 | 1000 | 0.007 | 0.007 | 932 |
| Nagaland | 0.272 | 0.275 | 1010 | 0.273 | 0.276 | 1012 | 0.275 | 0.278 | 1011 |
| Tripura | 0.026 | 0.022 | 824 | 0.059 | 0.049 | 831 | 0.064 | 0.052 | 805 |
| Sikkim | 0.041 | 0.034 | 830 | 0.039 | 0.032 | 832 | 0.037 | 0.031 | 852 |
| **Total** | **3.793** | **2.614** | **885** | **3.87** | **2.871** | **897.625** | **3.92** | **3.021** | **900** |

*Source: Directorate of Oilseeds Development,Ministry of Agriculture& Farmers Welfare*

## Constraints of oilseed production in North East Region India

Fluctuating yields and uneven growth in oilseed production has become a serious problem in the country. The most important constraints faced by oilseeds producers in North East India are as follows:

### Agro-climatic constraints

Oilseeds are energy-rich crops but they are grown under energy-starved conditions and about 8.5 percent of the area under oilseeds is rainfed comprising mostly marginal and sub marginal lands with soils of poor fertility. Among the agro-climatic constraints, crop failure due to various biotic and abiotic stresses is the most significant constraint. The soil in the NEH region is acidic to strongly acidic in reaction accounting for 70 per cent of the total geographical area. Low soil pH is basically due to leaching of the bases under the influence of high rainfall. Other important agro-climatic constraints included poor pod setting and extreme weather conditions such as heavy rains at critical stages of crop growth and temperature variations. Irregular rains, water scarcity during post-monsoon and inadequate alternate irrigation sources at maturity crop stage largely affect the final crop yield.

## Economic Constraints

Most of the oilseed farmers are small and marginal having little money to invest on various inputs. Further, the oilseed crops, grown under rainfed conditions become high-risks crops. The economic constraints included high prices of input and output, fluctuating crop price, profit risks and shortage of human labour. Rising input prices coupled with low and fluctuating product prices restrict marketing margins and adversely affect profitability. It is to be noted that price instability of agricultural commodity has far reaching consequences; the entire process of crop planning on the part of the farmers may get affected by any kind of instability. The bitter experience of farmers in selling their produce at lower prices may discourage them to adopt input intensive technology. In order to guard against price fluctuations of crops, the farmers may resort to measures like diversification of crops or flexibility in the production process. However, greater price fluctuations in case of agricultural products lie in the nature of supply and demand.

## Technological constraints

Although a large number of new high yielding varieties/hybrids and production technologies have been developed through NARS and other public and private institutions all over the country, there is still paucity of large range of high yielding varieties/hybrids and production technologies which could give high and stable yields under rainfed conditions and resist insects, pests and diseases. There is still lack of improved farm implements, irregular power supply for irrigation, low cost technology for control of diseases and insects, lack of suitable varieties, unavailability of seeds at the time of sowing, lack of appropriate post-harvest technology to prevent post harvest losses and deterioration in quality.

## Organizational and infrastructural constraints

Some organizational and infrastructural constraints stand in the way of achieving high yields of oilseeds. Inadequate production and distribution of quality seeds, timely supply of inputs, credit, irrigation, and transfer of improved technology from researcher to farmer, storage, grading and marketing of oilseeds are also responsible for low output of oilseeds. Rural infrastructure particularly poor road conditions leading to high transportation costs, lack of storage facilities, lack of reliable and

timely information about prices and adequate processing facilities are impacting oilseed cultivation in the Northeast India.

## Demand and Supply gap of oilseeds in Northeast India

Although the area and total production of oilseeds in NEH region has increased over the years, the growth rate was less than the population growth of the region. The requirement and deficit of oilseeds for NEH region, considering the per caput requirement of 18 kg/annum/person has been worked out in Table 8. The NE region as a whole has a deficit of 58.79 % in oilseeds ranging from 31.23 % surplus in Arunachal Pradesh to 74.36 % deficit in Sikkim. To reduce the demand-supply gap, Government of India has been pursuing several development programs such as Cluster Front-Line Demonstration on Oilseed crops.

**Table 8: Requirement, deficient/surplus of oilseeds in NEH region (computed considering per capita consumption levels of India at 10.95 kg/year) ****

| State | Production 2015-16 ('000 tonnes) | Requirement as per 2018 population ('000 tonnes) | Deficit/Surplus (000 tonnes) | Deficit/Surplus (%) |
|---|---|---|---|---|
| Arunachal Pradesh | 36.1 | 16.73 | 19.37 | 115.72 |
| Assam | 210.8 | 378.72 | -167.92 | -44.34 |
| Manipur | 31.8 | 32.94 | -1.14 | -3.47 |
| Meghalaya | 15.1 | 35.88 | -20.78 | -57.91 |
| Mizoram | 3 | 13.21 | -10.21 | -77.28 |
| Nagaland | 66.8 | 23.97 | 42.83 | 178.65 |
| Tripura | 8.1 | 44.43 | -36.33 | -81.77 |
| Sikkim | 3.1 | 7.36 | -4.26 | -57.85 |
| Total NER | 374.8 | 553.24 | -178.44 | -32.25 |

**Source**: *Directorate of Oilseeds Development, Ministry of Agriculture& Farmers Welfare*
http://www.populationu.com/india-population
*** ICMR recommendation i.e. 30 g/person /day: 10.95 kg/person/year*

## Cluster Front-Line Demonstration on Oilseed Crops

From the year 2015-16 to 2018-19, CFLD on oilseed crops conducted in the NEH region has achieved 833 number of demonstrations in 335 ha under soybean, 1236 number of demonstrations in 530 ha under sesame, 1025 number of demonstrations in 405.5 ha under groundnut, 1444 number of demonstrations in 626 ha under linseed and 5854 number of demonstrations in 2730 ha under rapeseed and mustard. With active participation of farmers, demonstration of improved technologies of oilseeds in the states of Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura were conducted so as to establish production potential of high yield oilseed varieties and related technologies to expand the area under oilseeds. Under CFLD oilseeds conducted in the year 2015-16 to 2018-19, the total area conducted under soybean was 335 ha and the total numbers of farmers were 833 with an average demonstration yield of 14.04 q/ha over local check of 10.51 q/ha with an overall increase in yield of 32.61 % having an average B:C ratio of 2.40. In sesame, total area conducted was 530 ha and total numbers of farmers were 1236 with an average demonstration yield of 6.35 q/ha over local check of 4.88 q/ha with an overall increase in yield of 30.67 % having an average B:C ratio of 2.50. Under groundnut, the total area conducted was 405.5 ha and the total number of farmers were 1025 with an average demonstration yield of 14.77 q/ha over local check of 10.54 q/ha with an overall increase in yield of 41 % having an average B:C ratio of 2.23. Under linseed, total area conducted was 626 ha and total numbers of farmers were 1444 with an average demonstration yield of 7.12q/ha over local check of 4.66 q/ha with an overall increase in yield of 55.42 % having an average B: C ratio of 2.08. The total area under rapeseed and mustard was 2730 ha and total numbers of farmers were 5854 with average demonstration yield of 8.74 q/ha over local check of 6.07 q/ha with an overall increase in yield of 44.63 % having an average B: C ratio of 2.37.

**Table 9: Summary of CLFD on oilseed crops conducted in the year 2015-16 to 2018-19**

| Crop | State | Year | No. of farmers | Area (ha) | Average yield (q/ha) | | Avg % increase in yield over local check |
|---|---|---|---|---|---|---|---|
| | | | | | Demo | Local check | |
| **Soybean** | Nagaland | 2016-17 | 61 | 30 | 8.94 | 7.27 | 22.97 |
| | Manipur, Mizoram, Nagaland | 2017-18 | 444 | 180 | 16.91 | 11.59 | 46.49 |
| | Manipur, Mizoram, Nagaland | 2018-19 | 328 | 125 | 16.27 | 12.67 | 28.37 |
| Total | | | **833** | **335** | **14.04** | **10.51** | **32.61** |
| **Sesame** | Assam, Tripura | 2016-17 | 688 | 280 | 6.09 | 4.395 | 38.45 |
| | Mizoram, Nagaland, Tripura | 2017-18 | 257 | 130 | 7 | 5.56 | 26.67 |
| | Mizoram, Nagaland, Tripura | 2018-19 | 291 | 120 | 5.95 | 4.69 | 26.9 |
| Total | | | **1236** | **530** | **6.35** | **4.88** | **30.67** |
| **Groundnut** | Tripura | 2016-17 | 197 | 60 | 12.88 | 8.8 | 46.36 |
| | Manipur, Mizoram, Nagaland, Tripura | 2017-18 | 497 | 195.5 | 15.16 | 11.04 | 38.39 |
| | Manipur, Meghalaya, Mizoram, Nagaland, Tripura | 2018-19 | 331 | 150 | 16.27 | 11.77 | 38.24 |
| Total | | | **1025** | **405.5** | **14.77** | **10.54** | **41.00** |
| **Linseed** | Assam | 2015-16 | 513 | 231 | 5.87 | 4.01 | 46.38 |
| | Assam, Tripura, Nagaland | 2016-17 | 654 | 265 | 8.6 | 4.15 | 107.23 |
| | Nagaland | 2017-18 | 102 | 60 | 7.03 | 5.03 | 39.6 |
| | Nagaland | 2018-19 | 175 | 70 | 6.98 | 5.43 | 28.47 |
| Total | | | **1444** | **626** | **7.12** | **4.66** | **55.42** |

| Crop | State | Year | No. of farmers | Area (ha) | Average yield (q/ha) | | Avg. % increase in yield over local check |
|---|---|---|---|---|---|---|---|
| | | | | | Demo | Local check | |
| Rapeseed & Mustard | Assam, Nagaland, Tripura | 2015-16 | 1563 | 782 | 8.2 | 5.86 | 39.93 |
| | Assam, Manipur, Tripura | 2016-17 | 1895 | 810 | 9.16 | 6.35 | 44.25 |
| | Manipur, Mizoram, Meghalaya, Nagaland, Tripura | 2017-18 | 1193 | 585 | 8.53 | 5.87 | 47.6 |
| | Manipur, Mizoram, Meghalaya, Nagaland, Tripura | 2018-19 | 1203 | 553 | 9.07 | 6.18 | 46.74 |
| Total | | | 5854 | 2730 | 8.74 | 6.07 | 44.63 |

**Table-10: Technological interventions conducted under CFLD in the NER region during the year 2015-16 to 2018-19**

| Kharif oilseeds | | | |
|---|---|---|---|
| **Oilseed practice** | **Soybean** | **Groundnut** | **Sesame** |
| **Improved variety** | JS-335, JS-95-60, JS-9305,RVS 2001-04,DSb-19 | TG-38,K-6, ICGS-76,G-2, TAG-24,TAG-28,TAG-38,GPBD4, ICGS-76 | ST-1683,AST-1,Kalaibortil,Tripura Seeping, Chhibung, Tilottama |
| **Seed rate** | 30-60 kg/ha | 60-100 kg/ha | 5-10 kg/ha |
| **Crop duration** | 95-100 DAS | 120-150 DAS | 100-150 DAS |
| **Sowing method** | Raised beds, line sowing and dibbling | Raised beds, line sowing, ridge and furrow | Line sowing, dibbling and broadcasting |

| | | | |
|---|---|---|---|
| **Planting season** | May-June upto 1st week of July | May-June | Last week of April to May (*kharif*) & September-October (*rabi*) |
| **Seed treatment** | Rhizobium japonicum @ 200g / 10 kg; Carbendazim 2g/kg seed | Rhizobium japonicum @ 200g /10 kg or Trichoderma harizanum @ 4 gm/kg | Trichoderma viride@ 4 kg/seed; Carbendazim 2g/kg seed; PSB @ 2 g/kg seed |
| **Integrated Nutrient management** | Chemical fertilizer doses N=20 kg/ha;P=60 kg/ha and K=40 kg/ha; FYM=2000kg/ha. | Fertilizer application of FYM=12.5 tonnes/ha; N=20 kg/ha; P=60 kg/ha; K- 74 kg/ha; lime application in the soil | Fertilizer application of FYM=5 mT/ha; N=40 kg/ha;P=30 kg/ha;K=30kg/ha |
| **Integrated pest and disease management** | For treatment of diseases like leaf spot, dichlovos is used. For treatment of cutworms and aphids, application of cypermethrin @ 1.5ml/litre and chlorpyriphos @ 2ml/litre respectively. Neem oil is also used as an alternative for treatment of insects. | For treatment of diseases such as tikka, application of bavistin @ 1g/ litre. For treatment of insects such as hairy caterpillars, application of methomyl @ 1g/litre. Quinalphos 25 EC @ 3.2 litre/ha used for treating white grubs. | For treatment of diseases such as root rot and seedling blight, application of copper oxychloride @ 2g/litre. For treatment of bugs, application of imidachloprid @1ml/litre |

| **Rabi oilseeds** | | |
|---|---|---|
| **Oilseed Crop** | **Rapeseed & Mustard** | **Linseed** |
| Improved variety | TS-36, TS-67,TS-38,M-27,RH-30,YSH-401, TRC T-1-1-5-1,NRCHB-101 | Ruchi,T-397,Padmini,NL-165,Local,Shekhar,Parvati,Sharda, RLC-92 |
| Seed rate | 5-15 kg/ha | 30 kg/ha |
| Crop duration | 100-135 DAS | 100-120 DAS |
| Planting season | 15 October- 15 November | Last week of October to November |
| Cropping System | Paddy-Mustard cropping system | Paddy-linseed based cropping |
| Sowing method | Broadcasting in rice fallow, line sowing, improved zero tillage cultivation | Broadcasting, line sowing |
| Seed treatment | Carbamendazim 50% + Mancozeb 50% @ 2g/kg seed; Phosphotica @ 250g/5 kg seeds;Azotobacter and PSB @ 40g each/kg of seed | Azotobacter + Phosphotica @ 200g/kg seed; Multiplex sulphur @ 1 litre/ha |

| | | |
|---|---|---|
| Integrated Nurtient management | FYM=5 mT/ha; N= 40 kg/ha;P=20 kg/ha;K= 20 kg/ha; S=20 kg/ha | FYM=5 mT/ha; no chemical fertilizers was used. |
| Integrated pest and disease management | For treatment of aphids, appplication of Imidachlophid @ 1 ml/litre of water. Neem oil @ 3ml/litre is used as an alternative against aphids and rust. | For diseases like rust, application of PP-450 at 0.5 % |

**Comparison of oilseed varieties between demonstration yield, farmer's yield and potential yield conducted under CFLD in NEH region in the year 2015-16 to 2018-19**

There has been a positive increase in high quality oilseeds production which was conducted under CFLD Oilseeds in the year 2015-16 to 2018-19. The varieties of oilseed crops grown under demonstration were observed to have a comparatively higher yield as compared to the local check. The high yielding varieties used under CFLD have higher resistance against diseases and pests providing higher yield and provide better economic returns than the local varieties.

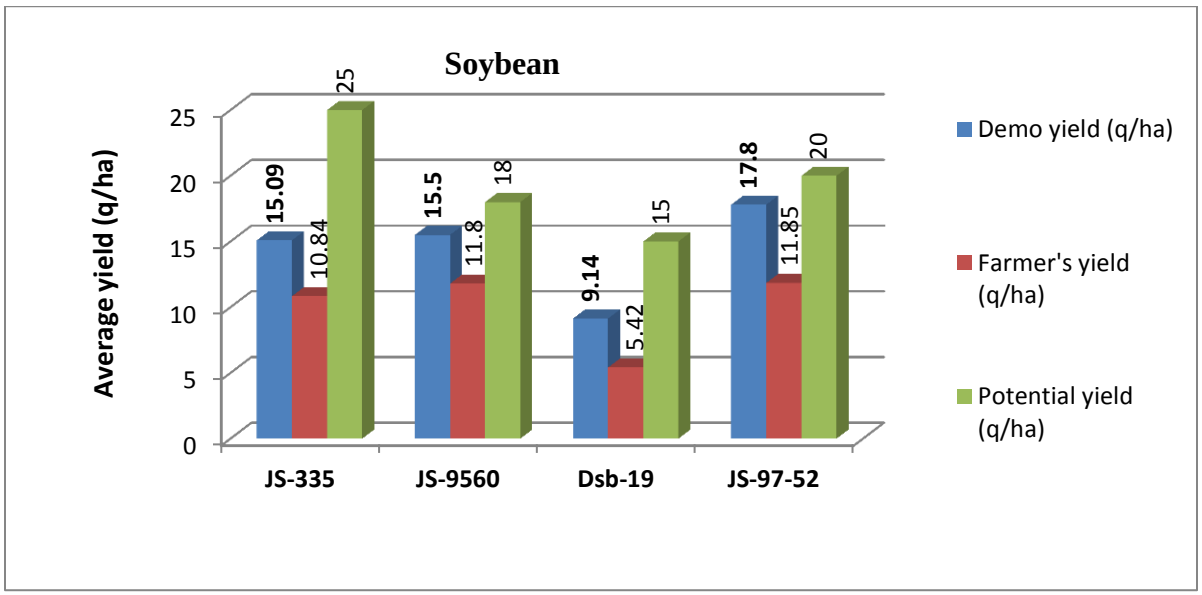



**Fig 5: Average yield (q/ha) of Soybean varieties under CFLD conducted in NEH region**

From Fig 5, it was observed that among the soybean varieties *i.e.*, JS-335,JS-9560,Dsb-19 and JS-97-52, the variety JS-97-52 recorded the highest demo average yield of 17.8 q/ha over farmer's yield of 11.85 q/ha as compare to the other soybean varieties conducted under CFLD.

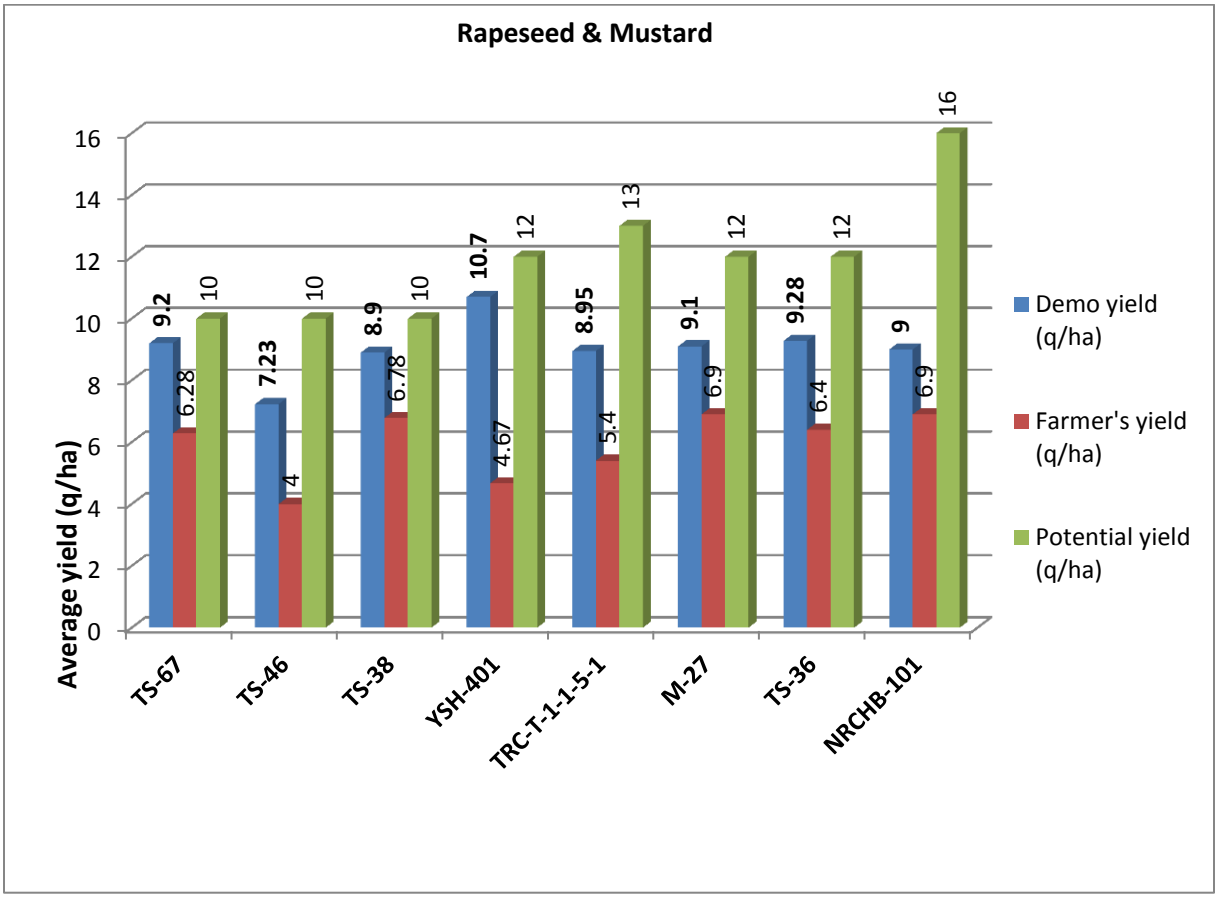



**Fig 6: Average yield (q/ha) of Rapeseed-Mustard varieties under CFLD conducted in NEH region**

From Fig 6, it was observed that among the rapeseed & mustard varieties *i.e.,* TS-67,TS-46,TS-38, YSH-401, TRC-T-1-1-5-1,M-27,TS-36 and NRCHB-101, the variety YSH-401 recorded the highest demo average yield of 10.7 q/ha over farmer's yield of 4.67 q/ha as compare to the other rapeseed & mustard varieties conducted under CFLD.

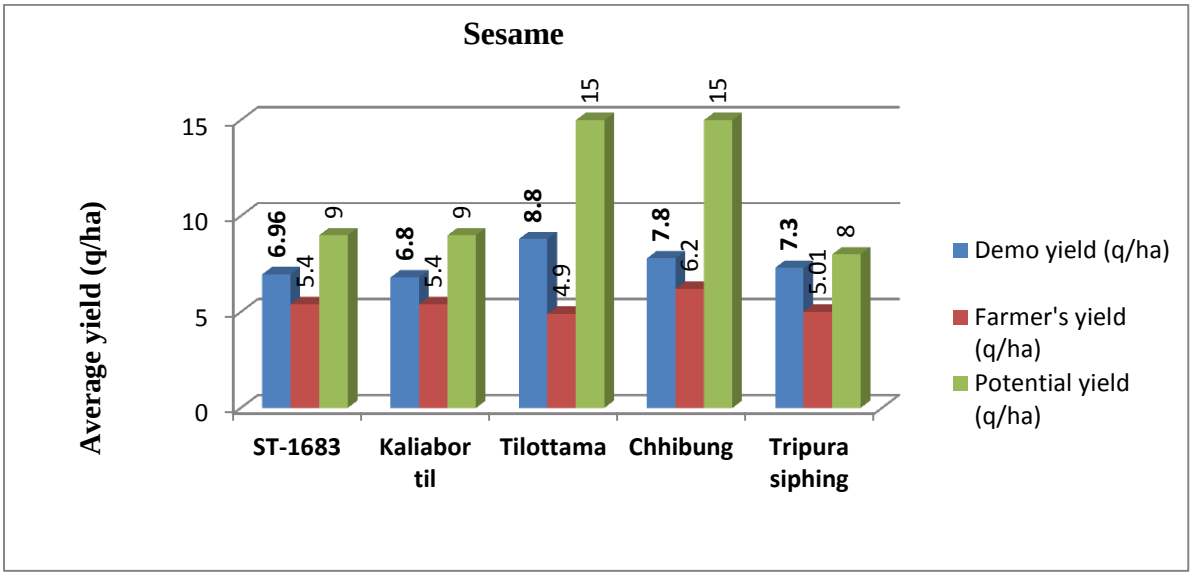



**Fig 7: Average yield (q/ha) of Sesame varieties under CFLD conducted in NEH region**

From Fig 7, it was observed that among the sesamum varieties *i.e.,* ST-1683, Kaliabor Til, Tilottama, Chhibung and Tripura siphing, the variety Tilottama recorded the highest demo average yield of 8.8 q/ha over farmers yields which of 4.9 q/ha as compare to the other sesame varieties conducted under CFLD.

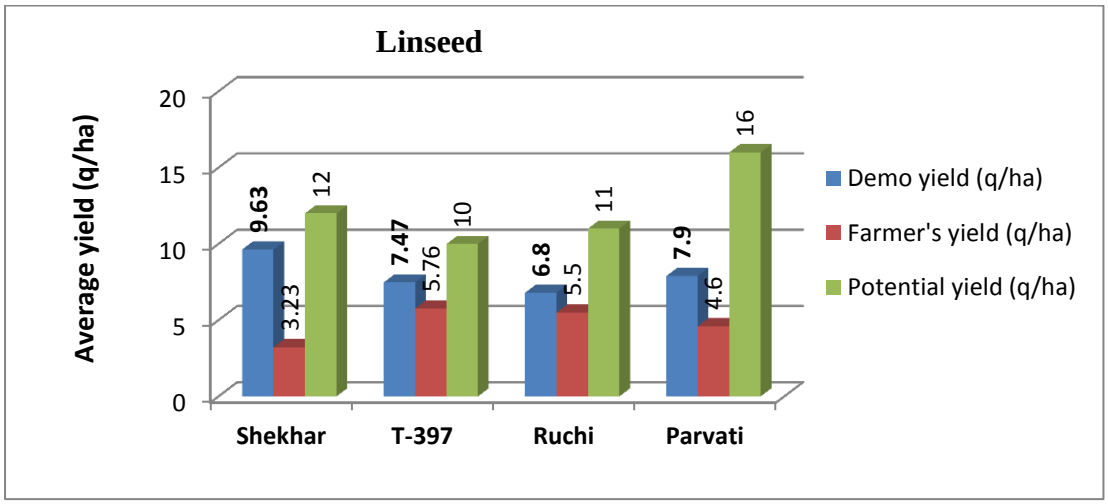



**Fig 8: Average yield (q/ha) of Linseed varieties conducted under CFLD in NEH region**

From Fig 8, it was observed that among the linseed varieties *i.e.*, Shekhar, T-397, Ruchi and Parvati, the variety Shekhar recorded the highest demo average yield of 9.63 q/ha over farmer's yield of 3.23 q/ha as compare to the other linseed varieties conducted under CFLD.

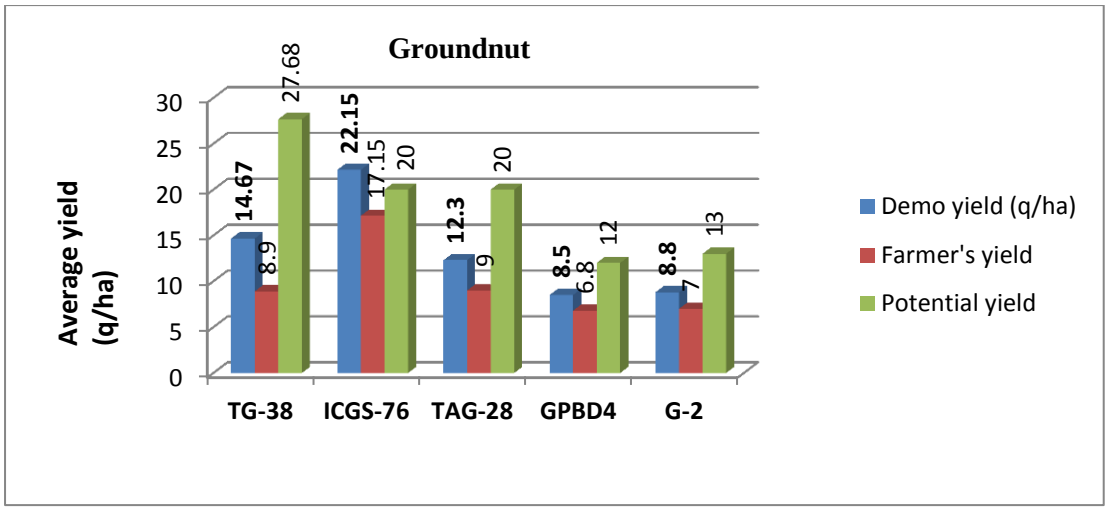



**Fig 9: Average yield (q/ha) of Groundnut varieties under CFLD in NEH region**

From Fig 9, it was observed that among the groundnut varieties *i.e.*, TG-38,ICGS-76,TAG-28,GPBD4 and G-2, the variety ICGS-76 recorded the highest demo average yield of 22.15 q/ha over farmer's yield of 17.15 q/ha as compare to the other groundnut varieties conducted under CFLD.

## Summary and Discussion

Looking into the deficit in oilseeds, the CFLD programme was launched all throughout the country and North East was no exception to that. The CFLD oilseed programme became an effective tool for increasing the area, production and productivity of oilseeds changing the knowledge, attitude and skill of the farmers on the adoption of improved technologies. The total area conducted under CFLD oilseeds has increased from 1249 ha in the year 2015-16 to 1500 ha in the year 2016-17. However total area conducted under CFLD oilseeds has slightly decrease to 1155.5 ha in the year 2017-18 . CFLD on oilseeds was conducted both in kharif and rabi season.

There was a tremendous positive growth in the productivity of soybean under CFLD. The productivity of soybean under CFLD over the years i.e., 2016-17, 2017-18 and 2018-19 has shown an increase in yield *i.e.*, 8.94 q/ha, 16.91 q/ha and 16.27 q/ha respectively. The use of HYVs such

as JS-335, JS 95-60,DSb-19 and JS-97-52 under demonstration has shown relatively higher increase in yield over the local check having average productivity of 7.27 q/ha, 11.59 q/ha and 12.67 q/ha respectively. The percentage increases in yield over check were 22.97%, 46.49 % and 28.37% in the year 2016-17, 2017-18 and 2018-19 respectively. The average B:C ratio in soybean has positively increase from 1.78, 2.65 and 2.78 in the year 2016-17, 2017-18 and 2018-19 respectively.

Under groundnut, area conducted under CFLD has increased from 60 ha in 2016-17 to 195.5 ha in 2017-18 and slightly decreased to 150 ha in 2018-19. The growth in productivity of groundnut has positively increased over the years *i.e.*, 2016-17,2017-18 and 2018-19 with 12.88 q/ha, 15.16 q/ha and 16.27 q/ha as compared to the local check having average productivity of 8.8 q/ha, 11.04 q/ha and 11.77 q/ha respectively. The percentage increase in yield over check were 46.36 %, 38.39 % and 38.24 % in the year 2016-17,2017-18 and 2018-19 respectively. The average B:C ratio in groundnut has positively increase from 1.7, 2.47 and 2.52 in the year 2016-17, 2017-18 and 2018-19 respectively.

From the year 2016-17 to 2018-19, the growth in area of sesame under CFLD has slightly decrease over the years *ie.*, 2016-17, 2017-18 and 2018-19 which were 280 ha, 130 ha and 120 ha respectively. The productivity of sesame has increased from 6.09 q/ha in 2016-17 to7 q/ha in 2017-18 however it has decreases to 5.95 q/ha in 2018-19. The use of HYVs such as ST-1683, Kaliabor til, Tilottama,Chhibung and Tripura Siphing under demonstration has shown positive results in increase yield over local check. The average B: C ratio in sesame has positively increase from 2.3, 2.51 and 2.7 in the year 2016-17, 2017-18 and 2018-19 respectively.

Under rapeseed and mustard, the productivity of soybean under CFLD over the years *i.e.*, 2015-16, 2016-17, 2017-18 and 2018-19 has shown a positive increase in yield of 8.2q/ha, 9.16q/ha, 8.53 q/ha and 9.07q/ha respectively as compared to the local check varieties having an average productivity of 5.86 q/ha, 6.35 q/ha, 5.87 q/ha and 6.18 q/ha respectively. The use of HYVs such as TS-36, TS-46,TS-38,TS-67, M-27, YSH-401, NRCHB-101 and TRC-T-1-1-5-1 under demonstration has shown relatively higher increase in yield over local check. The percentage increase in yield over check were 39.93 %, 44.25 %, 47.6 % and 46.74 % in the year 2015-16, 2016-17,2017-18 and 2018-19 respectively. The average B:C ratio of rapeseed and mustard has

slightly increase over the years 2015-16, 2016-17,2017-18 and 2018-19 which were 2.19, 2.05, 2.68 and 2.55 respectively.

From the year 2015-16 to 2018-19, linseed production under CFLD is concentrated in relatively fewer states *ie.*, Assam, Nagaland and Tripura with an average productivity of 5.87 q/ha, 8.6 q/ha, 7.03 q/ha and 6/98 q/ha in the year 2015-16, 2016-17, 2017-18 and 2018-19respectively as compared to the local check varieties having an average productivity of 4.01q/ha,4.15 q/ha ,5.03q/ha and 5.43 q/ha in the year 2015-16, 2016-17,2017-18 and 2019-20 respectively. . The use of HYVs such as Shekhar, T-397, Ruchi and Parvati under demonstration has shown relatively higher increase in yield over local check. The percentage increase in yield over check were 46.38 %,107.2 %, 39.6% and 28.47 % in the year 2015-16, 2016-17,2017-18 and 2018-19 respectively. The average B:C ratio of linseed has slightly increase over the years 2015-16, 2016-17,2017-18 and 2018-19 which were 1.94,2.1,2.31,1.97 respectively.

Besides FLDs, field days, training, workshops, seminars, farmers-scientists interaction *etc.* were also conducted to facilitate interactions between researchers, extension workers and farmers/farm women. During these interactions, knowledge/experiences/constraints were exchanged for improving the performance of different technological packages under FLDs. Hence, adoption of proven agricultural technologies on large scale could be ensured among farming communities.

## Conclusion

Oilseed cultivation in the Northeast India faces several constraints, such as water scarcity during post-monsoon season, unavailability of seeds at the time of sowing, lack of irrigation facilities. The production of oilseeds under acidic soils of the North East region can be augmented by adopting improved technologies. The area enhanced under oilseeds in NEH region was increased from 4.58 lakh ha in the year 2013-14 to 4.72 lakhs ha in 2015-16. Production and productivity of oilseeds in NEH region has increase from 3.38 lakh tonnes and 926.17 kg/ha in the year 2013-14 to 3.78 lakh tonnes and 928.84 kg/ha in the year 2015-16 respectively.

Oilseeds under Cluster Frontline Demonstration conducted in the NEH region have made a positive and significant impact on the productivity of oilseeds. The highest oilseed yield among the kharif oilseed crops conducted under CFLD was groundnut with 14.77 q/ha and an increase in yield

of 41% over local check followed by soybean with 14.04 q/ha and an increase in yield of 32.61 % over local check. Among the rabi crops, the highest yield among the oilseeds was rapeseed and mustard at 8.74 q/ha and an increase in yield of 44.63 % over local check. The CFLDs has showed a great potential on the use of improved high yielding varieties which gave higher yield as compared to the farmers practice. The local varieties of oilseeds such as soybean were replaced by improved cultivars such as JS-335, JS-95-60, Dsb-19 and JS-97-52 on a large scale in the demonstration cluster. In the year 2018-19, the highest cropping intensity was observed in sesame with 113.33 % and the most promising average B: C ratio was observed in soybean with 2.65. Improved production technology in sesame, use of foliar nutrition, INM, IPM and use of HYVs has increase the yield of sesame by 32 % in the year 2018-19. Adopting improved technologies including intercultural operations such as weeding, earthing up, *etc*. along with zero tillage operation, use of biofertilizers, lime application in the soil, intercropping system such as paddy-mustard cropping has help to maintain soil fertility in ideal conditions for oilseed production. Adopting INM and IPM has greatly help in maintaining the soil fertility and controlling pests and diseases. The beneficiary farmers of CFLD also plays an important role as source of information and quality seeds for wider dissemination of high yielding varieties of oilseeds for other nearby farmers. Therefore it can be concluded that CFLD are a proven extension intervention to demonstrate production potential of oilseed crop varieties on farmer's field in the North East region.

## References

1. Sonnad, J.S., Raveendaranl, N. Ajjanl and K.N Selvaraj (2011). Growth analysis of oilseed crops in India during pre and post-WTO periods. Karnataka J. Agric. Sci, 24 (2): 184
2. Ghosh T,et al. A review on seed borne mycoflora associated with different oilseed crops and their management. Int J Pure Appl Biosci.2018: 1526
3. Singh S.S and Singh Rajesh (2011). Crop Management (Under Irrigated and Rainfed conditions) 215-216
4. Thapa Sittal, Baral Ranjit and Subash Thapa (2019).Status , Challenges and Solutions of oilseed production in India.Research & reviews: Journal of Agriculture and Allied Sciences.Vol 8, Issue 1, 27:34
5. Government of India Ministry of Agriculture& Farmers Welfare. Directorate of Economics & Statistics. Pocket Book of Agriculture Statistics 2018, 55-59

6. Vijay Paul Sharma, Problems and prospects of oilseed production in India. Centre for Management in Agriculture (CMA), Indian Institute of Management (IIM), Ahmedabad.
7. http:// nmoop.gov.in/Guidelines.apx
8. 8.https://www.nfsm.gov.in/StatusPaper/NMOOP2018.pdf
9. http://www.sopa.org/presentations_2018/Vegetable%20oils%20vis-a-vis%20Soybean%20in%20India.pdf
10. ICAR-ATARI Kolkata (2017). Oilseed productivity enhancement through Identified Agro-technologies in Eastern region.
11. ICAR-ATARI,Zone VII (2018). Impact of technologies on oilseeds production in North East Region.
12. http://www.populationu.com/india-populationState-wise and crop-wise.Directorate of Oilseeds Development, Ministry of Agriculture& Farmers Welfare.

13. Dr. C Padma Veni, Dr. Bandaru Venkata Rajkumar, Dr. D Vijaya Lakshmi, Dr. M Swetha, P Vijay Kumar and Dr. M Bhavya Manjari (2018). Impact of cluster frontline demonstrations on yield enhancement of green gram and bengalgram. International Journal of Chemical Studies 2018; 6(5): 2294-2296.
14. Sandeep Suresh Patil, Mahesh Mavanjee Mahale, Sudeshkumar Shivajorao Chavan (2018). Impact of Frontline Demonstrations (FLDs) on oilseed crops in South Konkan Coastal zone of Maharastra. Current agricultural research journal (2018) ISSN: 2347-4688

# HORTICULTURE- A SUNRISE SECTOR IN NORTHEAST INDIA

**Bidyut C. Deka and Pijush K. Biswas**

Northeast India comprising of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura is bestowed with vast resources that provide unlimited opportunity for the growth and development of horticulture sector. The wide agro-climatic variation from subtropical to alpine, varieties of soil, wide range of biodiversity and rich variability in food habits etc are some of the most favourable factors that support the promotion of commercial horticulture in the region. Horticultural crops occupy about 1.40 million ha area in North Eastern region, which is roughly 19 % of the total cultivated area of the region. The region produces 43.44 lakh MT of fruits, 59.29 lakh MT of vegetables and 7.51 lakh MT of spices from an area of 4.52, 5.64 and 2.19 lakh hectares, respectively besides nut crops, flowers and medicinal and aromatic plants during 2017-18 (NHB Database, 2018). Moreover, the sector is growing with an annual growth rate of more than 5 % in last few years.

**Table 1. Area and production of horticultural crops in Northeast India during 2017-18**

| State | Fruits | | Vegetables | | Spices | |
|---|---|---|---|---|---|---|
| | Area (000' ha) | Production (000' t) | Area (000' ha) | Production (000' t) | Area (000' ha) | Production (000' t) |
| Arunachal Pradesh | 48.1 | 125.7 | 2.6 | 16.6 | 11.4 | 68.7 |
| Assam | 147.3 | 2123.6 | 300.2 | 3292.9 | 101.6 | 302.0 |
| Manipur | 47.6 | 455.6 | 45.3 | 342.1 | 10.5 | 23.1 |
| Meghalaya | 32.8 | 316.5 | 49.1 | 519.7 | 18.7 | 92.0 |
| Mizoram | 63.2 | 340.5 | 36.2 | 171.0 | 27.7 | 100.9 |
| Nagaland | 39.5 | 380.5 | 46.2 | 561.6 | 9.9 | 64.8 |
| Sikkim | 19.4 | 54.9 | 38.4 | 229.1 | 32.3 | 66.6 |
| Tripura | 53.8 | 547.5 | 45.9 | 795.7 | 6.6 | 32.4 |
| Northeast India | **451.7** | **4344.8** | **563.9** | **5928.7** | **218.7** | **750.5** |

The major fruits and vegetables cultivated in the region are banana, citrus, pineapple, papaya, potato, tomato, brinjal, cabbage, cauliflower, beans, colocasia, cucumber, ridge gourd, spine gourd, cow pea, ginger, turmeric, chilli, orchids etc. In recent years, horticultural crops like strawberry, kiwi, ber, litchi, dragon fruits, mango, guava, onion, king chilli, pumpkin, marigold, tube rose, gerbera, gladiolus etc are being popularized either by the Govt. Departments through various programmes or by the farmers themselves based on the demand in the market. Moreover, Northeast India has got lot of prospects for commercial cultivation of medicinal plants like tulsi, pudina, manimuni, bay leaf etc and different seed spices like cumin, fenugreek, coriander besides other indigenous fruits and vegetables. Despite its higher growth and prospects, horticulture is still priority number II for most of the farmers in the region as they are generally busy throughout the year in cultivation of field crops, with little time to invest for cultivation of horticultural crops on commercial basis.

## Growth and demand-supply analysis of fruits and vegetables in Northeast India

Presently horticultural crops account 18.6 per cent of total cultivated area in Northeast India. This share is highest in Sikkim followed by Manipur, Arunachal Pradesh, Meghalaya, Tripura, Mizoram, Assam and Nagaland (Lakshman, 2017). During the period 2007 to 2017, Mizoram recorded the highest growth in area (12%) under fruits production per annum followed by Nagaland and Tripura. In fruit production, Nagaland has the highest growth rate i.e. 17 per cent per annum followed by Manipur (14%) and are significant at five per cent level. The average annual growth in area and production of vegetables is highest in Nagaland state followed by Mizoram and Manipur.

The demand-supply analysis of fruits and vegetables in Northeast India has been calculated based on the estimated population of 2018 (5.05 crores) and 2030 (5.74 crores) as per the ICMR recommended rate of 120 g fruits and 300 g vegetables per day per adult. While calculating the demand, the possible post harvest loss has not been considered as the entire population is treated as adult. Therefore, the demand calculated may not be considered as absolute figure, but it would definitely give an idea about the present status and future requirement. The table 3 clearly indicates that the region has the surplus production of 21.34 and 4.09 lakh tonnes of fruits and vegetables, respectively in 2018. The surplus would further increase to 27.72 and 11.37 lakh tonnes in fruits and vegetables, respectively by 2030. This has clearly revealed that the region has good prospect for preparation of various value added products utilizing the surplus production besides marketing the

same outside the region as well as exporting the same to gulf countries and other South East Asian countries.

**Table 2: Compound annual growth rate and instability index in area, production and productivity of horticultural crops in Northeast India (2007 to 2017)**

| Fruits | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Particulars** | **A.P** | **Assam** | **Manipur** | **Meghalaya** | **Mizoram** | **Nagaland** | **Sikkim** | **Tripura** | **NE states** |
| **Area** | -1.99 | 2.68* | 0.79* | 2.05* | 12.11* | 10.79* | -7.03 | 6.85* | 3.51* |
| **Production** | 6.32 | 3.93* | 14.34** | 5.10* | 4.55** | 16.66* | -4.94 | 1.50 | 5.02* |
| **Productivity** | 8.48*** | 1.22*** | 13.44** | 2.99* | -6.74* | 5.29* | 2.26 | -5.01* | 1.46** |
| **Vegetables** | | | | | | | | | |
| **Area** | -8.56 | 0.98 | 12.58* | 1.64** | 13.98*# | 20.42* | 2.51 | 5.57* | 3.48* |
| **Production** | -10.03 | -1.04 | 8.51* | 4.60* | 3.44***# | 29.90* | 2.51 | 7.50* | 5.67 |
| **Productivity** | -1.61 | -2.05 | -4.78* | 2.69** | -9.25** | 7.72* | -1.13 | 0.74 | -1.61 |

Note: * indicates significant at 1 per cent, ** indicates significant at 5 per cent, *** indicates significant at 10 per cent. # indicates the data used from 2008 to 2017 for analysis.

**Table 3: Production and requirement of fruits and vegetables in Northeast India in 2030**

| Northeast India | 2018 | | | 2030 | | |
|---|---|---|---|---|---|---|
| | Demand (lakh tons) | Supply (lakh tons) | Deficit/Surplus (lakh tons) | Demand (lakh tons) | Supply (lakh tons) | Deficit/Surplus (lakh tons) |
| **Fruits** | 22.1 | 43.45 | +21.34 | 25.14 | 52.86 | 27.72 |
| **Vegetables** | 55.2 | 59.29 | +4.09 | 62.53 | 73.90 | 11.37 |

## Horticulture–An emerging platform for better income and employment generation

Horticulture plays a very significant role in income generation activities in most of the hilly states of Northeast India. In last couple of years, horticulture has registered a compound annual growth rate of more than 5 % in the region. Therefore, the young people of the region have shown interest to take up horticulture as one of the options for employment and income generation. North Eastern states are blessed by the nature with an abundance of natural resources which provides numerous opportunities to invest and venture in fields like production horticulture, high-tech horticulture, commercial floriculture, protected cultivation, amenity horticulture, post-harvest supply chain management & value addition and Horticulture based farming system.

### 1. Cultivation of high value horticultural crops and seed production

The different horticultural crops can be grown in different altitudes based on their climatic requirements in the region.

**Table 4: Suitable horticultural crops in NE India across different altitudes**

| Altitude (above MSL) | Suitable crops |
|---|---|
| **High hills (900 – 2000 m)** | Apple, peach, pear, plum, apricot, kiwifruit, strawberry, potato, colocasia, cabbage, cauliflower, radish, beans, different flower crops *etc.* |
| **Mid hills (below 800 m)** | Citrus, banana, pineapple, papaya, guava, dragon fruits, ginger, turmeric, chilli, brinjal, tomato, bean, potato, sweet potato, tapioca, colocasia, medicinal & aromatic plants, different flower crops *etc.* |
| **Foot hills** | Jackfruit, mango, dragon fruits, arecanut, cashew nut, coconut, black pepper, medicinal & aromatic plants, ginger, turmeric, seed spices, potato,other seasonal vegetables, orchids, tuberose, marigold, gerbera, gladiolus *etc.* |

It has been observed that the productivity of most of the horticultural crops in North Eastern Region is much lower than the average productivity of the country. The major reasons for the low productivity of the crops are: Non-adoption of commercial mode of production, non adoption of better crop varieties, lack of adequate irrigation facilities and poor marketing and post-harvest management infrastructure. Use of grafted/ budded seedlings in fruit crops should be given top priority. The region being rich in biodiversity in brinjal, chillies, cucurbits, beans, colocasia etc, there is immense scope for development of few hybrids locally. Moreover, all the hill states of the region may lay emphasis on organic cultivation in selected high value crops in both main and off-seasons having better market demand.

**Table 5: Horticulture crops having commercial importance in national and international market**

| Group | Crops | Market |
|---|---|---|
| **Fruits** | *Khasi* mandarin, Pineapple, Banana, Strawberry, Guava, Assam lemon, Litchi, Papaya *etc* | Indonesia, Bangaladesh, Phillipines, Vietnam, Laos, Middle East *etc* besides metro cities in India |
| **Vegetables** | Spine gourd, Bitter gourd, Ash Gourd, Cabbage, Beans, Tomato, Potato, Colocasia, leafy vegetables, cucumber, pumpkin, melons *etc* | Indonesia, Bangaladesh, Phillipines, Vietnam, Laos, China, Middle East *etc* besides metro cities in India |
| **Spices** | Ginger, Chilli, Turmeric, Black pepper *etc* | European market & metro cities in India |
| **Flowers & other ornamentals** | Orchids, Anthurium, Rose, Lillium, Tube rose, Ferns, Gerbera and Heliconia*etc* | European market besides local market |
| **Medicinal & Aromatic plants** | Tulsi, Manimuni, Bay leaf, Pudina, Coriander *etc* | Patanjali, Dabor and such other industries |

The production of seed and planting materials of horticultural crops is an emerging business in the region. In vegetables alone, the requirement is about 500 tonnes per annum and 50 % of it can be easily produced in the region itself. In the entire Northeast India, about 200 govt. farms having 50-100 ha of lands per farm are available for this purpose and most of the farms are equipped with all the required facilities. The young entrepreneurs may come forward for utilizing these farms for production of planting materials and vegetable seeds of identified crops.

## 2. Hi-tech horticulture

Hi-tech horticulture refers to the precise production techniques for efficient use of inputs at the appropriate time and quantity for maximization of yield and quality in different horticultural crops. It is an adoption of technology which is modern, less environment-dependent, capital intensive and has the capacity to improve productivity and quality of horticultural crops. Hi-tech horticulture is a powerful tool for doubling productivity of horticultural crops and can well be used for doubling farmers' income (DFI). The broad themes to carry forward the goal of hi-tech horticulture include the following.

- Climate-resilient production technology including nursery development through hi-tech interventions.

- Conservation of existing germplasm and exploitation of underutilized plant and land use with development of new varieties/ hybrids suited for hi-tech horticulture.
- High density planting with appropriate canopy management and promotion of bee keeping for better productivity with mutual benefits.
- Precision farming oriented to targeted yield, crop and region-specific nutrient management and irrigation resource conservation.
- Development of a value chain to reduce post-harvest losses and value addition.
- Application of biotechnology and nanotechnology for crop improvement and value addition.

## 3. Commercial floriculture

A vast treasure of ornamental plants and orchids exists in NE India. The important ornamental species that have now been adopted for cultivation include Bauhenia, Cassia, Calestemon, Erythrina, Jacaranda, Magnolia, Rhodedendron, Myria, *etc*. Some of the shrubs and climbers like Azalia, Achenia, Bougainvellea, Camilio, Gardenia, Hibiscus, Jatropha, Nerium, Thunbergia are colourful ornamentals. However, among the flowering plants, special mention may be made about the orchids,which have both ornamental and medicinal value. Out of 1300 orchid species reported, about 600species occur in north eastern region alone. Plants of the epiphytes origin have great opportunities fordevelopment and growth of industries. Mention may be made of *Vanda coerules* (Blue Vanda), *Renanthera imschootina, Paphiopedilum hirsutissimum, Dendrabium falconerii*and *Paphiopedilum fairicanum* (The lady's slipper) and *Cymbidium etc*.

The greatest advantage of the region is its varied climatic zone from subtropical to temperate condition and presence of native orchid species in respective conditions. The places situated between 700 m to 2000 m MSL with cool and humid climatic conditions are suitable for growing Cymbidiums. Similarly the places below 500 MSL with warm and humid conditions are suitable for warm growing orchids like *Cattleya, Dendrobiums, Vandas, Aerides, and Rhynchostylis.*

**Table 6: Growing of orchids at different altitudes**

| Orchid type | Altitude range | Climate | Species | States |
|---|---|---|---|---|
| Temperate orchids | Altitudes<br>Between 700 to 2000 MSL | Cool and humid conditions.<br>Temperature range Between 8º to 25 º C | Hybrids and species of Cymbidiums | Meghalaya, Arunachal Pradesh, Nagaland, Mizoram and Sikkim |
| Sub tropical to tropical or Warm growing orchids | Below 500 MSL | Warm and humid conditions.<br>Temperature range Between 15º to 35 º C | Hybrids and species of *Cattleya*, *Dendrobiums, Vandas, Aerides, Phalaenopsis and Rhynchostylis* | Meghalaya, Assam, Manipur, Arunachal Pradesh, Tripura |

By adopting the following steps a successful orchid enterprise can be developed in the rural areas of the region.

- An awareness program should be launched around the places where orchid cultivation is possible. This will help the rural farmers to appraise about the benefit of orchid growing.
- Majority of the farmers of the region are poor and they may not adopt orchid as a crop because of long gestation period and high initial investment cost to get the economic benefits .This is where Govt. agencies /Bank must come forward with financial assistance in collaboration with research organization.
- Farmers may be encouraged to grow orchid in their backyard garden with proper support from govt. /extension agencies in the form of supplying quality planting materials,cost effective shade net house and technical know-how.
- Formation of Orchid Co-operative society in a locality/village to channelize the marketing of the products *viz*. flower spike, pot plants, planting materials *etc.*
- Appropriate post harvest handling practices and packaging for different orchid species may be developed/ standardized and popularized.

## 4. Amenity horticulture

Amenity Horticulture is involved with growing plants for recreational or ornamental purposes. It includes providing, establishing and managing amenity horticulture sites. Amenity horticulture has a vital role to play in the future management of the environment. As custodians of both natural and developed landscapes, amenity horticulturists will be increasingly responsible for ensuring the Earth's resources in a sustainable manner. The wide areas of amenity horticulture include Arboriculture, Landscape industries, Parks and gardens, Nurseries, Turf management, Interior landscaping, Floriculture *etc*. It offers various benefits by providing Aesthetic value, Recreational benefits of public open space and Health benefits, Economic and Environmental benefits.

The young entrepreneurs, to start with may initiate various activities for beautification of public/ private properties with pot plants on rental basis in the establishments like corporate house, air port, railway station, bus station *etc*, sports facilities, auditorium/ cinema hall/ conference hall, schools/ colleges/ universities, hotels/ malls/ guest houses, govt. offices/ financial organization and private buildings/ flats etc.

## 5. Post-harvest supply chain management and value addition

Post-harvest management of horticultural crops are very essential as most of the produces are highly perishable in nature. Sorting/ grading of the produces alone enhance the value of the product. The young entrepreneurs may come forward to establish a small pack house facility having the facilities for sorting/ grading, washing, pre-cooling, surface drying, storage etc by forming a Farmer Producer Company. Besides, the following activities may also be undertaken in a phased manner.

- Minimal processing of fruits and vegetables for value addition of fresh produces
- Dehydration of fruits and vegetables, fruit pulp and juices
- Fruit processing (Jam, Jellies, pickles *etc*).
- Processing of spice crops *viz.*, ginger, turmeric, garlic *etc*. for spice oil, dry powder, natural dyes *etc.*
- Cold storage and Ware housing.

## 6. Horticulture based farming system

The R&D activities of research and academic organizations as well as different line departments across the hilly states of Northeast India reveal that the integrated farming system has the potential to sustain the production system with an average benefit cost ratio of 2.25-2.5. Under the scenario of climate change and gradual degradation of natural resources including lesser per capita availability of land, there has been an urgent need for location-specific measures to conserve, utilize and manage these resources for optimizing production on sustainable basis without adversely affecting its quality. The age old practices of *Bari* (Backyard farming) system in Assam, *Zabo* system in Nagaland and *Apatani* system in Arunachal Pradesh are some of the glaring examples of effective utilization of the bio-resources in farming systems mode.

Horticultural based farming system in varying topography with suitable soil and environmental conditions may be a profitable option for the *jhumias* with little modification in abandoned *jhum* lands and existing *jhum* fields.The horticulture based integrated farming system developed for hilly areas not only reduces the risk of soil degradation and environmental degradation, but also generate huge employment to the tune of 525-575 man days per hectare. ICAR Research Complex for NEH Region, Umiam has developed a number of models comprising of various fruit crops (*Khasi* mandarin/ Sweet orange, Pineapple, Assam lemon, Guava) with vegetables and flower crops like gerbera, marigold etc. as inter crops in a sustainable manner with adequate supplementation of manures through vermicompost units. The following are some of the models developed by ICAR Complex.

- **Tuber Crop Based Farming System**

The *tilla* (moderate hillock upland) land is suitable for cultivation of tuber crops. A tilla having no source of irrigation is divided into plots having the size of 800m$^2$ each for the individual tuber crops. In these plots tuber and rhizomatous crops like diascorea, elephant foot yam, tapioca, ginger, sweet potato etc. are cultivated. Boundary of each plot is planted with banana suckers. The total cost of production is Rs. 18,150.00/ha and farmers earned a gross return of Rs. 39,100/-. with a B:C ratio of 2.15 (Datta *et al*. 2012) from an area of 0.1 ha.

- **Agri-hort-silvi-pastoral system**

The system is being standardized in 0.80 ha area in ICAR Research Complex for NEH Region, Umiam, Meghalaya. In this system 0.10 ha of foothills is used for agricultural crop, 0.25 ha for horticulture and 0.44 ha for silvi-pastoral crops. The Agri-horti-silvi-pastoral system produces 8344 kg REY (rice equivalent yield). The highest REY of 3000 kg is estimated with cow milk followed by Capsicum-Turmeric (2006.5 kg REY). Vegetable component registers a net income of Rs.18365 while the fruit orchard (guava and pineapple) gives a net income of Rs. 5071 amounting to a total net income of Rs. 45,092 from the system (Annual Report 2015-16, ICAR Complex, Umiam).

- **Silvi-horticultural system**

The total area of Silvi-horticultural system is 3.13 ha with a forest land of 2.17 ha and planned land use of 0.96 ha of which 0.50 ha area is kept for system study. The average slope of the area is 53.18%. Lower terraces covering an area of 490 $m^2$ is utilized for growing of spices and vegetables in combinations like turmeric +bottle gourd, turmeric + pumpkin and turmeric alone. The middle portion of the system is utilized for fruit crops such as guava. Upper portion of the system is covered with the forest tree spp. *Alnus nepalensis*. A gross income of Rs. 34,400.00 is recorded from an area of 490 $m^2$ during 2015-16 (Annual Report 2015-16, ICAR Complex, Umiam).

## Way forward

The above discussion clearly reveals that horticulture is one of the important sectors that play a significant role in Agri-preneurship development in Northeast India. Development of economy of any state depends primarily on the role played by its entrepreneurs. The role played by such entrepreneurs is of vital importance in developing the region, where there are ample opportunities for using innovations to exploit the available resources. In the region, where human resources are found to be in plenty, the state govt. of the respective state in the region can identify individuals who have the requisite entrepreneurial skills for taking up horticulture based enterprises. The following strategies may be adopted by the respective govt. of the states in the region so as to support rapid development in horticulture sector with a target of annual growth more than 8% in next ten years.

1. Use of GIS/ Spatial data service for accurate mapping of various resources including areas covered under different horticultural crops so as to prepare a solid annual plan of activities in different horticultural crops.
2. Creation of few platforms for production of seed, planting materials and organic inputs in PPP mode with appropriate buy back arrangement by govt. and other organizations within and outside the states.
3. Cluster approach for growing of commercially important fruits, vegetables, spices, flowers and medicinal plants with scientific promotion of bee keeping utilizing rice fallow, waste/ unutilized uplands and abandoned/ sick tea gardens across the states.
4. Development of organic clusters in niche horticultural crops under protected environment having drip cum fertigation system with sound marketing strategies so as to get remunerative prices.
5. Promotion of Farm mechanization to reduce the cost of production by introducing machineries for bed making, pit making, mechanical pruner, grass cutting machines etc in each of the clusters.
6. Mission mode programme for promotion of medicinal plants, spices and citrus crops in large cluster with appropriate PHM infrastructural facilities like tea gardens.
7. Promotion of seed spices like cumin, coriander, fenugreek in char clusters in the state of Assam with appropriate processing and packaging facilities.
8. Establishment of integrated collection, grading, packaging and small scale processing centers with other logistics like cold storage, refrigerated van etc. in production catchment area, preferably in all the Development block of the region.
9. Development of *horti* based integrated farming system for small and marginal farmers having 5-7.5 bigha land for modest monthly net income of Rs. 15000-20000.
10. Promotion of roof top gardening and peri-urban horticulture in select cities like Guwahati, Bongaigaon, Jorhat, Dibrugarh, Tezpur, Silchar, Itanagar, Pasighat, Shillong, Tura, Imphal, Aizawl, Dimapur, Kohima, Mokochung, Agartala, Udaipur etc.

11. Introduction of nutritional gardens in school premises for conservation of indigenous fruits, vegetables, flowers, medicinal & aromatic plants and spices as an education project in order to prepare a group of skill hands when they are young.
12. Promotion of few groups of youth in amenity horticulture through paid contract service for beautification of public/ private building in the establishments like Airport, railway station, state capital complex, DC/ Block offices, Colleges/ Universities, Auditorium, cinema halls, hotel/ guest houses, interstate bus terminus, malls, sports facilities etc
13. Establishment of *Horti-incubation hub* having the facilities for sales counter of seeds, planting materials, farm machineries, agro-chemicals including organic input, Machinery repairing centre, Plant clinics for testing and plant protection, Bank finance, DPR preparation, Farmers' Club and Advisory services including market intelligence using ICT Kiosk etc in each of Development block of the region.

## References:

1. Deka, B. C. (2012). Entrepreneurship development through marketing of commercially important horticultural crops of NE India. In Souvenir of the North-East Connect 2011-12. Published by NERAMAC, Guwahati on the occasion of North-East Connect during February 24-25, 2012.
2. Deka, B. C. (2014). Prospect of employment generation through horticulture sector in Northeast India. In Souvenir, 7th National Extension Education Congress-2014 (November 8-11, 2014) brought out by ICAR RC NEH Region, Umiam.
3. Deka, B.C. (2015). Northeast India: Emerging hub for horti-business in South East Asia. In Souvenir, 2nd Assam International Agri horti Show-2015 (February 10-14, 2015) brought out by Deptt. Of Agriculture, Govt. of Assam.
4. Deka, B.C, ParisaDivya and Singha, A.K. (2018). Attracting and Retaining Youth in Agriculture (ARYA): A special Focus on North Eastern States of India. In: Souvenir of North Eastern Zone Regional Agri-Fair (RAF-2018). January 6-9, 2018.
5. Deka, B.C., Rymbai, H., Deshmukh, N.A., and Talang, H.D. (2017). Horticulture based farming systems: The engine for prosperity in Northeast India. In Doubling Farmers Income

through horticulture, ed. By Chadha, K.L., Singh, Kalia, P, Dhillon, W.S., Behera, T.K. and Prakash Jai and published by Daya Publication House, New Delhi.

6. Datta, M., Anup Das and Ngachan, S. V. 2012. Innovations in Agroforestry based Farming System for Sustainable Land Use and Rural Livelihood in Tripura. In: *Innovations in Integrated Farming System for Livelihood Improvement*. Book of Extended Summaries of the National Seminar On Livelihood Options for Small and Marginal Farmers Livelihood Options for Small and Marginal Farmers in Fragile Ecosystems, 9-10th August, 2012. pp 58-64.
7. Horticulture Statistics at a Glance 2018 Available online at http://nhb.gov.in/statistics/Publication/Horticulture At a Glance 2018.
8. Lakshman Chandra De, 2017, Horticulture Scenario in NE region of India, *International Journal of Agricultural Science and Research*, **7**(2): 243-254.

# PROSPECT OF LIVESTOCK AND POULTRY SECTOR IN NORTH-EASTERN REGION OF INDIA

**S K Baishya, H M Sangtam and Bidyut C. Deka**

The North-Eastern Region (NER) of India comprising the states of Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura occupies about 8% of total land area and 3.8% of total population of the country. Agriculture is the prime source of livelihood for the majority (75%) of rural population in this region. It is characterized by subsistence, low input-low output, technologically lagged mixed farming system, and is dominated by smallholders. Livestock and poultry sector are the integral component of mixed farming system providing food and nutritional security to the people. The dependence on livestock as an alternative source of income is significant with livestock accounting for 18 % of the value of output in agriculture sector in this region (Kumar *et al*., 2007). About 30 % of landless and 48 % of marginal households keep livestock in the NE region (NSSO, 2003).

Livestock is an important component of mixed farming system due to preference of meat in their diets. The region is known as meat consuming zone of India. The consumption of meat is relatively higher in this region because of social and religious acceptance, and the most preferred meat is pork, followed by beef, chicken and others. Nagaland is ranked top in meat consuming states of India. The consumption of milk and milk products is lower in this region in comparison other states of India due to food habit and less availability of milk, however due to increase in per capita income and changes in life style the demand for milk and milk products is also growing in last few years (Feroze et al., 2010).

Meat is an important and common source of animal protein in the NE India. The expenditure estimates reveal that out of total food expenditure, 15% and 18% is spent on meat in rural and urban areas, respectively. In recent years, few brands like Arohan Foods in Guwahati, Metro Meat in Nagaland and Meat Treat in Shillong (Mahajan *et al*, 2015) are engaged in production and processing of meat in a much organised way. Most of the states particularly the hill states in the region depend on inter-state trade in livestock and poultry to meet the domestic demand. It is deficit in all the three

components of animal proteins i.e., milk (41.54%), meat (54%) and eggs (87.31%). The annual production of meat, milk and eggs are recorded as 8114.45 thousand MT meat, 1454.17 thousand MT milk and 11356.90 lakh number eggs annually, respectively (Livestock census, 2019). The escalating demand for livestock products in a sustainable manner is a big challenge in one hand and on the other hand it is an opportunity for development of livestock and poultry sector in the region.

## Livestock and Poultry Resources

According to 20th Livestock Census 2019, NE region is the home for 243.50 lakh livestock and 692.25 lakh poultry which accounts for 4.5 per cent of the total livestock and 8.1 per cent of poultry birds in India (Table 1). Assam being the largest state has maximum of the total livestock and poultry resources in rural (75%) and urban (70%) areas of NE Regions followed by Meghalaya (8.5% and 8%).The region is also home tract of 91 percent of Mithun population of India and mainly concentrated in Arunachal Pradesh. Assam, Nagaland and Meghalaya are the major pig rearing states of NE region. The lowest livestock and poultry population is in the state of Sikkim.

**Table 1: State-wise Number of Livestock and poultry, 2019**

| States | Rural | | Urban | | Total | |
|---|---|---|---|---|---|---|
| | Livestock | Poultry | Livestock | Poultry | Livestock | Poultry |
| **Arunachal Pradesh** | 1126620 | 1489612 | 34808 | 109963 | 1161428 | 1599575 |
| **Assam** | 17662876 | 45668840 | 429325 | 1043501 | 18092201 | 46712341 |
| **Manipur** | 472294 | 4636781 | 78425 | 1260856 | 550719 | 5897637 |
| **Meghalaya** | 2005372 | 5179252 | 33731 | 200280 | 2039103 | 5379532 |
| **Mizoram** | 224264 | 1310814 | 135440 | 736996 | 359704 | 2047810 |
| **Nagaland** | 481710 | 2400500 | 72093 | 43844 | 553803 | 2838944 |
| **Sikkim** | 269526 | 572296 | 4806 | 8568 | 274332 | 580864 |
| **Tripura** | 1265410 | 3887504 | 52482 | 280742 | 1317892 | 4168246 |
| **NER** | **23508072** | **65145599** | **841110** | **3684750** | **24349182** | **69224949** |
| **All India** | **514110739** | **812197763** | **22650604** | **39612168** | **536761343** | **851809931** |

*Source: 20th Livestock Census, 2019*

There is a decrease in livestock population in 2019 registering a decline of 10.19 % in the total number of animals of various species in NER as compared to 2012 while in all India; a positive growth

of 4.64 % is recorded during the same period (Table 2). On the other hand, there is an increase in poultry population in 2019 registering a positive growth of 62.57 % in the total number of birds of various species as compared to 2012, which is five times more than the national growth rate during the same period.

**Table 2: Change in livestock and poultry population over 2012 to 2019**

| | Livestock | | | Poultry | | |
|---|---|---|---|---|---|---|
| | **Population (in thousands)** | | **% change** | **Population (in thousands)** | | **% change** |
| | **2012** | **2019** | | **2012** | **2019** | |
| **NER** | 27106.53 | 24343.18 | -10.19 | 42580.47 | 69224.95 | 62.57 |
| **All India** | 512057.30 | 535828.88 | 4.64 | 729209.32 | 851809.93 | 16.81 |

*Source: 20th Livestock Census, 2019*

## Production system of livestock and poultry

Although the region possesses a sizeable number of livestock and poultry, the productivity of livestock and poultry is very poor due to stunted growth and low production potentiality of local breeds of livestock and poultry and unscientific approach of livestock and poultry farming.

## Cattle

NER is still lagging behind in dairy sector against the spectacular progress made by other parts of the country. The average productivity of crossbred cattle (in milk) in India is 6.5 litres per day but it is 4.7 litres in the region. Assam which is the major milk producing state in the region has low productivity of animals compared to other NE states, except Sikkim and Tripura. The average productivity of local cattle and buffalo is less than half of the national average (NSSO, 2003).

Most of the indigenous non descript cattle which constitutes around 90% of cattle population in the region are reared under grazing system where the cattle are kept loose in the open field, roadside, forest and jungles with or without any attendants. In the evening the animals are brought back home and tied in the cattle shed made up of locally available bamboos, thatch and planks. Some farmers do

not even bring back the cattle to their home. In this system farmers do not provide any concentrate feed to the cattle although some farmers provide agricultural by product, kitchen wastes and vegetables along with salt in the evening. During cultivation season the cattle are grazed along with the supervision of one or two attendants. Some progressive farmers having high yielding animals like crossbred Jersey and Holstein freisian generally practice the stall fed system. The commercial dairy farming in the region is mostly in the hands of Nepali and Bihari community. The animals are provided with concentrate feed and grasses, fodder, tree leaves, paddy straw etc. without giving emphasis on the nutritive value (balance ration) of cattle ration. Two to three times feeding is practiced by the farmers.

Indigenous non-descript cattle are bred indiscriminately without much choice of male. Since the indigenous cattle are reared under free grazing system, there is no control over breeding. Inbreeding is commonly happened in this system of rearing which results in poor growth rate and low milk yield. Farmers particularly in remote area are not getting AI facility for breeding their animals though the AI technology was introduced long back in fifties.

The most common diseases of cattle in the farmers' field are mastitis, repeat breeding, anoestrus, milk fever, calf scours, HS, BQ, foot and mouth disease (FMD) and parasitic infection. Most of the farmers are not aware of vaccination against diseases like HS, BQ and FMD.

## Pig

Among the livestock, pig is the most popular and valued livestock in the entire North-Eastern region. NE region alone is the home for 38.42% of the total pig population of India and Assam possesses highest numbers (2,249,690) of pigs among the NE states (Livestock census, 2012). The bulk of the pig population (60-70%) is non-descript pig, whose growth rate is very poor and attain only 30-40 kg body weight in a year. Theses pigs are small in size, pot bellied, hairy and black in colour with elongated face and short ears. The majority of the farmers of the region practices almost zero to minimal grain pig production system. Pigs are mostly dependent on the local vegetation, agro industrial by-products, household and kitchen waste with or without little concentration feed. Majority of the farmers practiced the traditional type of housing system for pig. Farmers have evolved their own design

for pig house depending upon the locally available materials like bamboo, wooden plank and thatch grass.

Indigenous non-descript pigs are bred indiscriminately without much choice of male. Because of scavenging types of rearing of local pigs, there is no control over breeding. In this case inbreeding of local pigs is routine phenomenon, which results poor growth rate and less number of piglets. Most of the breeder farmers in the district use community boar of improved breed for mating of their sows/gilts of improved breed.

The most common diseases of pigs in the farmers' field are swine fever, pneumonia, piglet diarrhea, skin infection, foot and mouth disease (FMD) and parasitic infection. Most of the farmers are not aware of vaccination against diseases like swine fever and FMD.

## Goat

India occupies first position in terms of goat population with 148.88 million during 2019 showing an increase of 10.1% over the previous Livestock Census (2012). About 27.8% of the total livestock is contributed by goats. The NE region accounts for 5084.24 thousands (BAHS, 2019) nos. of goat with maximum number in Assam followed by Meghalaya (397.50), Arunachal Pradesh (159.74), Sikkim (90.51), Manipur (38.70), Tripura (36.20), Nagaland (31.60) and Mizoram (14.82). The goat breeds mostly found are Assam hill which is the indigenous breed of Assam and Bengal black. The Beetal goat breed has also been introduced in state of Assam and efforts are being made to propagate the breed in other NE region.

Goat also plays a significant role in providing supplementary income and livelihood to poor farmers and landless labourers in rural areas. Traditionally goat has served as source of livelihood and financial security to large section of society, mainly comprising of resource-poor people. In many small-herd dairy goat enterprises, not all does milked but meat is often the main product. Along with meat, the sale of breeding stock from small herds of dairy goats is an important income source. In the changing agro-climatic conditions, this small ruminant farm animal has tremendous potential to be projected as the "Future Animal" for rural and urban prosperity. The backyard goat rearing is steadily

turning as the fast growing "livestock industry". Goat husbandry provides glimpses of future hope for employment generation, nutritional security and prosperity to the millions of small and marginal farmers in the country.

### Poultry

The North Eastern region is considered as one of the original area in Asia for modern poultry, yet the poultry production is in its infant stage contributing only 4% of total egg production and 1.5% of total broiler production in the country. It is reported that more than 75% of total poultry population of the region are indigenous and their production potentialities is around 60 to 70 eggs per year per bird.

More than 90% farmers followed free range/ extensive system of rearing type of housing system where birds are allowed for scavenging in day time for 6-8 hours and night shelter is provided in huts made of locally available materials like bamboo, broom or thatch grasses etc. Traditional feeding practice with cereal grains and kitchen wastes to *desi* birds is a common phenomenon. Most of the farmers do not bother for health care and preventive measures against common diseases of bird. They do not even spend money on veterinary medicine and treatment on *desi* birds rather the farmer's resorted to their own local herbal treatments. Farmers are not aware about vaccination and deworming against common diseases. The major poultry diseases prevail in the region are coccidiosis, Ranikhet, salmonellosis, chronic respiratory disease, fowl pox and Marek's disease.

## Production of milk, meat and eggs

### Milk

The percentage growth increase in milk production during 2012-13 to 2018-19 is 142.51% in Arunachal Pradesh followed by Mizoram and Tripura with 88.92% and 56.95 % (Table 3), respectively. However, the negative growth of production is only in the state of Nagaland with -7.74%. The average percent increase of all India is 41.77% as compared to NE region with 17.69%. Among the NE region the percent increase of milk production is highest in Arunachal Pradesh. This increase might be due to the population of Yak and Mithun being the highest in numbers among the NE region. Similar increase in percent is observed in the state of Manipur and Meghalaya with 7.14% and 7.56%,

respectively. The consumption of milk and milk products among the tribal communities in NE region are less as compared to the other states of India. Even though, the milk is high in nutrients content, but the preference of meat is more among the tribal population compared to milk and milk products.

**Table 3: Milk Production during 2012-13 to 2018-19 (*In '000 tonnes*)**

| States | 2012-13 | 2013-14 | 2014-15 | 2015-16 | 2016-17 | 2017-18 | 2018-19 | % increase |
|---|---|---|---|---|---|---|---|---|
| Arunachal Pradesh | 22.72 | 43.35 | 46.07 | 50.13 | 52.53 | 54.02 | 55.10 | 142.51 |
| Assam | 799.67 | 814.52 | 829.47 | 843.46 | 861.27 | 871.89 | 882.27 | 10.32 |
| Manipur | 80.03 | 81.7 | 82.17 | 78.97 | 78.82 | 81.66 | 85.75 | 7.14 |
| Meghalaya | 80.52 | 82.16 | 82.96 | 83.95 | 83.96 | 85.03 | 86.61 | 7.56 |
| Mizoram | 13.63 | 15.3 | 20.49 | 22 | 24.16 | 25.02 | 25.75 | 88.92 |
| Nagaland | 78.66 | 80.61 | 75.69 | 77 | 79.37 | 74.09 | 72.57 | -7.74 |
| Sikkim | 42.24 | 45.99 | 49.99 | 66.74 | 54.35 | 58.67 | 60.85 | 44.05 |
| Tripura | 118.04 | 129.7 | 141.23 | 152.23 | 159.59 | 174.26 | 185.27 | 56.95 |
| NER | 1235.51 | 1293.33 | 1328.07 | 1374.48 | 1394.05 | 1424.64 | 1454.17 | 17.69 |
| All India | 132430.6 | 137685.9 | 146313.6 | 155490.5 | 163693.7 | 176347.35 | 187749.46 | 41.77 |

## Meat

The meat production between 2012-13 to 2018-19 has shown 4.33% increase in NE Region compared to national level of 36.41 % (Table 4). Highest percent increase is in Tripura with 50.42% followed by Assam and Mizoram with 37.70% and 33.36%. Among the NE region, Nagaland has witnessed a significant decrease in meat production from 70.64 MT in 2012-13 to 32.28 MT during 2018-19. The increase in meat production is significantly higher in Assam, Tripura and Meghalaya which may be due to their large livestock base and the preference for meat in the states. The lowest meat producing state in NE region is in the state of Sikkim with 3.72 MT during 2018-19.

**Table 4: Meat Production during 2012-19 *(In 000 Tonnes)***

| States | 2012-13 | 2013-14 | 2014-15 | 2015-16 | 2016-17 | 2017-18 | 2018-19 | % increase |
|---|---|---|---|---|---|---|---|---|
| Arunachal Pradesh | 17.64 | 18.04 | 18.72 | 19.38 | 20.47 | 21.39 | 21.87 | 23.97 |
| Assam | 36.6 | 38.3 | 42.58 | 44.76 | 46.86 | 48.35 | 50.40 | 37.70 |
| Manipur | 25.02 | 25.01 | 26.56 | 26.27 | 27.47 | 27.70 | 28.05 | 12.11 |
| Meghalaya | 38.52 | 40.34 | 41.32 | 41.13 | 41 | 43.09 | 45.25 | 17.47 |
| Mizoram | 12.08 | 12.19 | 12.56 | 13.55 | 14.79 | 15.68 | 16.11 | 33.36 |
| Nagaland | 70.64 | 67.48 | 66.98 | 35.93 | 31.37 | 32.40 | 32.28 | -54.30 |
| Sikkim | 3 | 3 | 3 | 5.84 | 4.4 | 4.40 | 3.72 | 24.00 |
| Tripura | 31.79 | 32.39 | 34.25 | 37.35 | 39.69 | 45.26 | 47.82 | 50.42 |
| NER | 235.29 | 236.75 | 245.97 | 224.21 | 226.05 | 238.27 | 245.5 | 4.33 |
| All India | 5948.17 | 6235.48 | 6691.08 | 7019.96 | 7385.61 | 7355.63 | 8114.45 | 36.41 |

*Source: Basic Animal Husbandry & Fisheries Statistics 2017, GOI Source: Basic Animal Husbandry Statistics 2019, GOI*

## Eggs

The percent increase in egg production during 2012-13 to 2018-19 is 76.31% (Table 5) in Tripura, which is the highest among the NE states followed by Arunachal Pradesh and Mizoram with 35.54% and 17.94%, respectively. However, the egg production in Assam is highest (5014.61 lakh) during 2018-19 followed by Tripura and Meghalaya with 2759.56 lakh and 1090.36 lakh, respectively. The state of Sikkim was the lowest in egg production among the NE states with 54.56 lakh during 2018-19. The percentage increase of egg production in NE region is 13.34% as compared to all India average of 48.16% from 2012-13 to 2018-19.

**Table 5: Egg Production during 2012-13 to 2018-19 *(In Lakh Number)***

| States | 2012-13 | 2013-14 | 2014-15 | 2015-16 | 2016-17 | 2017-18 | 2018-19 | % increase |
|---|---|---|---|---|---|---|---|---|
| Arunachal Pradesh | 438.69 | 400.02 | 417.26 | 427.31 | 495.21 | 550.08 | 594.64 | 35.54 |
| Assam | 4709.58 | 4717.34 | 4727.94 | 4740.48 | 4770.75 | 4951.84 | 5014.61 | 6.47 |
| Manipur | 1162.19 | 1163.81 | 1129.37 | 1037.4 | 992 | 1017.84 | 1053.24 | -9.37 |
| Meghalaya | 1028.18 | 1049.36 | 1056.99 | 1063.66 | 1063.9 | 1073.71 | 1090.36 | 6.04 |
| Mizoram | 352.02 | 362.31 | 377.33 | 391.13 | 408.07 | 409.95 | 415.19 | 17.94 |
| Nagaland | 617.98 | 223.34 | 352.77 | 464.52 | 397.35 | 401.42 | 374.74 | -39.36 |
| Sikkim | 146 | 99.35 | 57.53 | 101.57 | 68.49 | 63.28 | 54.56 | -62.63 |
| Tripura | 1565.17 | 1794.28 | 1979.49 | 2160.84 | 2294.26 | 2621.09 | 2759.56 | 76.31 |
| NER | 10019.81 | 9809.81 | 10098.68 | 10386.91 | 10490.03 | 11089.21 | 11356.9 | 13.34 |
| All India | 697307.2 | 747518.8 | 784838.7 | 829294.4 | 881369.56 | 952169.98 | 1033176.3 | 48.16 |

*Source: Basic Animal Husbandry & Fisheries Statistics 2017, GOI  Source: Basic Animal Husbandry Statistics 2019, GOI*

## Demand-supply of milk, meat and eggs by 2030

The projection study on production and requirement of milk, meat and eggs in NER has been carried out to estimate the demand-supply gap of livestock products by 2030 (Table 6). The growth of livestock rate is based on the Livestock Census 2012 and 2019 (*Basic Animal Husbandry Statistics 2019, GOI*). Requirement of milk, meat and eggs is estimated by multiplying the recommended amount of per capita consumption with the population of 2018 and the projected population of 2030 in NER. The population of the region is estimated to be 57415800 by 2030 from 49758267 during 2018.

The demand for livestock products is estimated to feed the growing population by 2030. The data in Table 6 shows that the demand is more than supply in all the three animal proteins by 2030. The projected milk, meat and egg production reveals that the region would have a deficit of 696.68 thousand MT, 259.44 thousand MT and 85200.90 lakh numbers by 2030 from 1033.71, 299.33 and 78207.94, respectively during 2018. However, the deficit percentage of milk, meat and eggs would be

reduced from 41.54%, 54.94% and 87.31% during 2018 to 24.26%, 41.26% and 82.44% respectively by 2030 with the present livestock and poultry production system in the region. Therefore, to make this region self sufficient in milk, meat and eggs a comprehensive approach should be under taken to accelerate the production and productivity of livestock and poultry birds in NER.

**Table 6: Demand-supply analysis of Milk, Meat and Eggs in Northeast India**

| States | Milk (000 MT) | | | | | |
|---|---|---|---|---|---|---|
| | 2018 | | | 2030 | | |
| | Demand | Supply | Gap (D-S) | Demand | Supply | Gap (D-S) |
| Arunachal Pradesh | 75.21 | 55.10 | -20.11 | 86.78 | 82.65 | -4.13 |
| Assam | 1696.15 | 882.27 | -813.88 | 1957.18 | 1323.40 | -633.78 |
| Manipur | 155.22 | 85.75 | -69.47 | 179.11 | 126.91 | -52.20 |
| Meghalaya | 161.26 | 86.61 | -74.65 | 186.08 | 129.91 | -56.17 |
| Mizoram | 59.63 | 25.75 | -33.88 | 68.81 | 38.11 | -30.70 |
| Nagaland | 107.54 | 72.57 | -34.97 | 124.08 | 108.85 | -15.23 |
| Sikkim | 33.18 | 60.85 | 27.67 | 38.29 | 90.05 | 51.76 |
| Tripura | 199.69 | 185.27 | -14.42 | 230.42 | 274.19 | 43.77 |
| NER | 2487.88 | 1454.17 | -1033.71 | 2870.75 | 2174.07 | -696.68 |
| Meat (000 MT) | | | | | | |
| Arunachal Pradesh | 16.47 | 21.87 | 5.4 | 19.00 | 32.80 | 13.80 |
| Assam | 371.45 | 50.40 | -321.05 | 428.62 | 76.60 | -352.01 |
| Manipur | 34.00 | 28.05 | -5.95 | 39.22 | 42.07 | 2.85 |
| Meghalaya | 35.31 | 45.25 | 9.94 | 40.75 | 67.87 | 27.12 |
| Mizoram | 13.06 | 16.11 | 3.05 | 15.07 | 24.16 | 9.09 |
| Nagaland | 23.55 | 32.28 | 8.73 | 27.17 | 48.42 | 21.25 |
| Sikkim | 7.26 | 3.72 | -3.54 | 8.38 | 5.58 | -2.80 |
| Tripura | 43.73 | 47.82 | 4.09 | 50.46 | 71.73 | 21.27 |
| NER | 544.83 | 245.5 | -299.33 | 628.67 | 369.23 | -259.44 |
| Eggs (lakh no) | | | | | | |
| Arunachal Pradesh | 2707.61 | 594.64 | -2112.97 | 3124.30 | 951.42 | -2172.87 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Assam** | **61061.61** | **5014.61** | **-56047.00** | **70458.67** | **8023.37** | **-62435.30** |
| **Manipur** | **5588.08** | **1053.24** | **-4534.84** | **6448.06** | **1685.18** | **-4762.87** |
| **Meghalaya** | **5805.46** | **1090.36** | **-4715.10** | **6698.90** | **1744.57** | **-4954.32** |
| **Mizoram** | **2146.96** | **415.19** | **-1731.77** | **2477.36** | **643.54** | **-1833.81** |
| **Nagaland** | **3871.44** | **374.74** | **-3496.70** | **4467.23** | **599.58** | **-3867.64** |
| **Sikkim** | **1194.74** | **54.56** | **-1140.18** | **1378.61** | **84.56** | **-1294.04** |
| **Tripura** | **7188.94** | **2759.56** | **-4429.38** | **8295.29** | **4415.30** | **-3879.90** |
| NER | **89564.84** | **11356.90** | **-78207.94** | **103348.42** | **18147.52** | **-85200.90** |

*Source: Basic Animal Husbandry Statistics 2019, GOI*

*Source: ICMR RDA 2010: Per capita consumption: Milk-50kg/yr; meat: 10.95kg/yr; egg: 180nos/yr*

## Major constraints in livestock and poultry sector

Livestock and poultry development have received little attention in the North Eastern regions of the country. Though the livestock improvement strategy has been laid down by the Govt. of India at national level, but it is very hard to implement at state level where the animals are being reared in small herd size of 2-3 animals mainly by small, marginal and landless farmers of different socio-economic strata. Some of the major constraints in livestock and poultry development in the region are as follows.

- Absence of quality breeds of livestock, all the animals and birds are nondescript types resulting in poor livestock productivity. Non availability of superior quality of piglets, poultry chicks and calf.
- The effective technology intervention on Artificial Insemination in cattle has not been fully put into gear. Except cows, other species of animals have not been covered under A.I programme resulting in indiscriminate breeding practices through community boar, bulls and goat.
- Lack of breeding policy for up gradation of existing livestock population in most of the Northeast states.
- Traditional and unscientific system of animals and poultry rearing. Poor perception of the farmers towards livestock production as a viable alternative.
- Acute shortage of feed concentrate and green fodder are the root cause of the poor performance as the genetic potentiality of an animal cannot be exploited fully in the absence of proper

nutrition. Inadequate availability of quality feed at economic price. There is no compound feed manufacturer in the whole of the N.E. India. As a result the utilization of non-conventional feed resources could not be maximized.

- Inadequate infrastructure facility for surveillance and monitoring of infectious and contagious diseases of animals and birds. Lack of proper animal disease diagnostic laboratory.
- Presence of fragmented and unorganized market for livestock products results mushrooming growth of middlemen, who thereby reap the actual benefits depriving the real producers of their rightful share.
- Lack of scientific slaughter house, processing and storage of meat and milk products.
- Lack of institutional credit is one of the major constraints for slow growth in livestock sector in NER.
- The transport and communication system is poorly developed resulting inaccessibility to majority of the area for animal and veterinary health care.
- Lack of institutional, technological and policy interventions to encourage farmers to keep livestock.

## Strategy for development of livestock and poultry in Northeast India

A number of pertinent issues need to be addressed and delivered to bridge the gap between the demand and production of animal protein in the region. The productivity of livestock and poultry birds is very low in NER as compared to the other parts of the country. The general strategy for sustainable improvement programmes for any livestock sector in any particular agro-climatic regions should focus on the optimization of the genetic potential according to environmental factors (e.g., the needs of the market, the ecological environment and future development), nutritional intervention, disease control management and proper marketing channels. Unfortunately, the production systems vary considerably from area to area and even from farmer to farmer. Therefore, breeding management, nutritional management, health management as well as proper marketing facility should be taken into consideration for improving the livestock and poultry sector in this region.

The following strategies may be adopted to augment the production of livestock and poultry sector in the region.

## A. LIVESTOCK SECTOR

### 1. Breeding policy for breed improvement of animals

- Up gradation of non-descript indigenous cattle, pig and goat by adopting cross breeding programme with superior exotic germplasm.
- Facility for A.I and pregnancy diagnosis at farmers' door needs to be created.
- Establishment of large scale animal breeding farms with superior breeds at district level to meet the farmers' need of genetically superior animals.
- Exploitation of modern tools for enhancing productive and reproductive performances in livestock.

### 2. Alternative Nonconventional Feed Resources

- The government should give more emphasis on proper use of locally available nonconventional feed resources like cassava leaves, sweet potato tuber, water hyacinth, banana stems, colocasia, silk worm pupae meal.
- Establishment of a compound feed manufacture for efficient utilization of non-conventional feed resource as a source of livestock feed.
- Cultivation of green fodder and quality proteins maize (QPM) maize needs to be promoted.

### 3. Modern Disease Diagnostic Laboratory

- Establishment of disease diagnostic laboratory at block level for animals and birds.
- Establishment of more number of veterinary dispensaries with adequate medicines and timely prophylactic measures and emergency services for health care of animals.
- Intensive epidemiological studies of the livestock diseases particularly the infectious diseases should be under taken for control and eradication.

### 4. Establishment of Livestock Extension Services

- Establishment of cyber livestock communication system for faster dissemination of information through communication information centre which is located in each district.
- Scientific survey of livestock production system is to be done from time to time to generate data base on livestock production system.

### 5. Training and Awareness among the Farmers

- For improvement of piggery sector, awareness programme of scientific pig rearing among the piggery farmers has to be taken up at regular manner.
- Training and empowerment programmes for livestock based entrepreneurship development among rural youth.

### 6. Establishing Livestock Cooperatives

### 7. Processing, Storage and Marketing Infrastructure

- Establishment of dairy processing and storage unit at state/district level to ensure less risk when production is high.
- Construction of medium/large-scale slaughter house at district head quarter for efficient slaughtering, processing and storage of pork products.
- The prices of livestock products are to be regulated by Govt. agencies so that the livestock farmers get due share for their products.
- Set up of organized marketing facilities by the govt. agencies to deter middleman and private sector role in marketing for better market price realized by the livestock farmers.

## B. POULTRY SECTOR:

### 1. Government policy to make available of improved dual multi-coloured poultry birds

- Initiation of Government policy to make available of improved dual purpose variety of poultry for backyard system of rearing.

- Establishment of poultry hatchery farms in state/district level for production of quality vanaraja/srinidhi/gramapriya/giriraj chicks for rearing in backyard as well as in small scale intensive rearing.

### 2. Policy on formulation of low cost poultry feed

- Formulation of low cost poultry feed incorporating locally available feed resources
- Establishment of small and large scale feed industry based on the locally available feed resources.

### 3. Policy for disease control measures

- Disease control measures, vaccination and deworming against most common diseases of poultry should be carried out.
- Emergency services for treatment of poultry to be ensured at farmer's doorstep by establishing more veterinary health care and diagnostic centres.

### 4. Training and entrepreneurship development

- Training and entrepreneurship development on poultry farming among the rural youth and farmers.
- Mass popularization of backyard poultry farming with improved dual multi-coloured poultry birds.
- Providing incentives and encouragement for taking up of commercial layer farming by the rural youth.

## Conclusion

There is a tremendous scope for growth of livestock and poultry in Northeast India. This sector offers a significant opportunity for household income augmentation and employment generation to a large proportion of landless labourers, small and marginal farmers. It also performs an important input functions in terms of contributing draught power and dung to crop production. Various pertinent constraints and issues need to be addressed to accelerate the development of livestock sector in the

NER of India. Therefore, supportive technical, institutional and policy initiatives for improvement of breeds, feed availability, disease control, food safety, meat production & processing and private investment are required to enhance the production and productivity of livestock in order to transform the NER from a deficit to a surplus region.

## References

1. Adams, Jr. Richard H. **(1996)** Livestock Income, Male/Female Animals and Inequality in Rural Pakistan. International Food Policy Research Institute, Washington D.C.
2. BAHS **(2019).**Basic Animal Husbandry Statistics, Government of India.
3. BAHFS **(2017).** Basic Animal Husbandry & Fisheries Statistics, Government of India.
4. Birthal, P.S. and M.K. Singh **(1995)** Structure of rural income inequality: A study in western Uttar Pradesh. Indian Journal of Agricultural Economics, 30(2): 168- 175.
5. Feroze, S.M., Raju, V. T., Ram Singh and Tripathi,A. K. **(2010).**Status of Livestock Sector: A Micro Study of North Eastern India. *Indian Journal of Hill Farming.* 23 (2):43-51.
6. ICMR RDA **(2010)**. Nutrient requirement and recommended dietary allowances for Indians. A report of the expert group of the ICMR. National Institute of Nutrition, ICMR, Jamai-Osmania, Hyderabad.
7. Kumar, A., Staal, S., Elumalai, K. and Singh, D.K. **(2007)**. Livestock sector in North Eastern region of India: An appraisal of performance. *Agric. Econ. Res. Rev*., 20(2): 255-272.
8. Mahajan, S., Papang, J.S and Datta,K.K. **(2015).**Meat consumption in North-East India: Pattern, Opportunities and Implications. *Journal of Animal Research*: Vol.5, No.1: 37-45.
9. National Sample Survey Organization **(2003**). Unit level data on land and livestock holdings (59th Round). Ministry of Statistics and Programme Implementation, Government of India, New Delhi.
10. National Sample Survey Organization **(2003**). Unit level data on land and livestock holdings (59th Round). Ministry of Statistics and Programme Implementation, Government of India, New Delhi.

# FISHERIES FOR PROSPERITY IN NORTHEAST INDIA UNDER CHANGING SCENARIO

**Biswajit Debnath, Bidyut C. Deka, Diganta Sharmah and Biswajit Bal**

The land-locked Northeast India, one of the 'hotspots of biodiversity' in India offers a great opportunity for development of fisheries sector. It has great potential for ushering economic prosperity with its unutilized and underutilized vast and varied inland resources spread across different states in the region. The fish production possibility frontier is yet to be achieved through efficient utilization of available and varied resources (Bareh, 2001). The region produces 470.88 thousand metric tonnes (MT) of fish (2017-18) with an annual average growth rate of 4.88% during last two decades (estimated using secondary data of DoF-GoI, 2019). The People of NE India have very high preference for animal protein in general and fish protein in particular.

Fish market by and large is demand driven almost in all the states of the region. The distribution and marketing of fish in NE Region i.e. the fish production-consumption dynamics and demand-supply pivot was substantially affected for more than two months due to lockdown on account of pandemic COVID-19 during March-May, 2020. With this background, this chapter aimed at describing the status and prospects of fisheries sector against fish consumption in North East Region. In the later part of this chapter, an attempt has been made to link up the status and prospects of fisheries sectors to post-covid situation based on some theoretical assumptions and hence, worked out few important strategic options to develop the sector in general and some specific issues to cope up the pandemic situation.

## Fisheries resources of Northeast India

The Northeast comprises of eight Indian states, *viz*. Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura has the total geographical area of 2,62,180 sq.km which is about 8% of the country's total area with a population of about 45 million. The region is having a total of 3.84 lakh ha water resources in terms of reservoirs, tanks and ponds, beels, oxbow lakes and other derelict waters, except the rivers and canals which are extending to a length of 20,875 km in all the NE states of India taken together. State-wise detail of fisheries resources of Northeast region is

presented in table 1. The resources are however not uniformly distributed across different states within the region.

Assam is the largest state of Northeast India which occupies nearly 30% geographical area with 68.2% water resources of the region excluding rivers and canals. Among capture fisheries resources, the floodplain wetlands or beels are prime resources of Assam (more than 1.0 lakh ha) and many of these are converted to swamps because of siltation and macrophytes infestation. Manipur is having 24,433 ha of beels which is the second highest capture fisheries resources among NE states. Besides, large areas under derelict water bodies having great potential to be explored are available in Assam (86,204 ha) and Arunachal Pradesh (11,864 ha), which are currently underutilized. Large potential for aquaculture development in ponds and tanks was observed in relatively low altitude areas of the region except Sikkim and Arunachal Pradesh. Nearly 87.5% of ponds and tanks fisheries resources of NE India are spread across three states namely Assam, Tripura and Manipur only. Enormous potential exists for creating impoundments in the region and increasing water areas under reservoir fisheries. A total of 23 nos. of small, medium and large reservoirs covering an area of 28,510 ha (≈7.4% of water resources of NE India) have high potential for fisheries development. Paddy-cum-fish culture practices are well established in Arunachal Pradesh and Nagaland. Traditional paddy-cum-fish culture in certain areas of Assam (Juria in Nagoan district) and Manipur (Ukhrul district) are notable. The region has 2,670 ha areas under paddy-cum-fish culture but has potential for expanding to 42,280 ha (Sugunan, 2007). However, recently estimated potential area for paddy-cum-fish culture in the NE region is 70,920 ha (Barman *et al*., 2012; Krishnan and Debnath, 2019).

**Table 1: Fisheries resources of Northeast India**

| Name of the states | Rivers &Canals (km) | Reservoirs Area (ha) | Tanks and Ponds (ha) | Beels (ha) | Oxbow Lake (ha) | Derelict water (ha) | Total (ha) |
|---|---|---|---|---|---|---|---|
| **Arunachal Pradesh** | 2000 | 160 (1) | 3625 | 2500 | 5 | 11864 | ***18,154*** |
| **Assam** | 4820 | 2000(1) | 73065 | 100815 | - | 86204 | ***2,62,084*** |
| **Manipur** | 3360 | 2142(6) | 11442 | 24433 | - | 4728 | ***42,745*** |
| **Meghalaya** | 5600 | 8000 (5) | 2000 | 221 | 61 | 54 | ***10,336*** |
| **Mizoram** | 1395 | 8100 (4) | 5468 | - | - | - | ***13,568*** |
| **Nagaland** | 1600 | 2258 (1) | 3426 | 3000* | 1700 | - | ***10,384*** |
| **Sikkim** | 900 | 850 (3) | 16 | 3000* | - | - | ***3,866*** |
| **Tripura** | 1200 | 5000 (2) | 17552 | 240[#] | - | 361 | ***23,153*** |
| **Total** | ***20,875*** | ***28,510 (23)*** | ***1,16,594*** | ***1,34,209*** | ***1,766*** | ***1,03,211*** | ***3,84,290*** |

***Note:*** *Figures in parenthesis mentioned in 3rd column are the numbers of reservoirs*
* These are mostly upland lakes, also known as upland wetlands, but not floodplain in nature.
***Source:*** DAHDF-GoI (2014) and DoF-GoI (2019); [#]Rudrasagar lake (Barman et al., 2013).

## Constraints of fisheries development in Northeast India

The region has considerable potential for substantial improvement in production from culture fisheries resources and yield from capture fisheries resources. There are many areas that require management interventions to achieve higher fish yields. However, despite having all the potentialities, the region is still deficient in fish production to meet the growing demand of the consumer. The following are some of the constraints that hold back the development in fisheries sector of the region.

- Non-availability of quality fish seed in adequate number has always been a constraint in the region (Sugunan, 2003). The problem is confounded by low temperature regime of the high altitudes, where breeding and rearing is difficult (Sugunan, 2003). Even in Assam and Tripura where a large number of carp hatcheries have been operating, considerable regional variations in seed availability occurs. Adequate facilities are also not available for growing fish spawn into fingerlings stage to stock the beels and reservoirs.

- Floods constitute one of the major constraints to aquaculture development on a commercial scale in the region especially in Assam and Tripura. Though the problem created by floods can be tackled to some extent by raising the height of the pond dykes/ pen screens, such a step will increase the capital investments.
- Construction of embankment along with the banks of rivers for flood control has also resulted in negligible auto-stocking of riverine fish species and annual flushing of water in many beels/pats, lakes and swamps (Choudhury and Bhattacharjya, 2006). Since most riverine fish species use the open beels as spawning and nursery ground, river regulations also adversely affect the fish stocks of the parent rivers (Bhattacharjya, 2004). The harmful effect of dams on the ecology and fisheries of rivers is well known (Jhingran, 1991) especially on the fisheries of migratory species.
- Shortage of fish feed as well as prevailing low temperature and acidic conditions also hinder aquaculture development. In addition, limited availability of plain lands, difficult terrains and aquatic pollution also hinder fishery development in the Northeast.
- Fish diseases in aquaculture system have emerged as a notable problem. There is no fish disease laboratory in the entire Northeast to diagnose the etiology of fish disease. Further, non-availability of prophylactic and therapeutic agents for treatment of common fish disease also creates problem for fish farmers of the region.
- In most open water fisheries of the region, conflicts arise between lessees/ fishers and agriculturists/ local residents over the use of marginal land and water for cultivation, irrigation, jute retting, navigation and other uses (Choudhury and Bhattacharjya, 2006).
- Due to years of reckless over-exploitation, stocks of major fishes got depleted in most rivers and its associated wetlands of the region. Absence of regulation or inadequate mechanism has resulted in reduced auto-stocking and fish yield.
- Prevalence of clan lands and absence of land ownership rights by individuals in the tribal/ hilly areas causes serious problems in getting financial support from the financial institutions (Sugunan, 2003), because mortgaging of land as security for loan is particularly impossible under such a situation.
- Non-availability of funds for fisheries development is a serious economic constraint for fisheries development in the region especially in large open water bodies. A substantial proportion of the

resources of Northeast comprise of capture or culture-based fisheries, development and management of which requires higher initial costs, compared to pond aquaculture. In addition, poor post-harvest infrastructure and exploitation by middlemen results in low share of fishers/ fish farmers in consumer's rupee.

- A few more constraints having technical (including environmental) and socio-economic ramifications are: reduction in productive beel area because of inclusion under wildlife (mainly bird) sanctuaries; absence of clear policy on multiple uses of open waters; lack of alternative employment opportunities for fishers and so on.

## Fish production in Northeast India

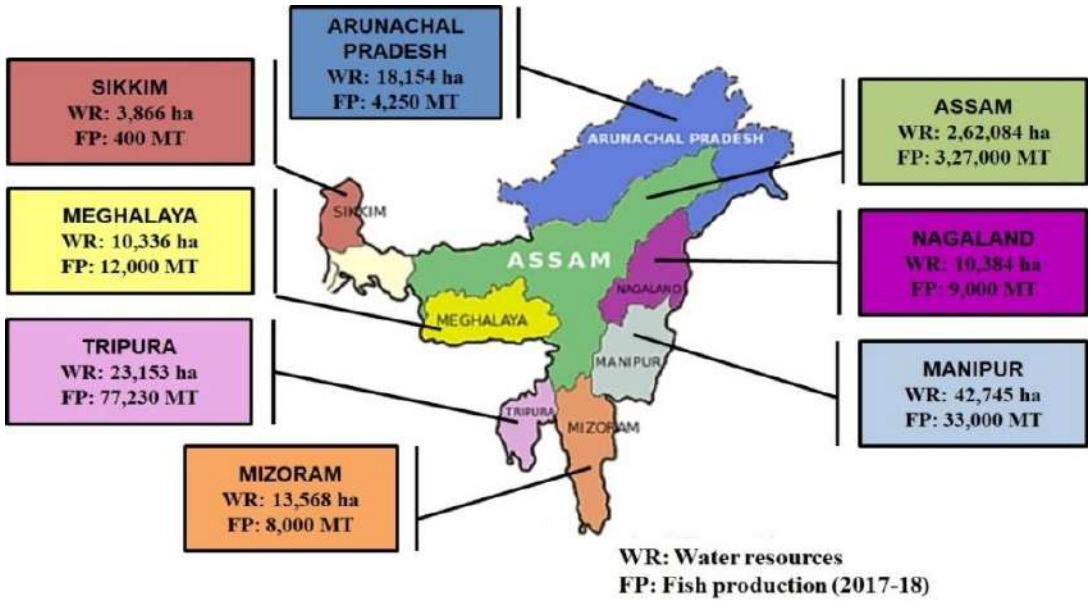



**Fig. 1: States of NE India with water resources and fish production (2017-18)**

The time-series data from 1999–2000 to 2017–2018 on fish production of different states of Northeast states of India is presented in table 2.During 2017–18, the region produced 470.88 thousand MT of fish with an annual compound growth rate of 4.53%. The highest growth rate in fish production

among all NE states has been observed in Tripura (11.41%) and less than 4% in the states of Arunachal Pradesh, Meghalaya and Nagaland. Contribution of fish production from the culture and capture fisheries differs across the states, but taken together, these two sectors contributed equally to the total production of the region (Barman *et al*., 2012). However, few states produced major share from aquaculture sector, for example, in the states of Nagaland (100%), Mizoram (89%) and Tripura (95%). Assam is the major contributor in fish production of the region, which produced 69.4% (327 thousand MT) of total fish production during 2017–18. Sikkim is the least contributor (<0.1%) in the total fish production of the region.

**Table 2.Time-series data on fish production (000't) in Northeast India**

| Year | AP | AS | MN | ML | MZ | NL | SK | TR | NE India |
|---|---|---|---|---|---|---|---|---|---|
| 1999 – 00 | 2.40 | 159.77 | 15.51 | 4.68 | 2.89 | 5.00 | 0.14 | 14.02 | *204.41* |
| 2000 – 01 | 2.50 | 158.62 | 16.05 | 6.18 | 2.86 | 5.50 | 0.14 | 14.35 | *206.20* |
| 2001 – 02 | 2.60 | 161.45 | 16.45 | 4.97 | 3.15 | 5.20 | 0.14 | 14.70 | *208.66* |
| 2002 – 03 | 2.60 | 165.52 | 16.60 | 5.37 | 3.25 | 5.50 | 0.14 | 16.15 | *215.13* |
| 2003 – 04 | 2.65 | 181.00 | 17.60 | 5.15 | 3.38 | 5.56 | 0.14 | 17.98 | *233.46* |
| 2004 – 05 | 2.70 | 186.31 | 17.80 | 5.64 | 3.68 | 4.90 | 0.14 | 19.84 | *241.01* |
| 2005 – 06 | 2.75 | 188.01 | 18.22 | 4.12 | 3.75 | 5.50 | 0.15 | 23.87 | *246.37* |
| 2006 – 07 | 2.77 | 181.48 | 18.61 | 5.49 | 3.76 | 5.80 | 0.15 | 28.63 | *246.69* |
| 2007 – 08 | 2.83 | 190.32 | 18.80 | 4.00 | 3.76 | 5.80 | 0.18 | 36.25 | *261.93* |
| 2008 – 09 | 2.88 | 206.15 | 18.60 | 3.96 | 2.89 | 6.18 | 0.17 | 36.20 | *277.02* |
| 2009 – 10 | 2.65 | 218.82 | 19.20 | 4.21 | 3.04 | 6.36 | 0.17 | 42.27 | *296.72* |
| 2010 – 11 | 3.15 | 227.24 | 20.20 | 4.56 | 2.90 | 6.59 | 0.18 | 49.23 | *314.05* |
| 2011 – 12 | 3.30 | 228.62 | 22.22 | 4.77 | 2.93 | 6.84 | 0.28 | 53.34 | *322.30* |
| 2012 – 13 | 3.71 | 254.27 | 24.50 | 5.42 | 5.43 | 7.13 | 0.49 | 57.46 | *358.41* |
| 2013 – 14 | 3.62 | 266.70 | 28.58 | 5.75 | 5.94 | 7.47 | 0.42 | 61.95 | *380.43* |
| 2014 – 15 | 4.00 | 282.70 | 30.50 | 6.04 | 6.39 | 7.84 | 0.44 | 65.16 | *403.07* |
| 2015 – 16 | 4.05 | 294.20 | 32.04 | 11.34 | 6.83 | 8.22 | 0.40 | 69.06 | *426.14* |
| 2016 – 17 | 4.11 | 306.60 | 32.00 | 12.00 | 7.63 | 8.61 | 0.40 | 72.45 | *443.80* |
| 2017 – 18 | 4.25 | 327.00 | 33.00 | 12.00 | 8.00 | 9.00 | 0.40 | 77.23 | *470.88* |
| ACGR* | 3.22 | 4.21 | 4.50 | 3.71 | 5.29 | 3.24 | 8.17 | 11.41 | 4.53 |

***Source:***DoF-GoI (2019)
****ACGR:** Annual Compound Growth Rate (Estimated)*

## Disposition of fish varieties in fish production

In this section, an attempt has been made to present the contribution of major fish groups to the total production of the state. The absolute quantities will not be much of interest as the total fish production varied widely across the states and hence the percentage of each group to the total fish production of the concerned state is presented in Table 3. When the entire Northeast region is considered, 46.55% of total fish production is contributed by Indian major carps (catla, rohu and mrigal), 19.65% by exotic carps (common carp, grass carp, silver carp etc) and 14.84% by minor carps (reba, gonia, kalbasu, bata etc.). However, exotic carps contribute about 55% of total fish production in Manipur. It is notable that Sikkim does not report production of Indian major or minor carps. It is to be noted that the contribution data of Mizoram state indicates an improper documentation, as the production of different fish groups is similar in proportions.

**Table 3: Production (MT) of different fish varieties in NE Region during 2017-18***

| State | Major Carps | Minor Carps | Exotic Carps | Murrels | Catfishes | others | NE India |
|---|---|---|---|---|---|---|---|
| **Arunachal Pradesh** | 2,010 (47.29) | 200 (4.75) | 1,820 (42.82) | 0 (0.00) | 0 (0.00) | 220 (5.18) | 4,250 (100) |
| **Assam** | 1,36,221 (45.00) | 53,435 (17.65) | 45,408 (15.00) | 9,535 (3.15) | 15,770 (5.21) | 42,348 (13.99) | 3,02,717 (100) |
| **Manipur** | 9,030 (36.13) | 1,290 (5.16) | 13,650 (54.62) | 595 (2.38) | 97 (0.39) | 330 (1.32) | 24,992 (100) |
| **Meghalaya** | 4,303 (38.76) | 915 (8.24) | 3,839 (34.59) | 209 (1..89) | 256 (2.31) | 1,579 (14.22) | 11,100 (100) |
| **Mizoram** | 1,274 (16.67) | 1,274 (16.67) | 1,274 (16.67) | 1,274 (16.67) | 1,274 (16.67) | 1,274 (16.67) | 7,643 (100) |
| **Nagaland** | 4,369 (48.59) | 58 (0.64) | 4,308 (47.91) | 16 (0.17) | 85 (0.94) | 156 (1.74) | 8,991 (100) |
| **Sikkim** | 0 (0.00) | 0 (0.00) | 200 (50.00) | 0 (0.00) | 0 (0.00) | 200 (50.00) | 400 (100) |
| **Tripura** | 46,348 (60.03) | 7,718 (10) | 15,444 (20) | 1,537 (1.99) | 3,855 (4.99) | 2,311 (2.99) | 77,215 (100) |
| **Total** | 2,03,555 (46.55) | 64,890 (14.84) | 85,943 (19.65) | 13,166 (3.01) | 21,337 (4.88) | 48,418 (11.07) | 4,37,308 (100) |

***Source:***DoF-GoI (2019)

**Figure in the parentheses indicates the percentage contribution to total State fish production*

## Production of fish seed

The availability of quality fish seeds is always the cause of concern in all states of the region. Table 4 indicates the status and trend of fish seed production in different states of the region. The growth rate in fish seed production in the region is quite impressive. In 2017–18, the region produced a total of 8795 million fry with an annual compound growth rate of 7%.

**Table 4: Fish seed production in NE during 2008-18 (values in million fry).**

| Year | AP | AS | MN | ML | MZ | NL | SK | TR | NE India |
|---|---|---|---|---|---|---|---|---|---|
| 2008 – 09 | 27.00 | 3429.00 | 125.00 | 1.13 | 16.50 | 48.50 | 3.20 | 305.50 | *3955.83* |
| 2009 – 10 | 29.00 | 3326.00 | 127.00 | 1.21 | 17.00 | 48.10 | 3.80 | 301.00 | *3853.11* |
| 2010 – 11 | 27.20 | 4263.00 | 134.00 | 2.96 | 16.60 | 47.50 | 3.00 | 602.00 | *5096.26* |
| 2011 – 12 | 22.90 | 3624.00 | 134.00 | 2.96 | 17.30 | 49.50 | 3.00 | 730.00 | *4583.66* |
| 2012 – 13 | 4.10 | 4364.00 | 139.00 | 2.18 | 54.00 | 48.00 | 2.10 | 700.00 | *5313.38* |
| 2013 – 14 | 9.64 | 4546.00 | 157.00 | 3.14 | 30.00 | 48.50 | 2.05 | 798.00 | *5594.33* |
| 2014 – 15 | 5.00 | 5793.00 | 167.00 | 7.05 | 30.00 | 47.70 | 2.95 | 328.56 | *6381.26* |
| 2015 – 16 | 5.50 | 5678.00 | 219.00 | 11.07 | 31.00 | 47.80 | 2.02 | 298.76 | *6293.15* |
| 2016 – 17 | 6.50 | 6758.00 | 215.00 | 7.56 | 31.00 | 48.00 | 2.32 | 313.70 | *7382.08* |
| 2017 - 18 | 7.00 | 8000.00 | 250.00 | 9.70 | 42.60 | 48.10 | 2.65 | 435.00 | *8795.05* |
| ACGR* | 4.64 | 7.97 | 5.87 | 27.09 | 8.04 | 0.35 | 3.36 | 9.32 | 7.00 |

***Source:*** DoF- GoI (2019)
****ACGR:*** *Annual Compound Growth Rate (Calculated), it is estimated for AP (from 2012 to 2018), Sikkim (from 2012 to 2018), Tripura (from 2014 to 2018) due to irregular trend.*

## Fish consumption in Northeast India

The annual growth rate of per capita fish consumption (India) during 2000 to 2006 was 1.7%, whereas the same is projected to be 0.8% by 2030. Keeping these two values in mind and also considering the high preference of NE people towards fish, a holistic ACGR of 1.5% was decided to be used for estimation in consultation with experts. The overall annual per capita fish consumption of Northeast region is estimated to be 6.48 kg in rural areas and 8.70 kg in urban areas during 2017-18.

Tripura has the highest annual per capita fish consumption than other states of the region during the same period. The least per capita consumption has however observed in the state of Sikkim. NE region has showed higher annual per capita fish consumption (7.59 kg) than the national average (less than 5 kg) and it is higher in both rural and urban areas. It is also interesting to note that the national average annual per capita fish consumption is higher in rural areas than in urban areas, unlike the Northeast region.

**Table 5.Annual per capita fish consumption (kg) in Northeast India during 2009–18**

| NE Sates | 2009 – 10* | | | 2011 – 12* | | | 2017-18** | | |
|---|---|---|---|---|---|---|---|---|---|
| | R | U | Avg. | R | U | Avg. | R | U | Avg. |
| Arunachal Pradesh | 8.45 | 9.35 | 8.90 | 6.96 | 7.76 | 7.36 | 9.52 | 10.53 | 10.02 |
| Assam | 8.23 | 11.89 | 10.06 | 7.98 | 9.20 | 8.59 | 9.27 | 13.40 | 11.33 |
| Manipur | 4.10 | 6.11 | 5.11 | 5.54 | 6.84 | 6.19 | 4.62 | 6.88 | 5.75 |
| Meghalaya | 4.12 | 5.05 | 4.58 | 4.84 | 6.20 | 5.52 | 4.64 | 5.69 | 5.16 |
| Mizoram | 2.40 | 2.68 | 2.54 | 2.11 | 2.44 | 2.27 | 2.70 | 3.01 | 2.86 |
| Nagaland | 4.21 | 6.74 | 5.48 | 3.42 | 5.78 | 4.60 | 4.74 | 7.60 | 6.17 |
| Sikkim | 0.46 | 2.12 | 1.29 | 0.12 | 0.73 | 0.43 | 0.51 | 2.39 | 1.45 |
| Tripura | 14.12 | 17.86 | 15.99 | 12.83 | 17.74 | 15.29 | 15.91 | 20.11 | 18.01 |

***Note:*** *R = Rural areas, U = Urban areas, Avg. = Average*
***Source:** NSSO (66$^{th}$ round) report, 2012 and NSSO (68$^{th}$ round) report, 2014*
***Estimated with ACGR of 1.5% considering base-year 2009 – 10, FAO (2013)*

## Fish production vi-a-vis requirement by 2030

Off late, the nutritional aspect of food intake has been given due emphasis at national level and subsequently, strategies are being taken up at micro level for the same. Fish is consumed as a source of animal protein and it may be a parallel substitute to other animal protein sources like meat, eggs and other plant protein especially pulses for a non-vegetarian Indian. So, the specific nutritional requirement through fish will depend on the intake of other protein sources in the form of meat, eggs and pulses. The data presented in the table 6 indicates the requirement of fish by 2030 against the level of production during 2017-18. While calculating the requirement, 11 kg of fish per capita per annum as suggested by Barman *et al.* (2012) has been considered for non-vegetarian people of Northeast India.

Population data of Census 2011 has been projected for the year 2030 using an average annual growth rate of 1.1 % per annum and considered for this estimation. The annual per capita requirement of fish i.e. 11 kg is multiplied by fish eating population separately for each state so as to determine the requirement for the entire region. Total requirement of fish in the region has been estimated to be 4.99 lakh MT and 5.76 lakh MT during 2018 and 2030, respectively. While comparing these figures with its respective level of production during 2018 and projected production of 2030, it has been observed that North East region is presently in deficit in production by 28 thousand MT. However, by 2030 the region is expected to achieve a surplus production of nearly 29 thousand MT, given the fact that the trend of production remains similar with per capita requirement of 11 kg fish per annum.

**Table 6: Fish production and its requirement in North East Region by 2030**

| States | % fish eating population | Fish production ('000 MT) during 2017-18 | Fish requirement ('000 MT) during 2017-18 | Surplus/ deficit ('000 MT) | *Estimated Fish production ('000 MT) by 2030 | **Estimated Fish requirement ('000 MT) by 2030 | Surplus/ deficit ('000 MT) |
|---|---|---|---|---|---|---|---|
| A.P | 99 | 4.250 | 16.381 | (-) 12.131 | 6.013 | 18.902 | (-) 12.889 |
| AS | 90 | 327.000 | 335.839 | (-) 8.839 | 509.383 | 387.523 | (+) 121.860 |
| MN | 90 | 33.000 | 30.734 | (+) 2.266 | 53.357 | 35.464 | (+) 17.893 |
| ML | 90 | 12.000 | 31.930 | (-) 19.930 | 12.073 | 36.844 | (-) 24.771 |
| MZ | 100 | 8.000 | 13.120 | (-) 5.120 | 12.146 | 15.139 | (-) 2.993 |
| NL | 99.5 | 9.000 | 23.541 | (-) 14.541 | 12.478 | 27.163 | (-) 14.685 |
| SK | 80 | 0.400 | 5.841 | (-) 5.441 | 1.114 | 6.740 | (-) 5.626 |
| TR | 95 | 77.230 | 41.736 | (+) 35.494 | 258.786 | 48.159 | (+) 210.627 |
| NE Region | | 470.880 | 499.112 | (-) 28.242 | 865.351 | 575.934 | (+) 289.417 |

*# Population has been projected using 1.2 % annual growth rate with base year 2011 census*
**Production has been projected using linear regression after taking log value*
***Considering annual per capita fish requirement of 11 kg, Barman et al (2012)*

## Impact of lockdown due to COVID 19 on Northeast fisheries sector

Economic activity came to standstill for nearly two months due to declaration of lockdown by Government of India on March 24, 2020. Everyone has been impacted due to the pandemic situation, and fisheries sector including its entire supply chain associated with it is no exception. Fishermen across the economic spectrum, the large scale mechanized fleets to the small scale fishers across the coastline have suffered an economic blow due to the lockdown. Given the fact that the marine capture fishing is already a stressed sector, the loss of fish has created a dent in the economy and food security for a number of people. It has been observed that at the very beginning of Lockdown 1.0, farmers faced a lot of problem to distribute the harvest and faced financial loss due to sudden stuck in fish supply chain, including the components like transportation, traders, labour, cold storage etc. Again, we could find important decisions of Government of India regarding the exemptions on fisheries activities during the later stage of Lockdown 1.0. Dynamics of fish supply chain and consumption pattern was also affected in Northeast region during the period. The following are some of the observation that needs attention from all stakeholders.

1. Sudden standstill in activities like transportation, labour, cold storage facilities etc. made substantial loss to traders during initial period of lockdown.
2. At the initial stage of lockdown, there was a sudden leftward (negative) shift in the supply curve, as the supply of fish from other states of mainland like Andhra Pradesh, West Bengal etc. and neighbouring country Bangladesh was brought to standstill as explained in fig 2. It caused rise in the level of fish price of the fish during initial period of lockdown. Effect of lockdown acted as one of the externalities in respect to fish supply chain of North East especially while outsourcing the fish.
3. The negative or leftward shifting of supply curve raised the price of fish and created a scope for marketing of fish produced by local fish producers. Here, the word ‘local’ indicates extremely a small area where transportation was not a constraint to distribute the fish to nearby market.
4. Again, supply of locally produced fish was not spontaneous as it was not sufficient to meet high demand of fish. The rise in the price of fish was not similar across different locations of

North East during lockdown; it was influenced by availability and supply of fish by local producers.

5. Over time, the supply chain is expected to shift back to normal when effect of externalities caused by lockdown will halt.
6. Rise of fish price in many rural and urban markets across the different states of the region proved the importance of local fish production and scope for income generation through of fish farming in the region.
7. Inward migration of substantial numbers of rural youths from mainland to their own North East Region is a matter of serious concern for employment generation. These youths may be motivated for income generation through fish farming within their native region using potential resources.

The above mention issues are based on expert opinion and subject to social science research.

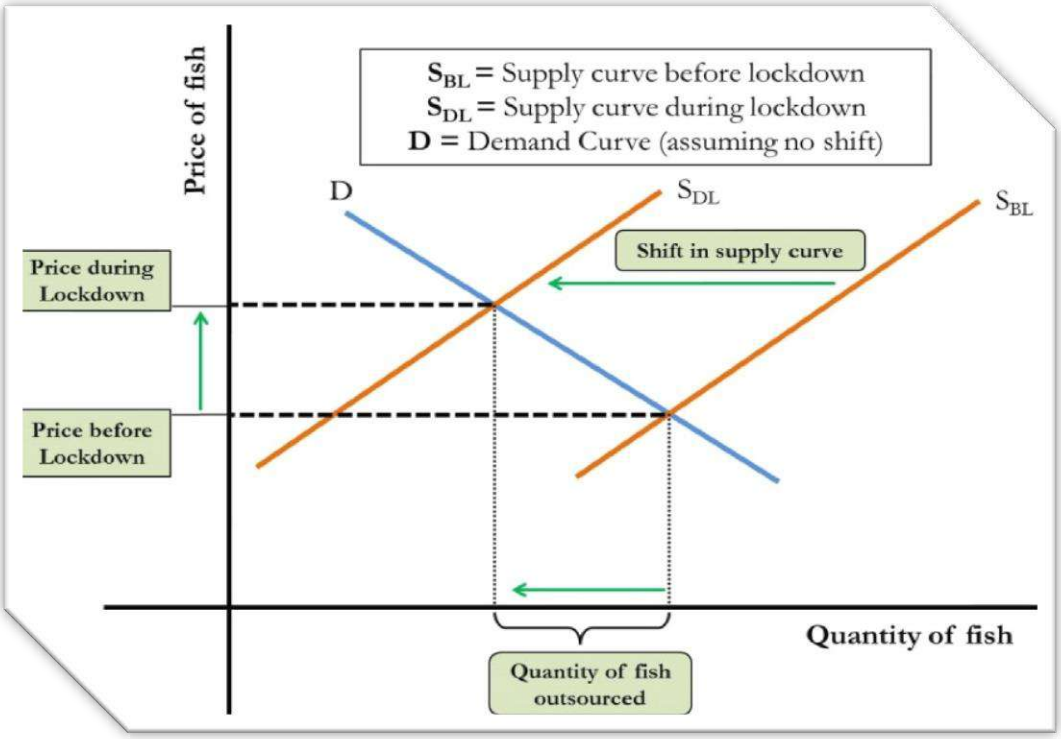



**Fig 2: Shift supply curve of fish in Northeast India due to lockdown**

## Opportunities and strategies for increasing fish production

The potential fish production from different resources in Northeast (Sugunan, 2007) is still not achieved due to a number of reasons. It is unequivocally felt that there exists large opportunities for development of culture and capture fisheries in the region. As the distribution of fishery resources are not uniform and fish consumption pattern also varies across different states, therefore it is necessary to workout location-specific strategies for improving fish production. The region is unable to meet the present demand through fish production, though it has huge potential. Further, the annual per capita requirement of fish i.e. 11 kg (Barman *et al*., 2012) is yet to be achieved; in fact the average annual per capita fish consumption is 69% of that i.e. 7.59 kg kg (2017-18).

**Table 6: Fish yield and potential for different fisheries resources in NE India**

| Fisheries resources | Fish yield (kg/ha/year) | |
|---|---|---|
| | Present | Potential |
| Ponds/ mini-barrages | 600 – 2800 | 2500 – 4000 |
| Beels | 14 – 488 | 100 – 300 (capture) |
| | | 500 – 750(enhancements) |
| | | 1500 – 2000 (aquaculture) |
| Reservoirs | 50 – 100 | 300 – 500 |
| Paddy-cum-fish | 400 – 600 | 1000 |
| Rivers | 50 – 100 | 200 – 2000 |

***Source:*** *Sugunan (2007)*

The strategy for realising the potential of the fisheries sector comprises efficient management of the natural water bodies such as rivers, beels and lakes; developing culture-based fisheries in the beels and reservoirs; extending the proven aquaculture technologies to all the ponds; and bringing more areas under paddy-cum-fish culture. By following such a combined strategy, it would be possible to raise the region's fish production substantially, thereby narrowing the deficit. However, the following areas also need attention from all stakeholders.

- Pen culture in beels of Assam has proven itself to be economically viable with positive benefit-cost ratios (Bhattacharjya, 2003 and 2011; Katiha *et al.*, 2005; Gorai *et al.*, 2006; Chandra, 2010;

Bhattacharjya *et al.*, 2015) for culture of varieties of major, minor and exotic carps, which has also enhanced fish production in Takmu pat of Manipur (Bhattacharjya *et al*., 2020) and improved economic conditions of the wetland fishers (Yengkokpam *et al*., 2020). Therefore, the respective state govt. should emphasize for development of pen culture across the beels and wetlands of the region.

- A judicial use of artificial feeds in fish culture systems of Northeast region should be advocated to increase the productivity leading to boosting of total fish production (Debnath and Yengkokpam, 2017).
- In order to minimize multi-user conflicts in marginal/ waste land, an integrated basin development plan should be drawn for the resources through participation of all stakeholders i.e. through co-management. Ensuring equitable distribution of benefits accrued from the resource among the riparian communities will help reduce the resultant social problems (Bhattacharjya, 2004).
- Regulation of fishing requires formulation of practical conservation methods suiting local conditions (e.g., minimum landing size is more practicable than mesh size regulation in case of multi-species fisheries). Empowerment of fisheries officials for enforcement, strengthening fishers' cooperative societies and creation of mass awareness among the fishers and beel managers are different options (Choudhury and Bhattacharjya, 2006).

## Conclusion

The fishery sector is an important sector for socio-economic development of Northeast region. Northeast India has witnessed an impressive growth in fish production during last few years, though it is not uniform across the states mainly due to diverse topography and availability of water resources. The production possibility frontier of fish production in this region is yet to be harnessed if we consider the potential of available water resources alongside the available technology backup with fisheries research institute. People of this region have very high preference for animal protein in general and fish protein in particular. It has boosted up the demand of fish in the region and almost all the states are presently outsourcing fish to meet the consumption requirement. Fish supply chain in the region, its distribution and marketing, including the fish production-consumption dynamics and demand-supply pivot is substantially affected by nationwide lockdown imposed to control the outbreak of pandemic COVID-19 during early 2020.

The fish price dynamics during lockdown has proved the market potentiality of fish at local level across different states and showed opportunities for income generation through fish farming by inward migrant youths. However, potential of fisheries sector for further improvement in fish production and productivity is very high, and regional demand of food fish can be fulfilled with efficient combination of resource utilization and technology backup. Likewise, on the development side, the government department and financial institutions will have to play a facilitating role and the capital needs of the fishers are also to be met by the concerned agencies. The overall development of capture and culture fisheries will provide more livelihood to the people of the region. Thus, concerted efforts are needed on the part of all concerned to realise the high fish production potential of all available aquatic resources, thereby contributing to the overall socio-economic development of the region. The information presented here indicates enormous potential of the untapped fisheries resources of Northeast India, which not only can meet the regional demand for fish, but also can supply to the rest of the country in next few years.

## References

1. Bareh, H.M. 2001. Encyclopaedia of Northeast India, Vol. I-VIII. Mittal Publications, New Delhi, India.
2. Barman D., Mandal S.C., Kumar V. 2012.Aquaculture status and potential in the northeastern region of India. World Aquaculture, pp. 26-31.
3. Bhattacharjya, B.K. 2003.Enhancement tool for augmenting fish production from floodplain wetlands. In: Vinci, G.K., Jha, B.C., Bhaumik, U., Mitra, K. (Eds.), Fisheries management of floodplain wetlands in India, CIFRI Bull. No. 125, Central Inland Fisheries Research Institute, Barrackpore, India, p. 34-42.
4. Bhattacharjya, B.K. 2004. Floodplain wetlands of Assam: management options and issues from the fisheries perspective. In: Choudhury, M.C., Srivastava, N.P., Manna, R.K. (Eds.), Participatory approach to management of inland fisheries resources of northeastern India, Bull. No. 135, Central Inland Fisheries Research Institute, Barrackpore, India.
5. Bhattacharjya, B.K. 2011.Management guidelines for floodplain wetlands of North-east India. In: Gogoi, A.K., Bhattacharjya, B.K., Singh, A.K., Debnath, D., Yengkokpam, S. (Eds.),

Training manual on Recent advances in management of fisheries and aquaculture in North-east region of India. Zonal Project Directorate, Zone-III, ICAR Research Complex for NEH Region, Barapani, Meghalaya, India, p. 1-11.

6. Bhattacharjya, B.K., Yengkokpam, S., Gogoi, P., Sarma, K K., Debnath, D. 2015. Rearing of carried over carp seed in pen enclosure in a closed floodplain wetland of Assam. J Inland Fish Soc India 47, 43-48.
7. Bhattacharjya, B.K.. Debnath, D., Yengkokpam, S., Anal, T.V., Singh, N.D., Parvin B.R., Saikia, S., Das, B.K. 2020. Upscaling of pen aquaculture technology for enhancing fish production in Takmu pat of Manipur. In: Book of Abstracts, International Conference on 'Ecosystem health and fisheries of Indian inland waters: multiple stressors, management and conservation'. College of Fisheries, GB Pant University of Agriculture & Technology, Pantnagar, Feb. 17-19, p. 87.
8. Chandra, G. 2010. Impact of adoption of pen culture technology on well-being of fishers of Haribhanga wetland in Assam.Indian Res J Ext Edu 10, 61-65.
9. Choudhury, M., Bhattachariya, B.K. 2006. Fisheries resources of northeastern region of India: management issues and strategies. In: Vass, K.K., Mitra, K.K., Suresh, V., Kathia, P.K., Srivastava, N.P. (Eds.). River fisheries in India: issues and current status. Inland Fisheries Society of Inland, Barrackpore, Kolkata, India.
10. DAHDF-GoI. 2014. Handbook on Fisheries Statistics 2014. Fisheries Statistics Unit, Fisheries Division, Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Govt. of India, New Delhi.
11. Debnath, D., Yengkokpam, S. 2017. Fish feeds and self-sufficiency in fish production. The Assam Tribune, Vol. 79, No. 171 (June 26, 2017), Guwahati, India.
12. DoF-GoI. 2019. Handbook on Fisheries Statistics 2018. Fisheries Statistics Division, Department of Fisheries, Ministry of Fisheries, Animal Husbandry & Dairying, Govt. of India, New Delhi.
13. Gorai, B.K., Sugunan, V.V., Jha, B.C. 2006. Raising of stocking materials of Indian major carps in pen enclosures in selected floodplain wetlands of Assam, India. Asian Fish Sci 19:185-197.

14. Jhingran, V.G. 1991. Fish and fisheries of India.3rd edition.Hindusthan Publishing Corp., New Delhi, India.
15. Katiha, P.K., Dutta, S., Barik, N.K. 2005. Pen culture for fish seed raising in beels of Assam: Economics and constraints. J Inland Fish Soc India 37, 23-29.
16. Krishnan, M., Debnath, B. 2019. Can fish production from own resources meet fish consumption demand in North East India? In: Patel, A.B., Pandey, P.K., Gon Choudhury, T., Priyadarshini, B. (Eds.), Souvenir of 31st All India Congress of Zoology & National Seminar on Climate-smart Aquaculture and Fisheries, January 15-16, 2019, North East Society for Fisheries and Aquaculture, Lembucherra, Tripura, India, pp. 39-45.
17. NSSO. 2012. Household Consumption of Various Goods and Services in India: 2009 – 10: NSS 66st Round, (Report No. 541/66/1.0/3): Available [online]: http://mospi.nic.in/ Mospi_New/upload/nss_report_541.pdf [accessed on November, 2018].
18. Sugunan, V.V. 2007. Development of fisheries in north-eastern India – potential and constraints. In: Compendium of lectures. HRD programmes on Recent Advances and Technologies for Fisheries development in North Eastern Region for KVK staff. Central Inland Fisheries Research Institute, Guwahati, India.
19. Sugunan, V.V., 2003. Fisheries resources potential of Northeastern region. In: Mahanta, P.C., Tyagi, L.K. (Eds.). Participatory approach for fish biodiversity conservation in Northeast India, Workshop Proceeding, NBFGR, Lucknow, India.
20. Yengkokpam, S., Debnath, D., Bhattacharjya, B.K., Debroy, P., Singh, N.D., Anal, T.V., Parvin, B.R., Saikia, S. 2020. Pen aquaculture demonstration in Takmu pat of Manipur led to improved economic condition of the wetland fishers. In: Book of Abstracts, International Conference on 'Ecosystem health and fisheries of Indian inland waters: multiple stressors, management and conservation'. College of Fisheries, GB Pant University of Agriculture & Technology, Pantnagar, Feb. 17-19, p. 125.

# IFS-A SUITABLE FARMING OPTION FOR SMALL AND MARGINAL FARMERS

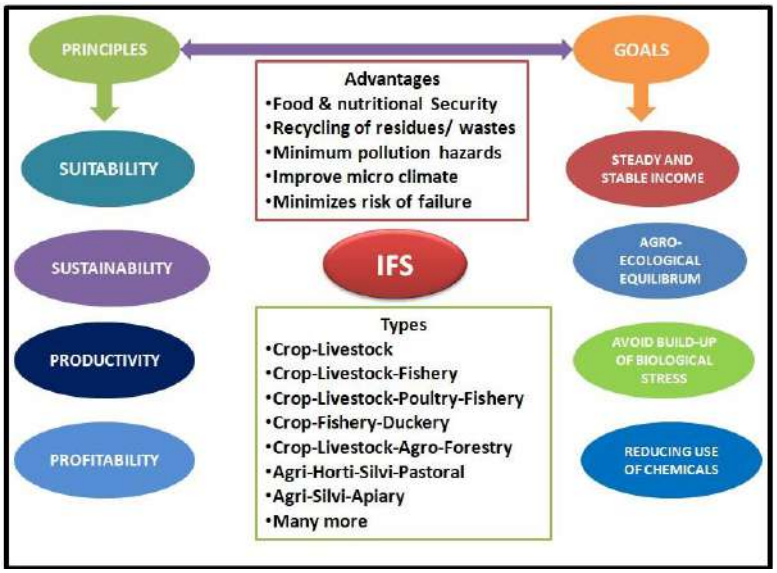
**Azriel M. Tariang**

Integrated Farming System (IFS) is the type of farming system or practice which utilizes waste products from one farming enterprise as an input for another farming enterprise such as the use of horticulture or field crop waste for utilization as animal feed of fodder, compost and vice versa. It is an eco-friendly approach towards a more efficient mode of farming (Gupta *et al,* 2020). An effective IFS involves the efficient use of waste materials generated from different farming enterprises within a farm as productive inputs for consecutive farming enterprises and relying less and less on external inputs such as fertilizers and other synthetic form of inputs.

With the declining operational farm holding per capita in India due to increasing population throughout the country coupled with poverty among the small and marginal farming community, there is practically no scope for horizontal expansion of land for agriculture. Among the possible solutions for food sovereignty amongst the small and marginal farmers in the country may be the IFS. It employs most of the improved farming practices such as vertical farming, efficient resource utilization, effective cost reduction techniques through input-output enterprise relationship and maximum utilization of farming land per unit area. IFS may also be the solution to modern farming problems which is currently being faced by the farmers of the country due to depleted soil and water quality.

## Primary Objectives and Goals of IFS

- Integration of different farm production systems such as agricultural crops, horticultural crops, fisheries, livestock, poultry, apiculture, sericulture etc., in
- such a way that leads to
- mutual benefit between the different farming systems.



- Increase use of farm resources for higher income generation per unit area and better employment generation.
- Promotion of intercropping of crops for high economic return in addition to proper land and soil management.
- To maintain healthy eco-system, ecological sustainability and overall environmental quality.

According to Gupta *et al*. (2020), the primary goals of IFS are:

- Maximization of yield from all the component enterprises for steady and stable income.
- Achieving agro-ecological equilibrium
- Practicing of natural cropping system management for avoiding high incidences of insect-pest, diseases and weed infestations.
- Complete exclusion or reduced use of synthetic chemicals in farming practices.

## Different types of Integrated Farming System

The different types of IFS commonly practiced in India can be based on different agro-ecosystem such as dry land, wet land and irrigated land ecosystems. The enterprises usually linked to such systems under the different ecosystems can be a combination of either two or more which is described as under:

- Dry land – Agriculture, horticulture, cattle, dairy, poultry, goat/sheep, agro-forestry, fishery, piggery etc.
- Wet land – Agriculture, horticulture, piggery, poultry, cattle, fishery, duckery, mushroom, apiary etc.
- Irrigated land – Horticulture, cattle, dairy, poultry, piggery, mushroom, apiary, Sericulture etc.

However, the combination of enterprises may also be based on other factors, including the demand of a particular commodity in an area, land management, availability of resources, location of the IFS and even upon the farmer's desires. The governing idea behind multi-enterprise agriculture system or integrated farming is to facilitate a farmer in adopting different forms of farming enterprises in his farm. The major factors to consider suitable models for IFS are soil types, rainfall and its

distribution, topography and length of growing season of suitable crops. The following are some of the combinations that are followed across different locations.

- Agriculture alone with different crop combinations
- Agriculture with livestock
- Agriculture with livestock and poultry
- Agriculture cum fishery cum duck cum poultry
- Agriculture with livestock, poultry, fishery and biogas
- Agriculture with horticulture and sericulture
- Agro-forestry and Silvipasture
- Paddy cum fishery
- Paddy cum fishery and mushroom cultivation
- Floriculture and apiary
- Fishery cum duck cum poultry; and many more.

## Advantages of IFS

Integrated Farming has several advantages as it is multidisciplinary in nature and is highly effective in solving the problems of small and marginal farmers (Kumar *et al*., 2018). The main advantages of IFS are as follows:

- Promotion of diversification as a form of risk reduction to monoculture.
- Establishing multiple source of income with the aim for year round income generation through multi-enterprise agriculture.
- Proper management of resources such as farm land, labour, capital and time.
- Effective recycling of byproducts and farm wastes.
- External input reduction in the forms of livestock feed, manure and fertilizers.
- Possibility of life saving irrigation of crops during dry period through pond irrigation.

In simple terms, the whole process of IFS leads to better utilization of resources of time, capital and energy and the output from which may lead to the following outcomes:

- **Higher productivity:** IFS leads to increase in economic yield per unit area and per unit time through intensification in cropping, livestock and other enterprises with less external input.
- **More profitability:** With increase in productivity and improved waste management practices, the cost of production of any given enterprise can be reduced to a large extent, thereby pocketing more profit.
- **Sustainability:** The effective utilization of farm waste leads to the incorporation of more amounts of organic compound into the soil. Moreover, the use of chemical fertilizers and other synthetic compounds gets drastically reduced and thus sustaining the health of soil in the long run.
- **Environment safety:** Reduction in the use of synthetic compounds and effective recycling of waste materials leads to more holistic development in and around the farm and thereby promotes a safe and healthy farming system.
- **Year round income generation:** Year round income generation can be realized from IFS due to multi-enterprise farming system.
- **Effective nutrient management:** Waste from the various agricultural enterprises and livestock are usually converted to nutrient rich composts and manures which are then incorporated as inputs in the production of other enterprises such as crops and fisheries. Livestock waste when utilized for biogas generation provides necessary fuel for household and the biogas sludge as manure for cultivation of vegetables and other crops. Recycling of crop residues and animal waste is highly efficient since approximately 70-80% of micronutrients remain in the biomass as well as animal wastes (Inman *et al.* 2005).

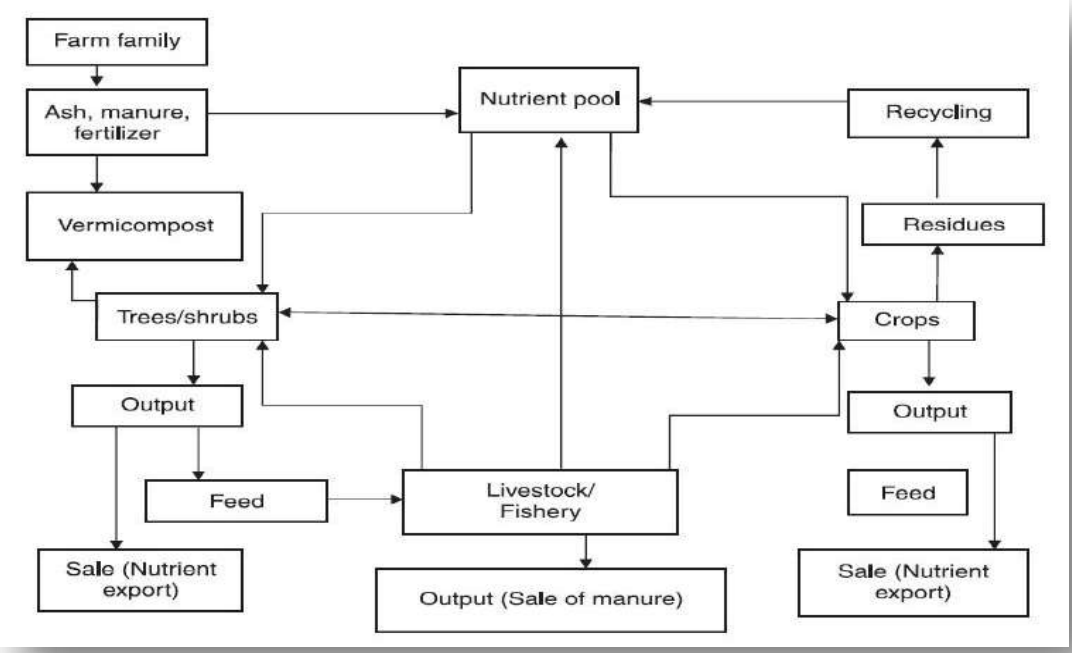
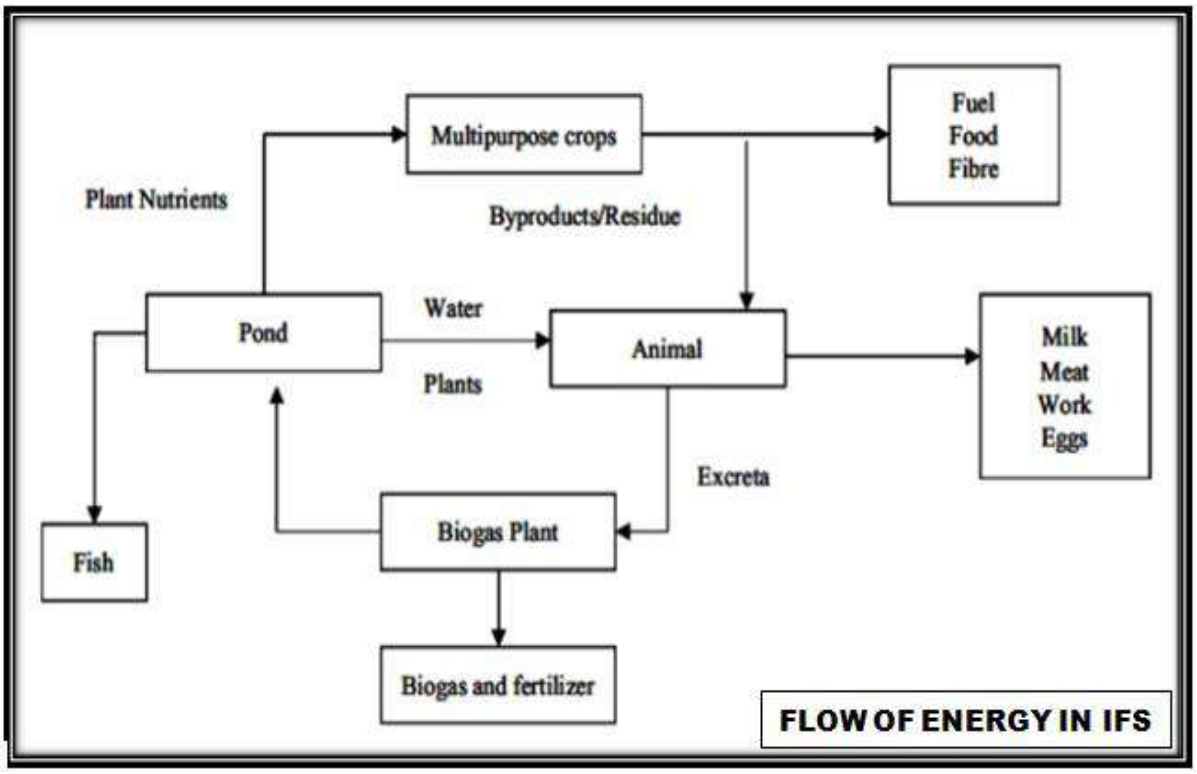



Fig 1: Flow of nutrients in IFS (Kumar *et al.* 2018)

- **Employment generation:** IFS usually requires labour throughout the year, especially one with livestock enterprise to look after the farm animals. Hence, employment generation is possible throughout the year.
- **Feed production:** The plantation of fodder feed and legumes can be effectively planted as the land is judiciously utilized. Fodder and other crop waste can be stored by preparing silage for future use.
- **Ease in adoption of improved technologies:** Farmers are easily motivated in adopting new technologies when the productivity of the farm increases and particularly when there is a possibility of increasing the farm's income. In the adoption of improved agricultural practices for income improvement of a farm, the farmers are always sensitive to financial gains of the farming practice. Higher the benefit obtained from the introduced system; the easier it is to persuade the farmers to adopt them in their farms (Ponnusamy *et* al., 2017).

- **Small scale industrialization:** The increased productivity of food crops leads to surplus production, thus, making it easier for the farmer to create value added products, which would otherwise be utilized in composting.




Source: Reddy V. 2016 <https://www.slideshare.net/VishnuReddy85/integrated-forming>

**Fig 2: Flow of energy in IFS**

## Suitable IFS Model

The selection of IFS model should focus on the achievement of the following goals depending on the prevailing situation in the farmer's field:

- Maximizing the return per unit area.
- Maintaining the status and fertility of soil by the use of safe materials and promoting long term sustainability.
- Judicious use of the byproducts of the enterprises and ensuring supplementary and complimentary enterprise relationship.

- Maintaining environmental health, quality and overall reduction of pollution in the farm and surrounding area.

The figure below depicts the relationship between the input and output flow between the different farm enterprises which may be considered in order to understand the dynamics of a suitable IFS model:

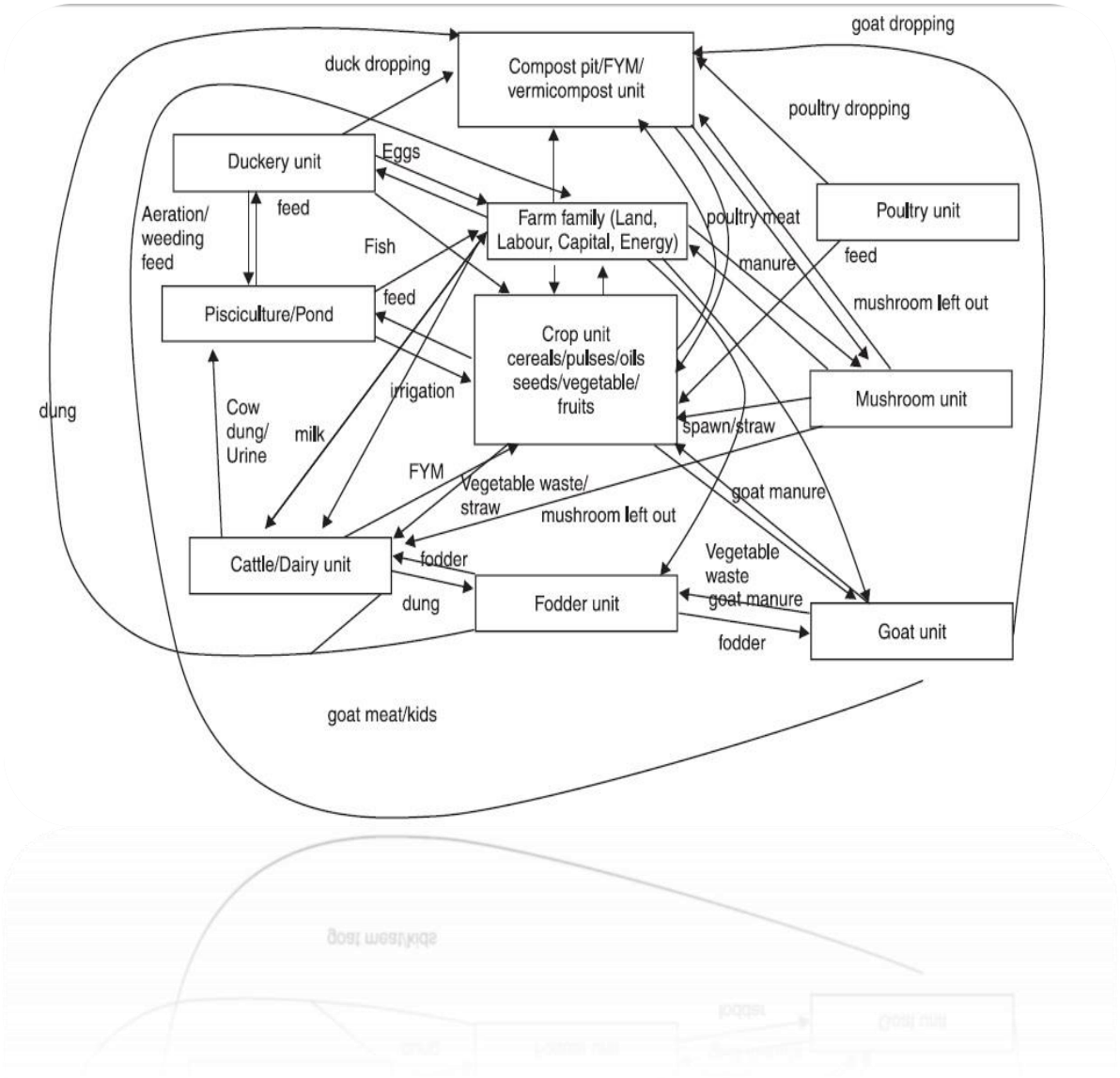



Fig 3: Input–output relationship between the enterprises in IFS (Kumar *et al.* 2018)

## Benefits of the different IFS models

A number of studies throughout the country have been made to evaluate the viability of different IFS models by various research organizations like IIFSR, IARI, and ICAR Research Complex during last few years. The following table as reported by Lal *et al.* 2018 revealed that there was a wide variation in annual net returns among different Integrated Farming System practices adopted in different states. However, all the IFS practices were found better over the prevailing farming systems irrespective of components and states.

**Table 1: Economic viability of IFS Research models developed in different states of the country**

| State | Prevailing system | Net return | Integrated Farming System | Net returns |
|---|---|---|---|---|
| Tamil Nadu | Rice-rice-blackgram | 8,312 | Rice-rice-cotton +maize | 15,009 |
| | | | Rice-rice-cotton +maize+poultry/fish | 17,209 |
| | Rice-rice | 15,299 | Rice-rice-Azolla/Calotropis+Fish | 17,488 |
| | Rice-rice-rice-fallow-pulses | 13,790 | Rice – rice-rice-fallow – cotton+maize+ duck cum fish | 24,117 |
| | Cropping alone | 36,190 | Cropping+fish+poultry<br>Cropping+fish+pigeon<br>Cropping+fish+goat | 97,731<br>98,778<br>13,1118 |
| | Rice | 22,971 | Rice+fish<br>Rice+Azolla+fish | 28,569<br>31,788 |
| Goa | Cashew | 36,330 | Coconut+forage +dairy<br>Rice-brinjal (0.5 ha) + Rice-cowpea (0.5 ha)+mushroom +poultry | 32,335<br>75,360 |
| Madhya Pradesh | Arable farming | 24,093 | Mixed farming + 2 cow<br>Dairy (2cows) +15 goats+10 poultry+10 duck+fish | 37,668<br>44,913 |

| | | | | |
|---|---|---|---|---|
| Maharashtra | Cotton (K) + Groundnut (S) | (-) 92 | Black gram (K) - Onion (R)- Maize +cowpea<br>Crop+dairy+sericulture<br>Crop + dairy | 1,304<br>3,524<br>5,121 |
| Uttar Pradesh | Crops (Sugarcane-wheat) | 41,017 | Crops (Sugarcane+wheat)+dairy | 47,737 |
| Karnataka | rice – rice system | 21599 | Rice-fish (pit at the center of the field) – poultry (reared separately)<br>Rice-fish (pit at one side of the field) – poultry (shed on fish pit) | 62, 977<br>49, 303 |

Source: Lal *et al.* 2018

The study conducted to develop suitable Integrated Farming System (IFS) model(s) in ≥1.0 acre area at ICAR Research Complex for North Eastern Hill Region, Nagaland Centre, Jharnapani, Nagaland during 2012-16 (Kumar *et al*., 2018) with various components like agriculture, horticulture, livestock and subsidiary components like fishery, vermicompost, mushroom and azolla etc. revealed that the combination of components like agriculture + horticulture + poultry + fishery (model–4) gave the highest net returns (Rs. 32040.00) followed by the model with agriculture + horticulture + fishery + piggery + vermicompost (model 3) with net profits of Rs. 21230.00. In terms of employment generation, IFS model-4 has shown maximum man-days engagement (395 days), followed by 350 days in model-3. Based on sustainability values index (SVI) derived from different IFS models, maximum SVI values was recorded in model-4 (0.71) followed by model-3 (0.47).

Case studies conducted on IFS (Table 2) in various parts of Northeast India during 2018-19 revealed that the average income per acre varied from Rs. 80000.00 to Rs. 1.75 lakhs depending on the components and its volume and intensity adopted by the farmers.

**Table 2: Details of farming system models developed in farmers' field in different villages of Northeast India**

| Sl. No | Location | IFS component | Area (acre) | Average income per annum (Rs) |
|---|---|---|---|---|
| **1.** | Senapati District, Manipur | Fish+ Poultry+ horticulture | 0.74 | 139000.00 |
| **2.** | Chandel District, Manipur | Livestock +poultry + Fish +Agriculture + horticulture | 7.5 | 917150.00 |
| **3.** | Ri Bhoi District, Meghalaya | Fish + poultry | 1.25 | 173106.00 |
| **4.** | Ri Bhoi District, Meghalaya | Fish+ Poultry+ horticulture | 0.50 | 55280.00 |
| **5.** | East Khasi Hills, Meghalaya | Fish + pig | 0.25 | 77000.00 |
| **6.** | West Garo Hills, Meghalaya | Fish +Duck +Banana | 0.40 | 59600.00 |
| **7.** | Champhai district, Mizoram | Fish + piggery +horticulture | 1.0 | 175000.00 |
| **8.** | Siaha District, Mizoram | Fish +Duck +horticulture | 1.12 | 105000.00 |
| **9.** | Peren District, Nagaland | Fish + poultry+ agriculture + horticulture | 1.2 | 167000.00 |
| **10.** | Mokokchung District, Nagaland | Agro-forestry + Horticulture + poultry | 2.0 | 125000.00 |
| **11.** | North Tripura District, Tripura | Fish +Duck | 1.0 | 84291.00 |
| **12.** | Dhalai District, Tripura | Fish + Duck +horticulture | 1.0 | 155000.00 |
| **13.** | Khowai District, Tripura | Fish +Duck +horticulture | 0.50 | 79000.00 |

*Source: ICAR-ATARI, Umiam*

## IFS for enhancing the income of farmers

The income of average farmers from prevailing cropping systems in most parts of the country is not sufficient to sustain the livelihood and many small and marginal farmers are reluctant to adopt new and improved farming systems or multi-enterprise farming due to numerous reasons (J.P. Singh *et al*. 2011). Several researchers over the years however reported that IFS has indeed raised the status of farmers due to higher income generation. The integration of livestock, fisheries and poultry along with the conventional crop husbandry methods have been found to increase the net profit significantly besides employment generation throughout the year as compared to cropping alone. The integration of paddy with fish and azolla reported a net profit of Rs. 31,788/ha/annum as compared to paddy (Rs. 22,971/ha/annum) alone (Balasamy *et al.* 2003). IFS studies conducted in farmers' fields of Punjab region reported that the gross profit increased from Rs. 81,200/ha/annum (paddy-wheat) to Rs. 1,54,000/ha/annum in crop integrated with dairy and to Rs. 1,13,200/ha/annum when integrated with fish and piggery (Gill, M.S., 2004). Based on the information received from several researchers and experiments conducted all over the country, farmers including small and marginal farmers may possibly be encouraged to adopt IFS and multi-enterprise farming in their farms for overall sustainability and enhancing their annual income.

## Conclusion

It can be concluded that the diversification of farming systems through the integration of several cropping systems, addition of livestock components like cattle, piggery, fisheries as well as the incorporation of horticultural crops for effective use of space per unit will indisputably enhance the income of small and marginal farmers in the country due to overall effective waste management practices. Moreover, IFS is a sustainable farming that improves soil and water properties with less negative impact on the environment altogether. The proper resource management in terms of waste and natural resources may lead to a saving of more than 40% in terms of cost of cultivation of a specific IFS model. Moreover, year round farming activities in such farming system generate employment opportunities throughout the year. With diversification in cropping and increased cropping intensity per unit area, the problem of food and nutritional security may be resolved to a great extent in the country.

## References

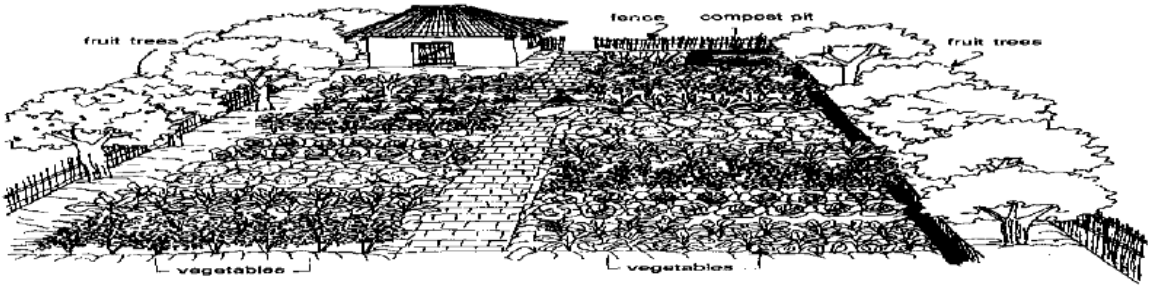
1. Balusamy, M., Shanugham, P.M. and Bhaskaran, R. (2003). Mixed farming an ideal farming. *Intensive agriculture.* **41**(11-12): 20-25
2. Gill, M.S. (2004). Methodologies for farming system approach- A case study. In: Proceedingsof National Symposium on Alternative Farming Systems held at PDCSR, Modipuram,16-18 September, 2004, pp. 95-108.
3. Gupta, A.K., Yadav, D., Dungdung, B.G., Paudel, J., Chaudhary, A.K., Arshad, R. (2020). Integrated Farming Syatems (IFS) – A Review Paper. *International Journal of Engineering Applied Sciences and Technology*, **4** (9): 134-137.
4. Inman D, Khosla R, Westfall D G and Reich R. (2005). Nitrogen uptake across site- specific management zones in irrigated corn production systems. *Agronomy Journal* **97**: 169–76.
5. Kumar Rakesh, Patra M.K., Thirugnanavel A., Deka B.C., Chatterjee D., Borah T.R., Rajesha G., Talang H.D., Ray S.K., Kumar M. and Upadhyay P.K. (2018). Comparative evaluation of different integrated farming system model for small and marginal farmers under the Eastern Himalayas. *Indian Journal of Agricultural Sciences* **88** (11): 1722–29.
6. Kumar, S., Bhatt, B., Dey, A. & Shivani, Kumar, U., Idris, M., Mishra, J. S. and Kumar, S. (2018). Integrated farming system in India: Current status, scope and future prospects in changing agricultural scenario. *Indian Journal of Agricultural Sciences*. **88** (11): 1661-1675.
7. Lal M., Patindar J., Kumar S. and Patidar A. (2018). Different integrated farming system model for irrigated condition of India on basis of economic assessment. A case study. *International Journal of Chemical Studies*, **6** (4): 166-175.
8. Ponnusamy, K. and Devi, M.K. (2017), Impact of Integrated Farming System Approach on Doubling Farmers' Income, *Agricultural Economics Research Review*, **4**: 233-240
9. Reddy Pulme V.V., (2016). Integrated Farming, Slide Share, accessed 28 April 2020, <https://www.slideshare.net/VishnuReddy85/integrated-forming>
10. Singh, J.P., Gangwar, B., Pandey, D.K. and Kochewad, S.A. (2011). Integrated Farming System Model for Small Farm Holders of Western Plain Zone of Uttar Pradesh. *Project Directorate for Systems Research Bulletin* No. 05, pp. 58. Project Directorate for Farming Systems Research, Modipuram, Meerut, India

# HOME GARDEN: AN OPTION FOR REGULAR SUPPLY OF VEGETABLES TO EVERY HOUSEHOLD

**Sarah Wahlang**

Food security and nutritional diversity are two complex issues that pause challenges in rural India (Jindal and Dhaliwal, 2017). With varying local opportunities and challenges, the nutrition garden forms a universal remedy to address food insecurity and bring in self reliance, sovereignty and dignity. With worsening of chemical uses and increased interest in organic and sustainable living, many people are turning towards nutrition gardening as a supplement to their family's diet.Households have labour power, the physical ability of household members to generate income. When this labour power is used in the nutrition garden, it has the ability to improve food security and nutritional diversity of the household. Even with the dwindling land resource small areas around the house can make a difference in the lives of many (Singh and Singh, 2017). It contributes to household food security by providing direct access to food that can be harvested, prepared and fed to family members often on a daily basis besides providing required nutrition (Jindal and Dhaliwal, 2017). Nutrition garden is considered as a sustainable model to improve nutritional security and diversity in the country (Suri, 2018). Therefore, more attention towards nutritional garden as a strategy to enhance nutritional security and part of food security is the need of the hour.

Nutrition garden is an improved form of kitchen garden where selected vegetables, spices and fruit crops etc are grown more or less systematically so as to meet the nutritional requirements of the family. Availability of fresh green vegetables/fruits and providing nutrition to the family are the main consideration for this type of cultivation in the smaller area located in the house premises. A well-developed nutrition garden contributes significantly to such needs. It can supply households with nearly all the non-staple foods they need, such as fruit, vegetables, spices, legumes and root crops etc.

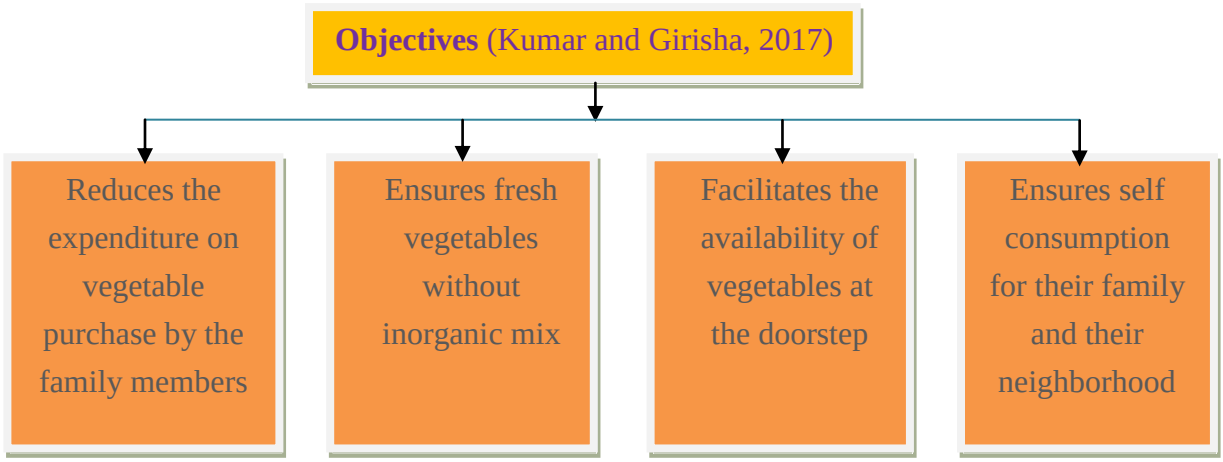


## Importance of Nutrition Garden

One of the easiest ways of ensuring access to adequate macro and micronutrients is to produce and consume different kinds of vegetables from the garden. Nutritional garden is the easiest way of growing desirable fruits and vegetables on one's own piece of land. It can be grown in the empty space available in the backyard of the house or a group of men/women/children can come together, identify a common place or land and grow the desired vegetables and fruits. This can benefit the family or a group of community as a whole. Home-grown vegetables are organic, low cost and could be totally free from chemicals and pesticides. Nutrition garden is sometimes called kitchen or home garden. These gardens have an established tradition and great potential for improving household food security and alleviating micronutrient deficiencies. Most importantly, it gives direct access to diverse nutritionally rich vegetables. It also increases the purchasing power through savings on food bills.

This is especially important in rural areas where people have limited income-earning opportunities and poor access to markets. Nutritional/ kitchen gardens are also becoming an increasingly important source of vegetable supplies and an additional income for poor households in peri-urban and urban areas (Kumar and Girisha, 2017).

## Objective of Nutritional garden



## Advantages of Nutrition garden:

- Ensures regular and convenient supply of healthy vegetables and fruits.
- Ensures food and nutritional security of the households.
- Provides economic returns through sale of excess produce.
- Helps in the conservation of traditional varieties of vegetable seeds.
- Contributes savings of household income by reducing spending on food.
- Better health from balanced diet reduces household medical expenses.
- Effective utilization of available free leisure time besides physical exercises
- Contributes financial independence to housewives/children for personal expenses.
- Improves planning, problem solving and management skills
- Acts as an experimental plot for organic techniques
- Provides opportunity to bond / share experiences with other group members.

## Layout of nutrition garden

The following are some of the important points to be considered for laying out and planning of a nutritional garden:

- Before laying out the nutrition garden, the available area should be properly fenced.
- Vine or trailing type of crops like cucurbits and beans can be trained on the fence.
- Three sides of the fence can be made to trail cucurbits during summer and rainy season, peas in winter and fourth side for perennial beans.
- Preferred shape of the garden is rectangular compared to square ones. Southern and western side of the area is to be reserved for vegetables so that it will be receiving maximum sunlight.
- Northern side is utilized for fruit plants. The bunds created to separate main plots can be used to grow root crops. High and low pergola may be prepared by using bamboo and GI wire to grow crops like spine gourd, snake gourd and other creepers. The area between perennial crops will be used to grow short duration shallow rooted annual vegetables or spices like garlic, green leafy vegetables, coriander.
- While selecting fruit trees, dwarf types with quick yielding capacity has to be selected. One or 2 trees of following fruit crops/perennial crops can be planted in the garden: Papaya, guava, Acid lime, banana, pineapple etc. Other fruit crops which are of dwarf in nature and develops small/medium canopy can be included based on preference.
- Some of the spice crops like ginger, turmeric, chilli etc can be included in the nutrition garden.

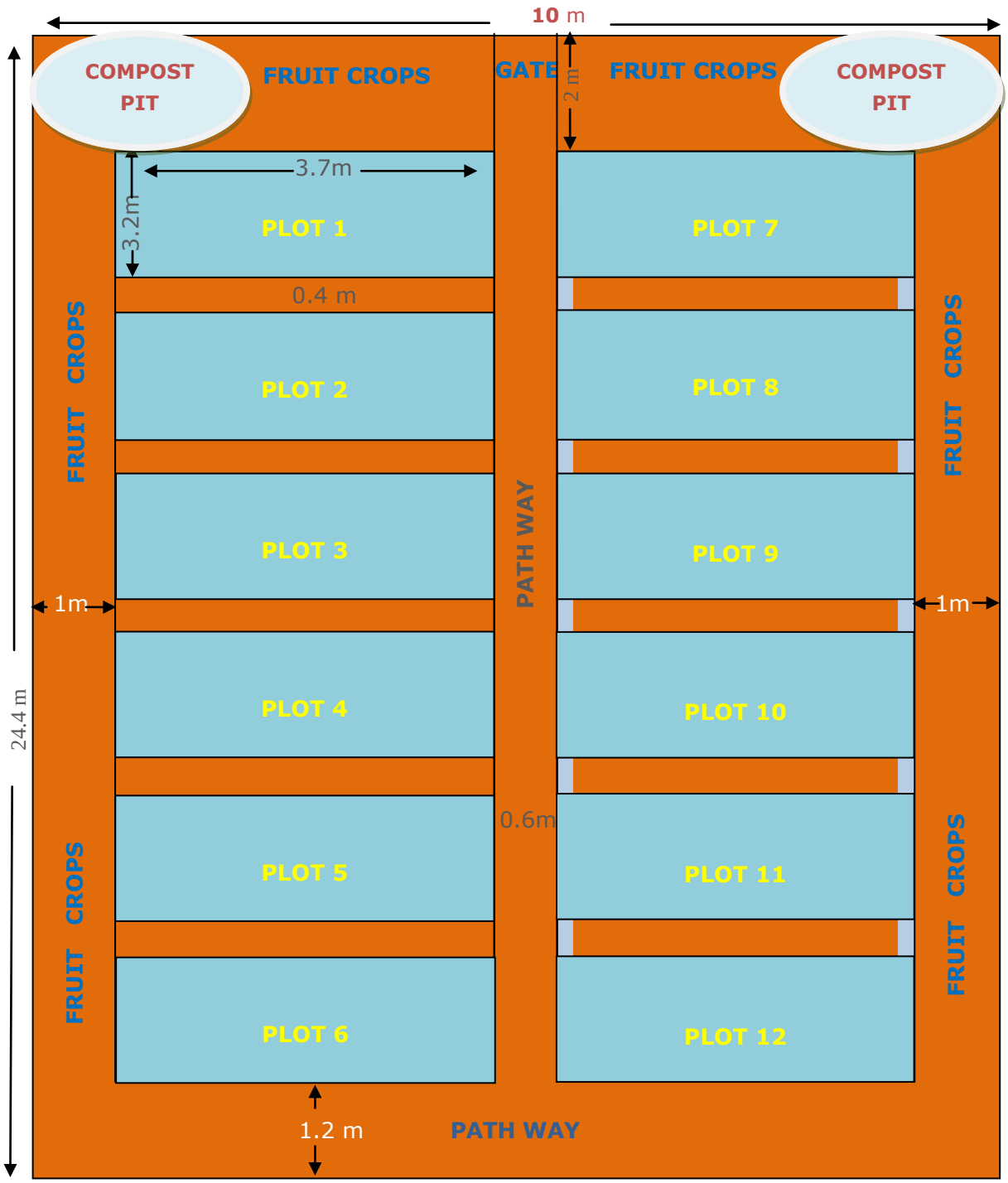
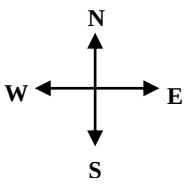



**FIG 1: NUTRITION GARDEN MODEL**

Total Area 250 square meter (25 x 10 m)
Total number of beds for vegetable growing=12
Area of one bed = 11.8 square metre (3.7 x 3.2 m)
Bund=0.4 m



## Management and Protection Measures

The nutrition garden area needs protection from the very beginning. A permanent fence should be made so that livestock and stray animal cannot enter the area. Thorny plants can be cut and used to make a fence, but the best method is to plant a living fence to protect the garden.

**Crop cultivation:** It is always better to follow organic method of crop cultivation in the nutritional/kitchen garden or if not possible safe method or integrated method has to be adopted, relying less on synthetic chemicals for nutrient supply and plant protection**.** Organic sources for plant nutrition are: compost, FYM, vermi-compost, coco-peat, oilcakes like neemcake, green manure crops, panchagavya and bio-fertilizers.

**Fertility**: All growers know that without fertility in the soil, crops will not grow. But fertility can be as limited as water. The kitchen garden needs to be self-reliant for fertility. Suggestions for sources of fertility are given below:

- **Liquid manure**: Liquid manure made in a pit or a drum gives nutrients to the plants as well as protect them from pests and diseases.
- **Sweepings pit**: By collecting everyday sweepings from the house and yard in one place, one can make enough compost for the kitchen garden.
- **Legumes**: Planting legumes such as peas, beans, sesbania, sunnhemp, etc. provides extra nitrogen to the soil which is good for other crops.
- **Green manure**: Sowing seeds of green manure helps to protect the soil and gives extra fertility for more production.
- **Mulching**: Putting a thick layer of biomass, mixed with compost on the soil, helps to increase fertility.
- **Other sources**: Ash, oil seed cake, etc. are all resources which can be added to the soil to increase fertility, as well as helping to prevent pests and diseases.

**Water management**: It is important to provide enough moisture for the nutrition garden. There are many ways of conserving and increasing the moisture available. For example:-

- **Mulching**: Prevents the wind and sun drying the bare soil.

- **Mist collection**: Mist collects on the leaves of trees around and within the kitchen garden, and drips into the soil to provide extra-moisture.
- **Provide shade**: In the hot season trees can provide shade to the kitchen garden. A few small trees or even fruit trees in the fence or within the garden can be used for this purpose. As well as giving shade, these trees can also provide other benefits, such as firewood, fodder or mulch materials.
- **Windbreak**: Wind will dry out the soil, so stopping the wind helps to conserve soil moisture.
- **Irrigation**: If there is no irrigation for main food crops, it is likely that there is also not enough water to irrigate the kitchen garden. If the above methods are used, then more water is conserved and so less is needed. Collecting and using waste water from the kitchen can be enough to water the garden.

## Organic Pest and Disease management practices:

A combination of practices is necessary, since no single practice is effective for all diseases that threaten production of a given crop. Some of the plant protection measures that can be followed in nutritional/ kitchen garden (Jana, 2015) are listed below:

- Use of resistant vegetable varieties wherever available
- Seed treatment with *Psuedomonas fluorescens* or *Trichoderma harzianum* or *Trichoderma viride* @ 1-2g/ 100g seeds
- Follow crop rotation using at least one legume crop in a cycle of one year
- Keep out weeds which harbour insects and diseases
- Irrigate early in the morning to reduce time plants are wet
- Remove and dispose of diseased plants
- Nursery beds are to be covered with 40 or 50 mesh nylon net cover to prevent insect vectors transmitting virus diseases.

**Table 1: Season wise cropping plan for nutrition garden in Northeast India**

| Kharif | Rabi | Summer |
|---|---|---|
| King Chilli, Brinjal, Pumpkin, Okra, Cowpea, Ginger, Turmeric, Amaranthus, Colocassia | Tomato, Cabbage, Carrot, Radish, Onion, French bean, Cauliflower, Broccoli, Coriander, Garden Pea, Lettuce, Capsicum, Potato, Methi, Cabbage | Bitter gourd, Snake gourd, Cucumber, French bean, Cabbage, Amaranthus |

*Source: ICAR-ATARI, Umiam*

**Table 2: Requirement of seeds and production of various vegetables from nutritional garden**

| Vegetables | Seed Rate (per $10m^2$) | Line to line distance (cm) | Plant to Plant distance (cm) | Harvesting time | Production (kg) (per 10 $m^2$) |
|---|---|---|---|---|---|
| **Okra** | 20g | 60 | 30 | Sept-Oct | 10 |
| **French bean** | 30g | 60 | 15 | Jan-Feb | 22 |
| **Cowpea** | 30g | 60 | 15 | June-July | 15 |
| **Pea** | 30g | 20 | 5 | Sept-Dec | 15 |
| **Cabbage** | 3g | 45 | 45 | Oct-Nov | 20 |
| **Carrot** | 5g | 45 | 30 | Oct-Nov | 15 |
| **Cauliflower** | 2g | 60 | 45 | Nov-Dec | 20 |
| **Brinjal** | 2g | 90 | 60 | Aug-Sept | 30 |
| **Onion** | 15g | 45 | 5-0 | May-June | 22 |
| **Chilly** | 2g | 60 | 30 | Oct-Nov | 15 |
| **Pumpkin** | 5g | 150 | 50 | March & October | 20 |
| **Radish** | 10g | 30 | 2-5&3-5 | Sept-Nov | 15 |
| **Spinach/ leafy vegetables** | 30g | 30 | 5&10 | October & January | 17 |
| **Tomato** | 2g | 60 | 30 | May-June | 32 |

*Source: ICAR-ATARI, Umiam*

**Table 3: Fruit Crops fornutrition garden in Northeast India**

| Plant | Spacing |
|---|---|
| **Lemon** | 3m x 3m |
| **Papaya** | 1.5m x 1.5m |
| **Mango** | 5m x 5m |
| **Guava** | 3m x 3m |
| **Mandarin** | 5m x 5m |
| **Banana (Dwarf)** | 2m x 2m |
| **Pineapple** | 0.3m x 0.6m |

*Source: ICAR-ATARI, Umiam*

**Table 4: Nutritional output from vegetables available in the nutritional garden**

| Vegetables | Production (kg/ 10 $m^2$) | Protein (g) | Iron (mg) | Vitamin A (IU) | Vitamin C (mg) | Calcium (mg) | Energy (Kcal) |
|---|---|---|---|---|---|---|---|
| **Okra** | 10 | 190 | 35 | 7160 | 1300 | 6600 | 3500 |
| **French bean** | 22 | 374 | 134.2 | 237.6 | 5280 | 11000 | 5720 |
| **Pea** | 15 | 1080 | 225 | 1147 | 1350 | 3000 | 13950 |
| **Cabbage** | 20 | 360 | 160 | 196 | 24800 | 7800 | 5400 |
| **Carrot** | 15 | 135 | 154.5 | 25059 | 450 | 12000 | 7200 |
| **Cauliflower** | 20 | 520 | 246 | 0 | 11200 | 6600 | 6000 |
| **Brinjal** | 30 | 420 | 114 | 69 | 3600 | 5400 | 7200 |
| **Onion** | 22 | 396 | 264 | 4.4 | 440 | 8800 | 12980 |
| **Chilly** | 15 | 435 | 660 | 1428 | 16650 | 4500 | 4350 |
| **Pumpkin** | 20 | 280 | 88 | 17026 | 400 | 2000 | 5000 |
| **Radish** | 15 | 90 | 55.5 | 10.5 | 2550 | 7500 | 4800 |
| **Spinach** | 17 | 340 | 193.8 | 15940.9 | 4760 | 12410 | 4420 |
| **Tomato** | 32 | 288 | 204.8 | 2665.6 | 8640 | 15360 | 6400 |

* Standard Nutritive Value according to Indian Council of Medical Research (ICMR)*Source: ICAR-ATARI, Umiam*

## Economic benefits of Nutritional Garden

The economic benefits of nutrition gardens go beyond food and nutritional security and subsistence, especially for resource-poor families. It contributes to:

- Income generation
- Improved livelihoods
- Household economic welfare
- Promoting entrepreneurship and rural development.

Home gardens can contribute to household economic well-being in several ways: garden products can be sold to earn additional income; gardening activities can be developed into a small cottage industry; and earnings from the sale of home garden products and the savings from consuming home-grown food products can lead to more disposable income that can be used for other domestic purposes. The income generated from the sale of home garden fruits, and vegetables allowed households to use the proceeds to purchase additional food items as well as for savings, education, and other services. Families can generate more than 22% of their cash income through home-gardening activities (Galhena *et al*., 2013).

## Investments and Returns from Nutrition garden

In the accompanying table, the investments and returns into a setting up of a home garden looking at a one year cycle is roughly estimated. It is seen that if an investment of Rs. 600/- is made in the setting up of a home garden, the returns may be Rs. 2,900/-. This is realized through the reduction of the family expenses on vegetables, sale of vegetables and savings on primary health care (Sridhar *et al.*, 2013).

**Table 5.Investments and Returns from Nutrition garden (120 $m^2$ area)**

| Sl No. | Particulars | Amount (Rs.) |
|---|---|---|
| | **INVESTMENT COST (120 $m^2$ area)** | |
| **1.** | Supply of 10 types of veg. seeds (two seasons) | 200 |
| **2.** | Supply of water saving kit (one time supply) | 150 |
| **3.** | Supply of 10 types of medicinal plants (one time supply) | 250 |
| | **Total investment cost / household / year** | **600** |
| | RETURN (120 $m^2$ area) | |
| **1.** | Reduction of family's vegetable expenses @ Rs. 150 / Month x 10 Months | 1500 |
| **2.** | Sale of vegetables @ Rs. 50 / Month X 8 Months | 400 |
| **3.** | Savings on primary health care @ Rs. 100/month x 10 Months | 1000 |
| | **Total returns from each household / year** | **2900** |

| **Sl No.** | **Particulars** | **Amount (Rs.)** |
|---|---|---|
| 1. | Total returns from each unit/ year | 2900 |
| 2. | Total investment cost per unit per year | 600 |
| 3. | Net Returns per unit per year | **2300** |

## Health Benefits of Home-grown Vegetables and Fruits

Lack of diet diversity causing micronutrient deficiency is common in developing countries including India. The deficiency of macro and micronutrients in the diet is one of the hidden consequences of impaired physical and cognitive development in large number of Indian children and women in rural areas. Establishment of nutritional garden in the backyard or household premises embrace lot of significance due to the following health benefits (Engels, 2019).

- They are truly fresh, rich and cheaper source of vitamins.
- They are good source of carbohydrates, proteins and minerals.
- They enhance the taste, palatability, increase appetite and provide fibre for digestion and prevent constipation.
- They also play important role in neutralizing the acids to produce valuable roughages which help in movement of food in intestine.
- They are almost free from dangerous toxins and pesticide residues.
- They are inexpensive as well as organic in nature.

## Initiatives taken to promote Nutritional Garden in Northeast

The age old traditional system "*bari*" is very much prevalent in the backyard of every household in rural areas of Assam and some other North Eastern states wherein all the essential food items like local fruits, vegetables, spices, medicinal & aromatic plants are grown to meet the family requirement all throughout the year besides their in-situ conservation. However, over the years, the importance of the *bari*, the cultural ethos of Assamese community has started declining due to no. of reasons. The *bari* is an extended version of kitchen/ nutritional garden and off late, the respective govt. of various states in the region and few NGOs have taken some initiative to engage the school children for setting up nutritional garden in the school premises.

### Assam

Farm 2 Food Foundation works with middle-school students (**grade 6, 7 and 8)** in Jorhat district so as to set up nutrition gardens in the schools and thereby support the process of learning self-sustaining and organic methods of growing their own food, eating healthy, learning about nutrition, and becoming entrepreneurs. The primary focus of the programme is to increase nutrition levels of children in the schools. Moreover, the foundation also works with mother's groups to enable the setting up of nutrition gardens in homes. It emphasizes the importance of high nutrition levels, with a special focus on women and children (Karelia, 2019).

## Meghalaya

North East Slow Food and Agro-biodiversity Society (NESFAS), an organization in Meghalaya engaged in the establishment of school kitchen garden. It has taken up the initiative and is continuously supporting the improvement of school kitchen gardens both as educational tools and for enhancing food diversity in mid day meals. It stands as a unique way of initiating a school garden giving children opportunity to acquire in depth knowledge of their local wild resources. It has helped in designing a school kitchen garden for schools within its premises. It aims at promoting the idea of "School kitchen garden is one way to defend our traditional farming systems" (NESFAS, 2018).

**Table 6: List of Schools promoting kitchen garden under the guidance of NESFAS**

| Sl.No | School | Village | District |
|---|---|---|---|
| **1.** | Lumstoin LP School | Mookyniang | Jaintia Hills |
| **2.** | Khliehumstem Presbyterian School | Khliehumstem | Ri Bhoi |
| **3.** | Khapmaw Presbyterian LP/UP School | Mawkynrew | East Khasi Hills |
| **4.** | Seng Kynthei Pres LP School | Sohliya | Ri Bhoi |

## Mizoram

Realizing the importance of the nutritional garden, the Deputy Commissioner of Lawngthlai, Mizoram's backward and disaster-prone district launched a programme 'My School, My Farm' by involving school children, the parents and teachers to create a nutrition garden in each school. The aim is to make every school, Anganwadi, child care institution and hostel in Lawngthlai self-sufficient in the local variety of fruits and vegetables. The Education Department has been asked to identify at least 100 sq meter in every school and the headmaster is responsible for involving the children in gardening. The headmaster is also tasked with preparing a timetable of batches of children to ensure every child gets at least an hour of nutrition garden time in a week (Kamakar, 2019).

## Nagaland

For the improvement of mid day meal through kitchen garden in the school, the Nagaland government has been promoting kitchen gardening in every school in Peren district of Nagaland. The main objective of the school kitchen garden is to help in addressing malnutrition and micro nutrient deficiencies of children by consumption of freshly grown vegetables besides giving them first-hand experience with nature and gardening and thereby to enhance the knowledge of children regarding nutritional aspect of vegetables and harmful effects of junk foods. School nutrition gardens are good for learning, they are highly practical, where children can learn how to grow good food, which not only improves health, but also provide opportunities for livelihood and increase self sufficiency (The North East Today, 2019). Similar programme has also been initiated in few govt. middle schools in Kohima district of Nagaland (Nath, 2020).

## Conclusion

In nutshell, nutritional garden is the easiest way to ensure access to a healthy diet that contains adequate amount of essential nutrients by producing diverse kind of vegetables. It can be established on a small piece of land and can provide healthy and pesticide free vegetables for the family. Thus, fresh and safe vegetables will be available for domestic consumption all the year round and consumption of plenty amount of vegetables will also help to address nutrient deficiency disorders like anemia, goiter, night blindness and so on (Jindal and Dhaliwal, 2017). Simultaneously, the nutritional gardens will help to improve the food and nutritional security of the family members (Rani *et al*., 2015). Moreover, it could be an important mechanism/platform for conservation of plant diversity through use as well as diversifying the nutrition of rural people and thereby contributing to food security at household and community level (Sahoo, 2009).

In the wake of food crisis and the soaring food prices, there has been increased emphasis on enhancing and building local food systems. In this context, there is renewed attention to food production and livelihood enhancement through nutritional gardens. There is also a need for research on the cost-benefit analysis to determine the economic value and to derive viable models that hold the most promise in diverse circumstances. However, more empirical evidence on the value and importance of nutrition gardens in conflict and post-conflict situations needs to be documented. The

areas of nutrition, access to new technologies, extension and advisory services, economic and non-economic benefits, women empowerment, and long-term sustainability of nutrition gardens specifically in post-conflict situations need further research.

## Reference

1. Engels, J. (2019). 9 benefits of Homegrown Vegetables. *One Green Planet.*
2. Galhena, D.H.; Freed, R and Maredia, K.M. (2013). Home gardens: a promising approach to enhance household food security and wellbeing. *Agriculture & Food Security*, **2**(8):142-145.
3. Jana, H. (2015). Kitchen gardening for nutritional security. *Rashtriya Krishi*,**10**(2) : 13-16.
4. Jindal S.K. and Dhaliwal, M.S. (2017). Development of Vegetable Nutrition Garden Model for Diet Diversification and Improved Nutrition Security of Urban and Peri-urban Households.*International Journal of Horticulture*,**7**(4) : 219-228.
5. Karelia, G. (2019, July, 6). "50K+ Assam Kids Grow Organic Veggies In School Backyards, Earn Neat Profits!". *The Better India*.
6. Karmakar, R. (2019, July, 17). "Schools turn nutrition gardens in Mizoram district". *The Hindu*.
7. Kumar, V. and Girisha, P.J. (2017). Nutritional Security through Kitchen Garden. Development Matters, pp. 13-17.
8. Nath, S. (2020, January, 14). "Nagaland School Kids Grow Their Own Organic Mid-Day Meals, Inspire Whole Village." *The Better India*.
9. North East Slow Food & Agrobiodiversity Society (NESFAS). (2018). A Manual for initiating & Establishing a school Garden. NESFAS, Meghalaya. pp. 1-27.
10. Rani, T. S., Supraja, T. and Reddy, P.L. (2015). Nutrition Intervention and Homestead Kitchen Gardening-Improving Nutritional Security in Rural Livelihoods. *Journal of Krishi Vigyan*, **4(**1): 63-66.
11. Sahoo, U.K. (2009). Traditional home gardens and livelihood security in North-East India. *Journal of Food, Agriculture & Environment*, **7** (2) : 665-670.
12. Singh, G. and Singh, R.K. (2017). Economic analysis of kitchen gardens at farmers' doorsteps. International Research Journal Agricutural Economic & Statics, **8**(2) : 299-304.

13. Sridhar, S.; Subramanian, K.; Vijayalakshmi, K. and Balasubramanian, A.V. (2013). Home Gardens for Seed Conservation and Supplementary. Centre for Indian Knowledge Systems, Chennai. pp.19-20.
14. Suri, S. (2018). Nutrition Garden: A sustainable model to improve food diversity and security in Africa. *Observer Research Foundation*.
15. TNT bureau. (2019, August,30), "Nagaland govt to promote kitchen gardening in every school." *The North East Today*.

# EMERGING TRENDS IN FARM INNOVATIONS AND RURAL BIO-ENTREPRENEURSHIP

**Divya Parisa**

Innovation is more important in modern agriculture than ever before. The agriculture industry as a whole is facing huge challenges, from rising costs of supplies, shortage of labor, and changes in consumer preferences for transparency and sustainability. There is increasing recognition from agriculture corporations that solutions are needed for these challenges. In the last 10 years, agriculture technology has seen a huge growth in investment, with $6.7 billion invested in the last 5 years and $1.9 billion in the last year alone. Major technology innovations have focused around areas such as boosting production by indoor vertical farming, automation and robotics, livestock technology, farm mechanization and artificial intelligence, and block chain**.**

Bio-entrepreneurshipis the integration of two different discipline, i.e. science (bio) and entrepreneurship. It is the smoothest sailing of innovation from academia to industry. It can also be defined as 'the use of biological entities or any idea, related to sciences for purpose of acquiring profit and establishing a business. There are several names referring to it such as BioE or science entrepreneurship or bioscience enterprise. Also, others include; life science entrepreneurship, entrepreneurship in biotechnology or biotechnology enterprise.

## Bio entrepreneurship

A researcher usually starts a business based on science. That's why a bio-entrepreneur has a lot of data, and more knowledge about its product which makes it easier to identify and solve problems. A scientist develops an idea, invent something and then he/she will share it with the world, for-profit in return. In this way, not only the world and society are getting benefit from that invention, but the inventor itself gets a reward for his/her hard work. It encompasses the realization of ideas and concepts that arise from biology and other science fields. Also, further implementing them into prospective business plans and start-ups. That was the reason behind the creation of bio entrepreneurship.

## Bio entrepreneurship lead to Bio-economy

Bio-based products lead a country to bio-economy. Bio-economy is the world's second largest economy that remodels the potential of biotechnology to endorse economic growth by transforming health, energy, agriculture, and the environment. In 2018, U.S Department of Agriculture (USDA) published a report that global calculated worth of bio-economy together with industrial biotechnology, renewable chemicals, and polymers, biofuels, enzymes, and biomaterials is $355.28 billion. It is expecting to increase to approximately $487 billion by 2024. We are moving forward in every field. Soon a time will come, there will be more demand for highly effective production of better crops and other life-related problems will become such huge challenges.

## The Emerging innovations of bio-entrepreneurship across the Nation

The following are some of the emerging innovations that led to development of bio-entrepreneurship across different countries.

### Reviving the use of natural colours

To eliminate the damage caused by synthetic colours, creation of natural colours by using microbes is an innovation. Microbes are among the cheapest, most abundant, and unexplored biological feedstock available in large quantities and can be exploited to extract colours. These natural colours can find applications in food, pharmaceuticals, textiles, and cosmetics. The microbes as an inexhaustible source can be used for extracting different natural colours.

### Floral waste to bio leathers

Retrieving floral waste from temples, mosques, and other religious spaces, is the world's first "flower cycling" technology to produce animal-free, cost-effective, and engineer-able bio-leather out of floral waste. The initiative also addresses air and water pollution caused by traditional leather industries. Help Us Green bio-leathers are a genesis of a new circular economy model with triple bottom benefits of environmental, societal, and financial sustainability.

### Bio-activators to replace chemical fertilizers

An alternative bio-organic and sustainable solution for crop improvement, nutrition, and protection is utmost necessity for promotion of organic farming in any given society. The bio-

activators, an alternative to conventional chemical pesticides also allow growers to maintain beneficial insect (natural predator) populations in their fields. Its SNIPR technology (Smart Nano-molecules induced Physiological Response) based products are certified organic and residue-free. SNIPR-based products have been commercially launched in 10 states in India. For farmers who are battling with crop loss in changing climatic conditions, the SNIPR offers certified residue-free, organic next-gen biological products simulating the defense/adaptation system evolved and perfected by nature itself.

## Scope of bio-entrepreneurship in Northeast India

In NE India, innovative technologies which are simple, low-cost and environment friendly have a better and wider acceptance. Apart from enhancing production of shifting agricultural crops, the eco-technologies also have potential in capacity enhancement and entrepreneurship development. Considering the social and economic dependency of the ethnic communities on this agro-ecosystem that integrates both material and non-material cultures, and the way of life for the upland communities of NE India, it is essential to make the practice ecologically and economically sustainable through simple and low-cost innovative technologies. Although replication of one model may not be appropriate to all localities, simple, low-cost technologies have the potential to be replicated and adapted. The agro-ecosystem being endowed with rich traditional ecological knowledge and practice has the potential to mitigate climate change impacts when it is made more productive using technologies and enhancing its fallow period.

## Innovative agriculture practices in North Eastern region of India

Farming needs of the North Eastern region are different due to highly diverse land-use system in a wide range of distinct socio-economic and ecological conditions, from hill to lowland ecosystems. The tribal dominated hill farmers of the region have developed many innovative technologies that are being documented by the Krishi Vigyan Kendras under ICAR-ATARI, Umiam. Some of the prominent technologies like Zero wastage, innovative livestock production, processing and value addition of natural dyes from agro wastes are being popularized and promoted on a large scale paving a way for the rural bio-entrepreneurship.

The following are some of the frugal innovative approaches that few *Jugaad* innovators of the region have developed over the years after lot of trial and error methods.

- Tea processing through indigenous methods
- Innovative egg laying cabin
- Use of vegetable peels and flowers for preparation of natural dye
- Bamboo based drip irrigation for production of fruit crops
- Floating duckery unit integrated with fish farming
- Water reed cum fish farming
- Homestead cultivation of Azolla to minimize the use of FYM
- Cardboard Box Hatchery for quail
- Easy Way of Making Home Made Natural Soap


1


2


3


4


5


6


7


9

1&2: Innovative Tea processing methods, 3. Innovative egg laying cabin, 4. Banana fibre extraction, 5&6: Bamboo based drip irrigation, 7. Homestead azolla production, 8. Floating duckery Unit, 9. Waterreed cum Fish culture, 10. Natural soap making, 11. Natural Dye making, 12. Low cost hatchery for quail.

## Road Ahead

The rise of technology coupled with the need for higher productivity has opened up a wealth of new understanding with the collection of accurate data. The investment in agriculture technology has seen accelerated growth of more than 40% just last year. This adds up to approximately around $17 billion. Innovations can now provide farmers better reign over crop quality control, pest management, and even the optimization of their existing practices to achieve higher revenue. Farmers can now leave less to speculation with the new understanding and accurate forecasts of their harvests. With the country offering numerous comparative advantages in terms of R&D facilities, knowledge, skills, and cost effectiveness, the agriculture innovations in India has immense potential to emerge as a key player.

## Reference:

1. Bidyut. C. Deka., A. K. Singha., Divya parisa., and R.Suchiang. 2018. In: Genesis: Dynamics of Farm Innovations. Published by: ICAR-ATARI, Umiam. Pp.1-52.

# MARKETING STRATEGIES FOR AGRICULTURAL COMMODITIES IN NORTH EAST INDIA

**Anik Lyngdoh**

North- East India comprises 8 states namely Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim. Geographically the North East region contributes only about 8 per cent the total size of the country which has a humid sub-tropical climate with humid summers, harsh monsoons and breezy winters. If farmers are unable to sell their produce at a fair market price, their productivity will be unfair to hard work. It illustrates the severity of problems faced by farmers related to marketing of their agricultural produce and suggests the possible solutions for either eradicating or eliminating the complications. To improve the efficiency in marketing of agricultural produce, the Government of India under the ministry of agriculture has set up specific Commodity Boards and Export Promotion Council for monitoring and boosting the production, consumption, marketing and export of various agricultural commodities. National Agricultural Market (eNAM) was also set up to create online trading platform for agricultural commodities, which networks the existing, APMC mandis to create a unified national national market.

The world of marketing has changed dramatically. The easy, high-growth markets have been replaced by mature, low-growth demand patterns that have forced suppliers to question their erstwhile successful business models, such as, for example, those that consisted largely of making ‘products’ and selling them to intermediaries, who magically got rid of them somehow to an unsophisticated general public who were in awe.

In the recent years there has been great concern regarding the efficiency of the marketing of agricultural produce in India. It is believed that poor linkage in the marketing channels and poor marketing infrastructure are leading to high and fluctuating market prices. Marketing infrastructure serves as the wheels to carry out economic activities. In India, agriculture is considered to be the mainstay of the large number of population which directly or indirectly contributes to the livelihood of the rural masses as a whole. In NorthEast Region of India about 77 per cent of the working population

are engaged in agriculture. Therefore, Marketing of one's own produce is the most important activity for small and marginal farmers who have low or small surpluses for marketing.

## Constraints in marketing of agricultural produce in India

**1.** The important component of infrastructure necessary for growth of agricultural marketing are communication/ transport and storage facilities which are utterly deficient. Road transport being the primary mode of transport from farmer's to the primary, secondary and final consumers. The physical access to market is constrained by bad road condition of the road and high transportation cost. The rural markets often become inoperable because of various compulsive forces such as road infrastructure, unpredictable weather conditions, timely transportation to market centre, inefficient trade and pricing structure.

Storage structures are either outdated or not available in most cases.Earlier, marketing was described as being a process which matches the supplier's capabilities with the customer's wants. We also saw that this matching process took place in a business environment which could pose threats for the supplier, but which also created opportunities.

## Marketing

The marketing mix refers to the set of actions, or tactics that maybe used to promote its brand or product in the market. The 4Ps make up a typical marketing mix - Price, Product, Promotion and Place. Product refers to the item actually being sold. The product must deliver a minimum level of performance; otherwise even the best work on the other elements of the marketing mix won't do any good. Price refers to the value that is put for a product. It depends on costs of production, segment targeted, ability of the market to pay, supply - demand and a host of other direct and indirect factors. There can be several types of pricing strategies. Pricing can also be used a demarcation, to differentiate and enhance the image of a product. Place refers to the point of sale. In every industry, catching the eye of the consumer and making it easy for her to buy it is the main aim of a good distribution or 'place' strategy. Retailers pay a premium for the right location. In fact, the mantra of a successful retail business is location. Promotion refers to all the activities undertaken to make the product or service known to the user and trade. This can include advertising, word of mouth, press reports, incentives,

commissions and awards to the trade. It can also include consumer schemes, direct marketing, contests and prizes.

A tremendous range of options open to the marketer who chooses to explore all of the services available from marketing mix possibilities, but to be taken in to account an important factor is that the whole marketing process really hinges on how accurately the needs and wants of customers are accurately researched.

## Marketing Channels of Distribution

A distribution channel represents a chain of businesses or intermediaries through which the final buyer purchases a good or service. Distribution channels include wholesalers, retailers, distributors, and the Internet.In a direct distribution channel, the manufacturer sells directly to the consumer.

Producer/ Farmer → Medium/Agent → Wholesaler/Distributor → Retailer → Final Consumer/Buyer.

Producer/Farmer → Wholesaler/Distributor → Retailer → Final Consumer/Buyer.

Producer/Farmer → Retailer → Final Consumer/Buyer.

Producer/Farmer → Final Consumer/Buyer.

## Developing Marketing Plan

Value in marketing, also known as customer-perceived value, is the difference between a prospective customer's evaluation of the benefits and costs of one product when compared with others.

### 1. Marketing and Customer Value:

- Marketing involves satisfying consumers' needs and wants.
- The task of any business is to deliver customer value at a profit.
- In a hypercompetitive economy with increasingly rational buyers faced with abundant choices, the value of delivery process and choosing, providing, and superior value.
- In this view, marketing takes place in the second half of the process.
- The producer knows what to make and the market will buy enough units to produce profits.

### a) The value delivery process:

- The traditional view of the business process, however, will not work in economies where people face abundant choices.
- The smart competitor must design and deliver offerings for well-defined target markets.
- This belief is at the core of the new view of business processes, which places marketing at the beginning of planning.

### b) The Value Chain:

Michael Porter of Harvard has proposed the value chain as a tool for identifying ways to create more customer value.

According to this model, every producer has a combination of activities performed to design, produce, market, deliver, and support its product.

The value chain identifies nine strategically relevant activities that create value and cost in a specific business.

These nine value-creating activities consist of five primary activities and four support activities.

- The primary activities cover the sequence of:
  i. Bringing materials into the business (inbound logistics),
  ii. Converting them into final products (operations),
  iii. Shipping out final products (outbound logistics),
  iv. Marketing them (marketing and sales), and
  v. Servicing them (service).

- The support activities:
  i. Technology development,
  ii. Human resource management,
  iii. Firm infrastructure—are handled in certain specialized departments, as well as elsewhere.
  iv. Procurement and hiring

## Prospects of marketing Agricultural produce to South East Asian

The Asia-Pacific is a region of contrast. It is an important player in the world with a quarter of the world GDP and trade originating in the region. It consists of several economies of various types and structures. Two of the world's largest economies are in this region, namely China and Japan, and much smaller economies such as Lao People's Democratic Republic and Nepal. A handful of emerging economies, mostly from East and Southeast Asia, are growing faster in trade also. There are evermore investment destinations in the region. Agricultural mechanization, modern production methods and high-yield crop varieties are replacing traditional practices of agriculture.

## Share of agriculture in national economy

The share of agriculture in the Asia-Pacific countries is not uniform. The poorer economies in this region have relatively higher share of agriculture in GDP in comparison with the rich economies. Data from FAO (2009) shows that the least developed countries in the region have on average 34% of their GDP coming from agriculture. Whereas, developed nations such as Australia and Japan have minimal share of 2.4% and 1.5%, respectively. Many countries in the region have significant socio-economic implications for agricultural trade, as a high proportion of the population is dependent on the sector. The proportion of population dependent on agriculture sector is relatively high particularly in the Asia-Pacific compared to the rest of the world, Livelihoods of half to three quarters of the total population in developing countries including a number of LDCs such as Nepal, Lao People's Democratic Republic and Cambodia depend on agriculture. The two emerging countries, China and India are also part of this list. The chances of enhanced dividend of growth to the larger section of the population depend mostly on the developments in the agricultural sector.

Both China and India are important trading partners in the Asia-Pacific region due to their sheer size and, rapid import and export growth. China is the second largest importer of agro-products, while India is ranked eighth. Additionally, China tops the agro-export list, where India is fifth. Both economies have large populations, are undergoing rapid urbanization and have an impressive GDP growth rate. These call for an in-depth look at their agro-trade performances.

## Marketing Strategies for North East India

Since, the farmers of North East India are by and large are having small and marginal land holdings and the marketable surplus in most of the crops at farm level is quite negligible. Therefore, the aggregation of the small quantity of the farmers in one banner for the profitable marketing is the need of the hour by taking the advantage of ICT. The followings are the ways for effective marketing of the commodities in North East India.

1. **Online Marketing (Social Media):**Internet marketing or online marketing, refers to advertising and marketing efforts that use the Web and email to drive direct sales via electronic commerce, in addition to sales leads from websites or emails. Internet marketing and online advertising efforts are typically used in conjunction with traditional types of advertising such as radio, television, newspapers and magazines.

2. **Banner Marketing:** Banner ads are one of the dominant forms of advertising online. Buyers can easily secure placements at most sites, and publishers can accept ads from most advertisers.

3. **Word of Mouth:** Word-of-mouth marketing (WOM marketing) is when a consumer's interest in a company's product or service is reflected in their daily dialogues. Essentially, is it is free advertising triggered by customer experiences and usually, something that goes beyond what they expected. Word-of-mouth marketing can be encouraged through different publicity activities set up by companies, or by having opportunities to encourage consumer-to-consumer and consumer-to-marketer.

4. **Direct Selling:** Direct marketing is the sale of agricultural goods and products from the farm straight to the consumer, without intervening distributors or retailers. Direct marketing can benefit farmers by allowing them to earn a greater portion of the consumer food dollar by eliminating intermediary brokers, buyers, and distributors. Examples of direct marketing include community supported agriculture (CSA) ventures, farmers' markets and farm stands, and direct sale to businesses and institutions, such as restaurants, schools or hospitals. Direct marketing can contribute toward sustainable agriculture and food systems by increasing farmer

profitability, promoting the local economy, and providing consumers with higher quality and healthier products.

5. **Local marketing:** It is used by small local businesses to conserve resources and develop unique advantages by reaching the customers closest to them. Local marketing can also be used by large firms as a micromarketing strategy. The following are common types of local marketing.

## Ways to improve the marketing efficiency

To tackle the problems faced by producers/farmers', a few possible solutions may be adopted in order to ease and or eliminate the difficulties, they have been further enumerated in the following points:

- Formation of marketing cooperatives
- Strengthening Access to markets
- Government Intervention

## Formation of marketing cooperatives:

The problems faced in the sale of surplus goods are quite complex and complicated. The farmers who have surplus goods have to sell them generally in un-regulated markets. They do not get fair and reasonable price for their produce due to numbers of reasons. For examples, the goods produced by the farmers are generally perishable and cannot be stored for a longer period of time.

Cooperative societies are formed on a cooperative basis. These societies arrange to sell the produce of the farmers and charge only a normal commission. Cooperative societies or cooperative marketing thus is a voluntary association of farm producers for the joint sale of their surplus products. It is the system by which a group of farmers voluntarily pool their resources and join together to carry on some or all of the process in marketing of the agricultural produce.

## Strengthening Access to markets:

Farmers sell their produce to a weekly market within close proximity. While deciding which market to sell to, the most important factor is the price. Distance from the market and related transportation cost followed by infrastructure facilities are other considerations. Farmers get

knowledge about prices through word-of-mouth which is often unreliable making the farmer unable to demand the right price. The markets with weekly periodicity have been handling agricultural and non-agricultural products for last 40 to 50 years. The marketing system is in dire need of attention for development of infrastructure, expansion of market network and channels to help in delivering the benefits of marketing opportunities. At rural markets and primary markets, only unauthorized middlemen or agents of outside district operate as buyers. These middlemen neither maintain any documents nor issue any receipts. The method of sale is traditional, non-transparent and coercive.

Promoting the development of efficient and competitive system that can effectively respond to the changes require greater role of public and private sector in providing enabling environment for growth, increasing, enhancing market facilities and market information.

## Government Intervention:

The northeastern states like Assam, Meghalaya and Tripura have the legislation for the marketing of agricultural produce but there exist many problems in enforcing the Act in various markets in the states through the regulated market committees. Consequently a large number of rural markets are unorganized and should be brought into regulation in a phased manner. The management of rural professionally qualified managerial talent should replace the officers on deputation to facilitate long term planning and development of marketing institutions.

## Government schemes for promotion of Agriculture marketing:

The following are the most important agriculture schemes introduced by the government of India in recent times.

1. **eNAM:** National Agriculture Market (eNAM) is a pan-India electronic trading portal which networks the existing APMC mandis to create a unified national market for agricultural commodities. Small Farmers Agribusiness Consortium (SFAC) is the lead agency for implementing eNAM under the aegis of Ministry of Agriculture and Farmers' Welfare, Government of India. Whereas, in Northeast India particularly according to the E-NAM site it has been shown that eNAM has not been initiated as of yet.

2. **National Mission For Sustainable Agriculture (NMSA):** National Mission for Sustainable Agriculture (NMSA) has been formulated for enhancing agricultural productivity especially in rainfed areas focusing on integrated farming, water use efficiency, soil health management and synergizing resource conservation. NMSA will cater to key dimensions of 'Water use efficiency', 'Nutrient Management' and 'Livelihood diversification' through adoption of sustainable development pathway by progressively shifting to environmental friendly technologies, adoption of energy efficient equipments, conservation of natural resources, integrated farming, etc.

**Schemes under NMSA**

- Rainfed Area Development (RAD): RAD is being implemented by RFS Division
- Soil Health Management (SHM): SHM is being implemented by INM Division
- Sub Mission on Agro Forestry (SMAF): SMAF is being implemented by NRM Division
- Paramparagat Krishi Vikas Yojana (PKVY): It is being implemented by INM Division
- Soil and Land Use Survey of India (SLUSI): Being implemented by RFS Division
- National Rainfed Area Authority (NRAA): Being implemented by RFS Division
- Mission Organic Value Chain Development in North Eastern Region (MOVCDNER)
- National Centre of Organic Farming (NCOF): Being implemented by INM Division
- Central Fertilizer Quality Control and Training Institute (CFQC&TI): implemented by INM Division

3. **Pradhan Mantri Krishi Sinchai Yojana (PMKSY):** Government of India is committed to accord high priority to water conservation and its management. To this effect Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) has been formulated with the vision of extending the coverage of irrigation 'HarKhetkopani' and improving water use efficiency 'More crop per drop' in a focused manner with end to end solution on source creation, distribution, management, field application and extension activities.

4. **Paramparagat Krishi Vikas Yojana (PKVY):** The Paramparagat Krishi Vikas Yojana (PKVY), an initiative to promote organic farming in the country, was launched by the NDA government in 2015. According to the scheme, farmers will be encouraged to form groups or clusters and take to

organic farming methods over large areas in the country. The aim is to form 10,000 clusters over the next three years and bring about five lakh acres of agricultural area under organic farming. The government also intends to cover the certification costs and promote organic farming through the use of traditional resources. To avail the scheme, each cluster or group must have 50 farmers willing to take up organic farming under the PKVY and possess a total area of at least 50 acres. Each farmer enrolling in the scheme will be provided INR 20,000 per acre by the government spread over three years time.

5. **Gramin Bhandaran Yojna:** Create scientific storage capacity with allied facilities in rural areas.
   - To meet the requirements of farmers for storing farm produce, processed farm produce and agricultural inputs.
   - Promotion of grading, standardization and quality control of agricultural produce to improve their marketability.
   - Prevent distress sale immediately after harvest by providing the facility of pledge financing and marketing credit by strengthening agricultural marketing infrastructure in the country.

**6.** **Livestock insurance Scheme:** This scheme aims to provide protection mechanism to the farmers and cattle rearers against any eventual loss of their animals due to death and to demonstrate the benefit of the insurance of livestock to the people and popularize it with the ultimate goal of attaining qualitative improvement in livestock and their products.

7. **AatmaNirbhar Bharat Abhiyan:** The newly introduced AatmaNirbhar Bharat Abhiyan scheme in the midst of the 2020 Pandemic, the Government of India has introduced this as an economic package of Rs 20 lakh crores and will cater to the sustenance of labourers, middle class, cottage industry, MSMEs and other industries.

## CONCLUSION

Marketing of agricultural produces with the concept of win-win for both producer and consumer should be the new mantra for sustainable development in the region. The lockdown due to COVID 19 had forced the farmers as well as govt. to initiate new methodology for marketing of agricultural produces more particularly the perishable commodities. Online marketing and home

delivery of fruits, vegetables, meat, fish and such other commodities during lockdown period in cities like Guwahati, Shillong, Imphal have created a new opportunities for the youngster to take it as a vocation for employment with much more aggressive and systematic ways. A mobile App in the line of UBER/ OLA may be developed exclusively for marketing of the produces to ensure timely delivery of quality produces at reasonable price in selected locations of the region to promote complimentary and supplementary agriculture production system

## References:

1. https://economictimes.indiatimes.com/definition/marketing-mix
2. www.investopedia.com › Business › Business Essentials
3. http://www.marketingmo.com/strategic-planning/how-to-develop-your-distributionchannels/
4. AGRICULTURAL MARKETING SYSTEM IN ASSAM 2011-12, National Institute of Agricultural Marketing (NIAM) Jaipur Rajasthan
5. https://www.krishisandesh.com/role-cooperative-marketing-agricultural-produce/
6. International Journal of Multidisciplinary Research and Development Online ISSN: 2349-4182, Print ISSN: 2349-5979 Impact Factor: RJIF 5.72 www.allsubjectjournal.com
7. Adrian Payne, Malcolm McDonald, PennieFrow-Marketing Plans for Services_ A Complete Guide-Wiley (2011)
8. Peter Mudie, Angela Pirrie-Services Marketing Management, Third Edition (Services Marketing Management) (2006)
9. K. Douglas Hoffman, John E.G. Bateson-Services Marketing_ Concepts, Strategies, & Cases, 4th Edition -South-Western College Pub (2010)
10. https://www.unescap.org/sites/default/files/4-IOVE~1.pdf
11. https://simplicable.com/new/local-marketing
12. https://www.investopedia.com/terms/w/word-of-mouth-marketing.asp
13. https://www.marketingterms.com/dictionary/banner_ad/
14. https://asi.ucdavis.edu/programs/ucsarep/about/what-is-sustainable-agriculture/practices/direct-marketing

# ROLE OF DISTRICT AGROMET UNITS (DAMUs) IN CHANGING CLIMATE SCENARIO

**Mesaya Rangsa Marak**

Climate change, the present day's serious global concern is primarily caused by the increase of greenhouse gases like carbon dioxide, methane, and nitrous oxide in the atmosphere. Global warming, a consequence of climate change, refers to the observed increase in the average temperature of the air near earth's surface in recent decades. Changes in rainfall due to global warming will influence the hydrological cycle and the pattern of stream flows and demands (particularly agricultural), requiring a review of hydrologic design and management practices. The rainfall and temperatures (Singh et al., 2013) are the most important fundamental physical parameters among the climate as these parameters determine the environmental condition of the particular region which affects the agricultural productivity (Modarres and da Silva, 2007; Kumar and Gautam, 2014).

According to the NOAA 2019 Global Climate Summary, the combined land and ocean temperature has increased at an average rate of 0.07°C (0.13°F) per decade since 1880. However, the average rate of increase since 1981 (0.18°C / 0.32°F) is more than twice which is alarming. In terms of livelihood, smallholder rain-fed subsistence farmers and pastoralists are considered to be the most vulnerable to climate variability and change and need interventions to adapt their livelihood systems to changing climatic conditions (NMA, 2007; EPCC, 2015). In a highly agrarian community where the livelihood of the population is almost entirely dependent upon rain-fed agricultural production, analysis of precipitation and temperature patterns has paramount importance to cope with impacts on agriculture and allied activities and ecosystem management.

**Predicted effects of climate change on agriculture over the next 50 years:**

| Climatic element | Expected changes by 2050's | Confidence in prediction | Effects on agriculture |
|---|---|---|---|
| **CO2** | Increase from 360 ppm to 450 - 600 ppm (2005 levels now at 379 ppm) | Very high | Good for crops: increased photosynthesis; reduced water use |
| **Sea level rise** | Rise by 10 -15 cm Increased in south and offset in north by natural subsistence/rebound | Very high | Loss of land, coastal erosion, flooding, salinisation of groundwater |
| **Temperature** | Rise by 1-2$^{o}$ C. Winters warming more than summers. Increased frequency of heat waves | High | Faster, shorter, earlier growing seasons, range moving north and to higher altitudes, heat stress risk, increased evapotranspiration |
| **Precipitation** | Seasonal changes by ± 10% | Low | Impacts on drought risk' soil workability, water logging irrigation supply, transpiration |
| **Storminess** | Increased wind speeds, especially in north. More intense rainfall events. | Very low | Lodging, soil erosion, reduced infiltration of rainfall |
| **Variability** | Increases across most climatic variables. Predictions uncertain | Very low | Changing risk of damaging events (heat waves, frost, droughts floods) which effect crops and timing of farm operations |
| **Source: Climate change and Agriculture, MAFF (2000)** | | | |

## Role of District Agromet Units (DAMUs) to mitigate ill effects of Climate Change

The Government of India has come up with certain schemes to aid and create awareness through trainings, bulletins, mass media etc. to reduce the losses to minimum. Some of which are given below.

### ❖ Agrometeorology:

Agro meteorological services programme of the Ministry of Earth Science has a direct impact on agricultural production. The services are available in 550 districts. Farmers receive advisories before various stages of farming. Currently, about 25 lakh farmers are using this information through mobiles. This programme would be continued to have larger coverage with improved advisories, and having closer coordination with State government authorities.

### Objectives:

1. To improvise the existing district level Agromet Advisory Services (AAS) so as to deliver crop and location specific AAS to farmers at block level.
2. To design optimum observatory network for issuance of village level advisories for implementation of crop weather insurance.
3. To establish District Agromet Units as nodal centre for catering the needs of agriculture services.
4. To provide customized advisory bulletins through last mile connectivity to farmers with personalized agromet advisory services.
5. To extend the weather based advisory service to the allied areas like livestock, grazing of farm feed etc.
6. To establish appropriate dissemination and support system for weather-based crop insurance in the country.

The following table indicates the state wise distribution of the agro-meteorological services to be rendered by the Ministry of Earth Science in a phased manner.

| AGROMET ADVISORYSERVICE(AAS)BULLETINS(STATEWISE) | | | | | |
|---|---|---|---|---|---|
| **S.No** | **State** | **No. of districts** | **S. No.** | **State** | **No. of districts** |
| **1** | Andhra Pradesh | 22 | 15 | Manipur | 9 |
| **2** | Assam | 26 | 16 | Meghalaya | 7 |
| **3** | Arunachal Pradesh | 14 | 17 | Mizoram | 8 |
| **4** | Bihar | 38 | 18 | Nagaland | 11 |
| **5** | Chhattisgarh | 20 | 19 | Orissa | 29 |
| **6** | Gujarat | 26 | 20 | Punjab | 16 |
| **7** | Haryana | 21 | 21 | Rajasthan | 33 |
| **8** | Himachal Pradesh | 12 | 22 | Tamil Nadu | 34 |
| **9** | Jammu & Kashmir | 17 | 23 | Tripura | 8 |
| **10** | Jharkhand | 24 | 24 | Uttar Pradesh | 71 |
| **11** | Karnataka | 30 | 25 | Uttarakhand | 6 |
| **12** | Kerala | 14 | 26 | West Bengal | 18 |
| **13** | Madhya Pradesh | 50 | 27 | New Delhi | 1 |
| **14** | Maharashtra | 32 | 28 | Andaman & Nicobar | 1 |

**Implementation Plan:**

District Agromet Units (DAMUs) would be set up to address the objectives at block level. It will strengthen the existing centres of (SAU's), ICAR and Krishi Vigyan Kendras. Preparation of high resolution weather forecast at block/taluka level is required. It is proposed to start issuing the forecast, particularly for the agromet service at relatively smaller areas at sub-district level. Efforts

are to be increased to disseminate the advisories and cover 50 percent of farming community. Need-based agromet advisory services are to be rendered for the farmers engaged in cultivation of commercial field crops and horticultural crops involving Crop Growers Associations for important cash crops like tea, coffee, apple, mango, sugarcane, cotton, grapes, etc. Application of Remote Sensing in AAS (crop, productivity and soil moisture status of a region under water stress, other biotic or abiotic conditions along with the possibility of forewarning pest and disease outbreak for smaller areas) is to be expanded. Training to extension workers as well as farmers along with climate awareness programmes is also important, and should be planned. The studies will be undertaken to observe whether based advisories and its positive impact on the overall yield and also how best can help in decreasing the cost of cultivation. These exercises will be carried out at all the field units and DAMU stations.

**Deliverables:**

- Improved district scale agromet advisory services and experimental generation of sub-district scale agromet advisories
- Development of customized advisories for livestock and grazing of farm feed (in drought prone areas)

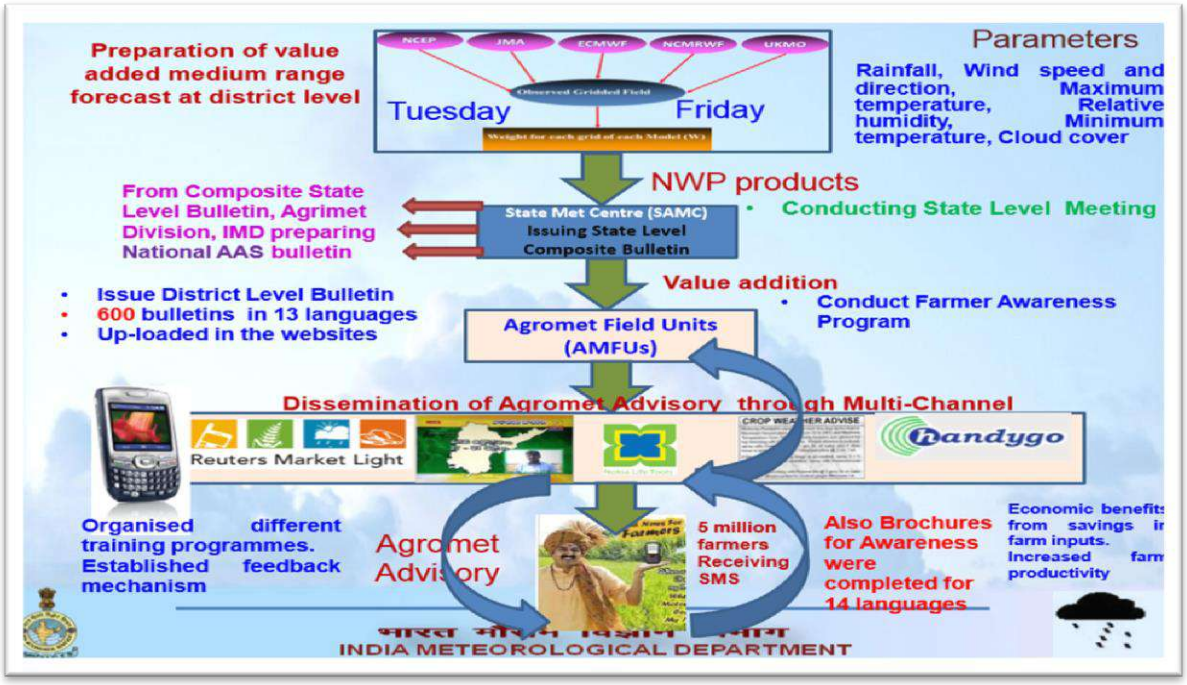
### ❖ Gramin Krishi Mausm Seva

Though district level medium range forecast is generated, there is an urgent need to develop and issue high resolution accurate weather forecast at sub-district level to prepare crop & location specific advisory. Expansion and strengthening of existing set up at ACZ level needs to graduate at district level. Need to strengthen Observation, Manpower, Real Time Information Flow, Research and Development (R&D), Dissemination, in order to generate Accurate Weather Forecast for the benefit of the end user Farmer.

**Objectives of GKMS:**

To improve the existing District level Agromet Advisory Services (AAS) to the sub district level and in pilot mode at block level.

1. To establish District AgroMet Units (DAMU) in 240 selected districts, in addition to already operating 130 AMFUs /DAMUs, in order to meet the said expansion.
2. To expand the existing channels of communication of weather based agromet advisory to the farmers through on line mode.
3. To establish Agromet Data Centre, as part of the National Data Centre of IMD, for archiving and reaping maximum benefits out of agro meteorological information.
4. Creation of Cell for Research and Excellence in Agrometeorology (CREAM) in IMD New Delhi, for converging the R&D needs for operational Agromet services.




## Dissemination of Agromet Advisory

1. Mass Mode: All India radio, Television, Print Media
2. Outreach at Village level:
   - Ministry of IT Internet based Village Connectivity
   - Web Pages: IMD, SAUs, ICAR Web Pages
   - Mobile Phones (SMS & IVRS) through Public & private agencies

- "Kisan SMS", a portal for farmers under www.farmer.gov.in 5 million farmers
- Kisan Call Centres

## Human face for advisory dissemination:

- KVK (ICAR):Training + interaction
- DAO (SDA): Coordinate Farm inputs with Line Dept. in rhythm of weather forecast
- NGOs & other intermediary groups, Awareness Programme.
- To make farmers become more self-reliant in dealing with weather and climate issues that affect agricultural production on their farms.
- To increase the interaction between the farmers and the Agro-meteorological Service providing agencies i.e. IMD, SAUs, ICAR etc.
- The overall goal is "to secure farmer self reliance, through helping them better informed about effective weather and climate risk management by sustainable use of natural resources for agricultural production".

## Agromet Advisory Services in North East India

District Agromet Units (DAMUs) were set up to strengthen the existing centres of (SAU's), ICAR and Krishi Vigyan Kendras. The DAMU units established in North East Indian States are given below:

| S.No. | State | KVKs |
|---|---|---|
| **1** | Arunachal Pradesh | Namsai and Papumpare |
| **2** | Assam | Cachar, Hailakandi, Borpatra, Darrang, Dhubri, Baks, Udalguri, Goalpara |
| **3** | Manipur | Chandel |
| **4** | Meghalaya | West Garo Hills and West Khasi Hills |
| **5** | Mizoram | Mamit |
| **6** | Nagaland | Kiphire, Mokokchung |
| **7** | Tripura | Dhalai |
| **8** | Sikkim | West Sikkim and East Sikkim |

**The state wise AMFUs set up in North East India are:**

| S.no | State | AgroMet Field Units (AMFU) |
|---|---|---|
| **1** | Arunachal Pradesh | Basar |
| **2** | Assam | Jorhat, Nagaon, Karimganj,Sonitpur, Kokrajhar,Diphu |
| **3** | Manipur | Chandel |
| **4** | Meghalaya | Barapani |
| **5** | Mizoram | Kolasib |
| **6** | Nagaland | Jharnapani |
| **7** | Tripura | Lembucherra |
| **8** | Sikkim | - |

IMD has set up a network of AFMUs, which are multidisciplinary units used for preparation and dissemination of agromet advisories. There is a considerable scope for decreasing the vulnerability of agriculture to increasing weather and climate variability through weather forecast based agro-advisories. The parameters recorded by each Agromet Field Unit (AMFU) are Rainfall, Temperature (min and max), Relative Humidity, Wind Speed, Wind direction and cloud coverage.

## Agromet advisory services:

- Weather Summary of the recent days (4 days) and Short-Medium Weather forecast
- Agricultural Advisories like the type of main crops that can be sown, varieties that are best suited for the region along with the various operations like sowing, weeding, fertilizer application, etc. that has to be conducted in 4-5 days. They also forecast the incidences of the possible outbreak of pests and diseases and likewise give the recommendations on the control measures that can be taken.
- Animal Science Advisories including the care and precautions to be taken in rearing of poultry, piggery, cattle, etc. Hygienic management of animal houses, proper diet, and requirement of heath supplements and vaccines for the animals at different growth stages are included in this

section. The probabilities of outbreak of various diseases are also noted and likewise control measures are given alongside the diseases.

- Fishery advisory gives information on the type of fish species to be reared in the region, the feed requirements and disease (if any) control measures.

## Conclusion:

NEH region is most vulnerable to climate change in India. Small scale and marginal farmers are most vulnerable to current climate variability as well as projected climate change. With the help of District agromet units there have been major improvement in response to climate change adaptation. With greater understanding of the risk and vulnerability to climate change it is important to accelerate its efforts further. In summary, adaptation to climate change is still a relatively new field of work. Apart from the high priority of reducing emissions of greenhouse gases through mitigation, the importance of dealing with inevitable impacts of climate variability and change through adaptation is being recognized. The ultimate goal of attaining farmer's self-reliance, through DAMU's will definitely be achieved through effective provision of advisories for weather and climate risk management.

## References:

1. Epcc (***ethiopian*** panel on climate change). 2015. First assesssment report. Working group ii agriculture and food security. ***Ethiopian*** academy of sciences. Addis, ababa, ethipoia.
2. Kumar, R. and Gautam, H.R. (2014) Climate change and its impact on agricultural producti ity in India. Journal of Climatology and Weather Forecasting, 2, 109. https://doi.org/10.4172/2332-2594. 1000109.
3. Modarres R. and da Silva, V.P. (2007) Rainfall trends in arid and semi-arid regions of Iran. Journal of Arid Environments, 70, 344–355.
4. Nma, 2007. Climate change national adaptation programme of action (napa) of ethiopia national meteorological agency. Addis, ababa, ***ethiopia***.
5. Singh, O., Arya, P. and Chaudhary, B.S. (2013) On rising temperature trends at Dehradun in Doon valley of Uttarakhand, India. Journal of Earth System Science, 122, 613–622

# INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) AND ITS ROLE IN BRINGING AGRICULTURE REVOLUTION IN NORTH EAST INDIA

**Lawanrisha Lyngdoh**

"The right signal is that technology is going to boost (Economic) development of our nation."

*-A.P.J. Abdul Kalam*

According to UNESCO (2002) information and communication technology (ICT) may be regarded as the combination of 'Informatics technology' with other related technology, specifically communication technology. It refers to technologies that provide access to information through telecommunication. It is similar to Information Technology (IT) but focuses primarily on communication technologies. This includes the internet, wireless networks, cell phones and other communication mediums (Ratheeswari, 2018). ICT has become one of the basic building blocks of modern society within a very short time (Daniels 2002). Many countries now regard understanding ICT and mastering the basic skills and concepts of ICT as part of the core of education, alongside reading, writing and numeracy. Pelgrum and Law (2003) stated that near the end of the 1980s, the term 'computers' was replaced by 'IT' (information technology) signifying a shift of focus from computing technology to the capacity to store and retrieve information. This was followed by the introduction of the term 'ICT' (information and communication technology) during 1992, when e-mail started to become available to the general public. The various kinds of ICT products available and having relevance to education, such as teleconferencing, email, audio conferencing, television lessons, radio broadcasts, interactive radio counseling, interactive voice response system, audio-cassettes and CD ROMs etc. have been used in education for different purposes (Sharma, 2003; Sanyal, 2001; Bhattacharya and Sharma, 2007).

## ICTs in Agriculture

The Indian Agriculture sector is a gigantic sector contributing 17 percent as its share to the gross domestic product (GDP) in the economy. Agriculture research and extension can help to meet the increasing demand for food grains. Even though we have a large economy, agriculture lags behind due to poor connectivity and disintegration of market, unreliable and delayed information to the farmers, small land holdings, non adoption or less adoption of improved technology and so on. It is therefore required to explore various ways to keep our farmers updated about modern technologies and relevant information to keep up with the current technologies.With the introduction of information and communication technologies (ICTs), the traditional agriculture has been reformed and thus contributing to the significant improvements in agricultural and rural development in the country.

Empowering farmers with the right information at the right time and place is essential for promoting the efficiency and viability of all small and marginal holdings. Large data and information can be effectively generated, stored, analyzed, disseminated and used to upgrade agriculture by use of various ICT tools. This may result in increasing the production many folds by providing prompt, reliable and locality based information services to the farmers. However, we are bound to ponder on the limiting aspects of using technologies in a developing country like India. While these initiatives are intended to address the needs of the farmers through ICT, their actual usage and their ability to bring significant impact on the farm productivity and socio-economic development of the intended beneficiaries actually use the facilities provided for them meaningfully to meet their needs. The common problems in adoption of ICTs in rural segments are ICT illiteracy, availability of relevant and localize contents in their own languages, easy and affordable accessibility and other issues as awareness and willingness for adoption of new technologies among the rural people etc. Thus, there is a need to understand as to how far the ICT initiatives are able to address the farmers' need so that better solutions can be developed to address those unmet needs.

## Role of ICT in Agriculture

Information and Communicational Technology (ICT) has many roles to perform for agricultural development starting from decision support system to the trading of crops.

## Decision Support System

ICT has a great role as decision support system to the farmers. Through ICT, farmers can be updated with the recent information about agriculture, weather, new varieties of crops and new ways to increase production and quality control. The dissemination of adequate, efficient and tailored technologies related to agro-climatic zone, size of farm and soil type etc. to the farmers is deficient in Indian agriculture and it is the real challenge in front of policy makers in India (Bahl, 2008). Information and communication technologies can broadcast the precise and authentic information at right time to the farmers so that they can utilize it and get benefits. The decision support system through ICT facilitates farmers for planning type of crops, practicing good agricultural practices for cultivating, harvesting, post harvesting and marketing their produce to get better results. Varied information is required in agriculture based on the different agro climatic regions, size of land holdings, types of crops cultivated, technology followed, market orientation, weather condition, etc. As reported by many researchers, 'question and answer service' was perceived as the best facility by majority of the farmers to get personalized solutions to their specific agricultural problems (USAID, 2010).

## Widen Market Access

One of the major drawbacks in Indian agriculture is complex distribution channels for marketing of agricultural produce. Farmers do not get acquainted with the updated prices of commodities, proper place for selling their produces. ICT has the great potential to widen marketing horizon of farmers directly to the customers or other appropriate users for maximum benefit. Farmers may connect directly with many users and may get information about current prices for their commodities. They can get access to the market sitting at home. Further, it will curtail the role of middlemento a great extent, thereby benefiting the farmers. This can improve farmer's source of revenue; empower farmers for making good decisions about appropriate future crops and commodities and marketing channels to sell their produce as well as to get inputs (Singh *et al*, 2017).

## Strengthen and empower farming community

ICT technologies can help for strengthening farming communities through wide networking and collaborations with various institutes, NGO's and private sectors. Further, farmers may enhance their own capacities through updated information and wide exposure to scientific, farming and trade community (Singh *et al*, 2017).

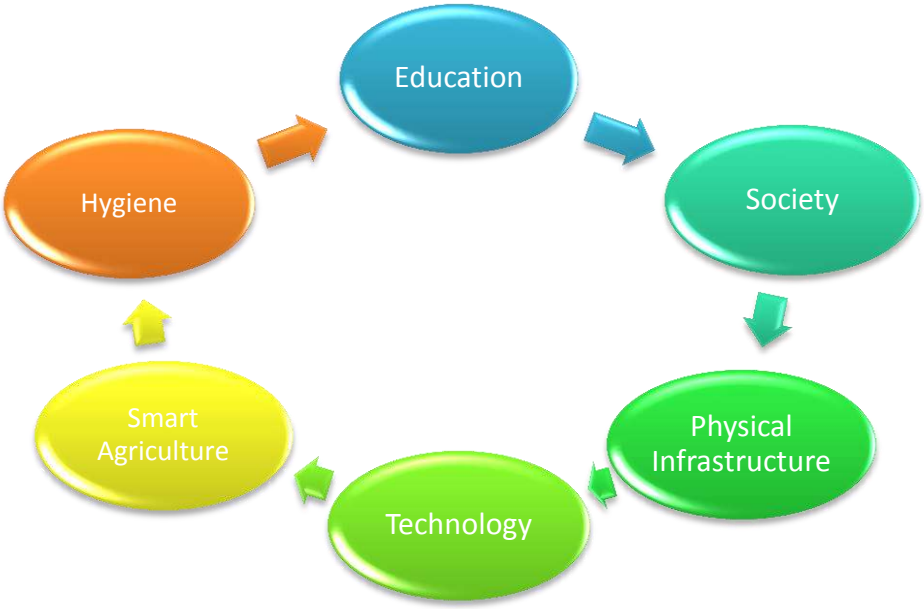



**Fig-1: Components of ICT**

## Types of ICTs

**Radio:**Radio has brought changes in different sectors of the society, radio broadcast agriculture programmes and latest information for farmers. Radio has provided new approaches and knowledge to millions of people in remote areas. The radio is an effective tool of communication especially for illiterate farmers to gather information on various kinds on agriculture and other features to keep them up to dates about their knowledge and services. The credibility regarding radio information is one of the most important elements of communication process and its success will grow proportionally if the receivers of the information perceive the sources to be trust worthy and competent (Sadaqath and Mariswamy, 2007).

**Television:** Television disseminates scientific and agricultural knowledge among farmers and provides latest information with the discussion of agriculture experts.

**Internet:** The internet is a virtual, artificial environment which is experienced by sight and sound. Internet has created a room for farmers to get latest information on market. Farmers mostly were using Internet and their emails for communicating with their family and friends in other places of the country. Nowadays farmers are using different websites for getting the information about proper use of pesticides in their farms (Joshi and Ayyangar, 2010).

**Mobile:** The mobile phone has reduced the gap among traders and farmers and at same time farmers directly communicate with buyers and customers to find the good price of their product.

**Table-1: Brief description on use of ICT tools in the country**

| Sl. No. | ICT Tools | Features | Examples in India |
|---|---|---|---|
| **a)** | Radio | Community radio Stations<br>Special Audience Programs | Namma Dhwani Community Radio (Karnataka)<br>Kutch MahilaVikasSangathan (Gujarat)<br>Deccan Development Society (Andhra Pradesh) |
| **b)** | Television | Programme Broadcasting | Kisan TV<br>KrishiDarshan<br>PrasarBharati |
| **c)** | Internet | Web Portals<br>Video conferencing<br>Kiosk<br>Global Positioning System (GPS)<br>Geographic information System (GIS) | E-Krishi (Kerela)<br>ASHA (Assam)<br>AGRISNET<br>AGMARKNET<br>e-choupals (ITC) |
| **d)** | Mobile | Audio conferencing<br>SMS (short message service)<br>Voice Message<br>Mobile Application | mKrishi<br>mKisan<br>PMKISAN<br>IFFCO KISAN |

## Benefit of using ICT tools in Agriculture

- Easy access to government information and services by promoting e-Governance.
- Increases efficiency, productivity and sustainability of farmers.
- Precise information on early warning systems, pest and disease control, new varieties, production and quality control.
- Employment generation in various rural information centres.
- Decision making in marketing of the future crops and commodities.
- Up to date information on prices for inputs, commodities and consumer trends in the market.
- Empowerment of rural communities by strengthening human resource development and capacity building of the farmers.
- Easy access to business opportunities and better contact with communities.
- Promote gender equality as technologies are gender neural.

## Research findings on different ICT Tools

| a. | **Radio** |
|---|---|
| | Very high frequency (VHF) Radio broadcast on weather forecast through loudspeakers to inform the fishermen about low and high wave's before going to sea for fishing and use the pesticides in their field (Rao, 2004). The use of Radio among farmers in remote areas is still popular and most of farmers depend on traditional media such as radio and newspaper. These media channels could transfer information among farmers in remote areas and can enhance the knowledge and skills for the development of agriculture (Ani& Baba, 2009). |
| **b.** | **Television** |
| | Television has created awareness and knowledge among farmers about use of technologies in farming. Mostly the masses depend on media for getting the information regarding education, health and agriculture (Age, 2012). A study indicated that in various issues related to agriculture like bad weather situation, the television is one of the most important source for disseminating agricultural related information among farmers (Nazaril& Hassan, 2011, Loges, 1994) |

| c. | Internet |
|---|---|
| | Mori &Assumpção (2007) reported that community Internet access centres provided good opportunities to people. This approach could focuses on the major number of decentralized initiatives, where in the farmers of rural areas are getting benefits. Internet is one of the most important sources of finding information about agriculture as well as other related issues (Burke &Sewake, 2008). |
| **d.** | **Mobile** |
| | Mobile phones have created a new business opportunities for the poor farmers and has given the access to information about market, health and weather services in remote areas. The uses of mobile phones among farmers have played positive impact in their income and productivity due to timely contract between farmers and buyers to sell their product in good price (Fafchamps& Hill 2005). Due to the availability of mobile phones, the farmers need not to go to market to enquireabout the price of their product and thereby save their money, time and energy (Muto*et al.* 2011, Lee *et al,* 2013).Farmers are using SMS services for keeping the up to date information about weather as well as use of pesticides in their farms (Murthy, 2009). |

## ICTs in North East India

The North Eastern Region of India comprises of seven sisters (Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Nagaland, Tripura) and one brother-Sikkim. These states are characterized by their unique geographical area and location having vast potential for economic growth. One of the impediments in this area is the lack of connectivity which is accounts to underdeveloped infrastructure that includes transportation, digital infrastructure, market linkages, etc. The need for rural development has paved the way for the importance of Information and Communication technologies in rural development. Due to the tough terrain and remote locations in North East India, the farmers face difficulty in reaching nearest CD (Community Development) Block office to get help and assistance for agricultural development. They need assessment related to the field surveys, analysis of Kisan call centre (KCC) logs and various researches from the field. Intelligent Advisory System for Farmers (IASF), a project of Centre for Development of Advanced Computing (CDAC), Mumbai in collaboration with Department of Agriculture Manipur, Meghalaya and Central

Agricultural University, Imphal has come to the aid of more than 1800 farmers residing in 9 districts of Manipur and 5 districts in Meghalaya. Funded by DEITY, Ministry of Information Technology, Government of India, this project integrates web technologies with mobile services to connect farmers to agricultural experts and KVK Scientists in real time.

The Census, 2011 reveals that the average number of households with internet in terms of percentage in NER is below the all India average of 3.1 percent while Assam has one of the lowest percentage in terms of households with internet.

**Table-2: State-wise Internet Users in North Eastern Region**

| States | Households | Phone users | % | Landline | % | Mobile | % | Both | % |
|---|---|---|---|---|---|---|---|---|---|
| Sikkim | 128131 | 93536 | 73 | 2306 | 1.8 | 86745 | 67.7 | 4485 | 3.5 |
| Arunachal Pradesh | 261614 | 126360 | 48.3 | 7587 | 2.9 | 104122 | 39.8 | 14650 | 5.6 |
| Nagaland | 399965 | 212381 | 53.1 | 5200 | 1.3 | 194383 | 48.6 | 12799 | 3.2 |
| Manipur | 507152 | 291612 | 57.5 | 15215 | 3 | 265240 | 52.3 | 11157 | 2.2 |
| Mizoram | 221077 | 160944 | 72.8 | 3758 | 1.7 | 141268 | 63.9 | 15918 | 7.2 |
| Tripura | 842781 | 405378 | 48.1 | 17698 | 2.1 | 359867 | 42.7 | 27812 | 3.3 |
| Meghalaya | 538299 | 231469 | 43 | 8074 | 1.5 | 210475 | 39.1 | 12919 | 2.4 |
| Assam | 6367295 | 3049934 | 47.9 | 140080 | 2.2 | 2763406 | 43.4 | 146448 | 2.3 |
| India | 246692667 | 155909766 | 63.2 | 9867707 | 4 | 131240499 | 53.2 | 146448 | 6 |

Source: India 2011 Census data State wise internet users

## Prospects of ICTs in North East Region

Firstly, agriculture and allied sectors are the backbone of NER, the region produces tea, bamboo, silk, herbal pants, rubber, etc. Secondly, NER has the boundary with many neighboring countries of India and this can act as a gateway for international trade. Thirdly, the availability of educated youth can contribute to the workforce required to strengthen ICTs and lastly NER is blessed with rich natural resources, if it is utilized efficiently, it can boost export potentiality of the country.

## Proposed Framework of ICT in agriculture in North East India

A framework can be worked out for North East Region of India keeping in mind the requirements, physical and infrastructural background and constraints of the farmers to disseminate the related information regarding agriculture related issues. Farmers can be educated by field workers to directly access the agriculture information using various ICT tools. A Kiosk may be developed to broadcast and disseminate information on agricultural practices, weather forecast, schemes available, and procurement of inputs and marketing of the produce. Agriculture experts can be contacted only when required genuinely and coordinators can answer to the queries of the clients. This model will require various stakeholders to coordinate among themselves to form a network working in activities such as providing information, supply of inputs, transportation of produce, processing and marketing. If the farmers are unable to browse or comprehend information from the system, the field coordinators can assist them by providing a helpline number or by using the Common Service Centers (CSCs). More advanced and high tech tools can be included to this model. Other non agricultural aspects such as, rural educational, health, employment, e-governance can also be incorporated in the model. This will benefit not just the farming community but other clients of the rural population.

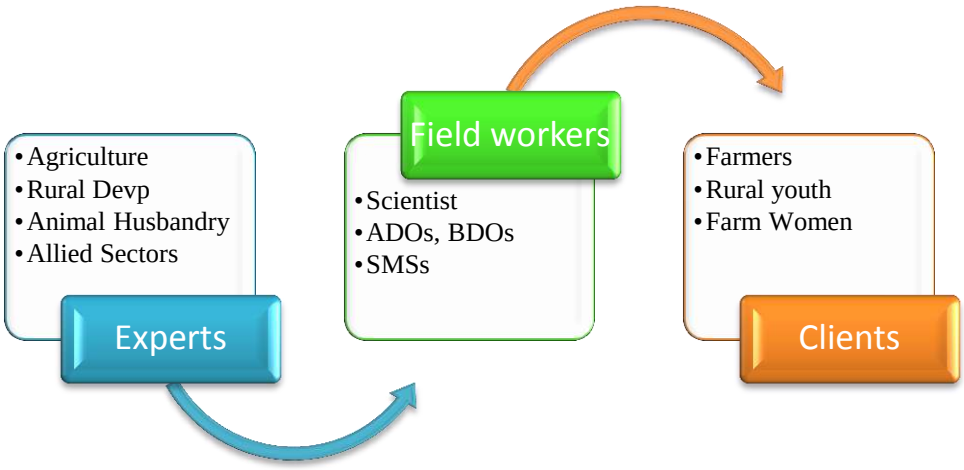



**Fig 2: Flow of information among the stakeholders**

## Conclusion

With the advancement in Information and communication technologies (ICT), people in rural India can connect with markets, access banking and financial services. ICT helps in accessing price information from national and international markets. There are dedicated apps that help in maneuvering the status of the crops and irrigation system remotely. It also helps in training farmers with innovative techniques for better production and also supports in creating future opportunities for agricultural sector. One of the effective tools of ICT is the internet and India has become a major economy which has witnessed a rapid growth of telecommunication technology in urban and rural spheres. This new age technology is helping India to create new chapters of development and formulate broader discourses of participatory development. However, despite the rapid advancement of ICT the main problem lies in the adoption process. Still there is a large population in communities who are facing certain problems in accessing this technological advancement due to illiteracy. To deal this issue, major organization such as Microsoft, Google are actively engaged in enhancing digital literacy and providing the resources for the availability of relevant and localized contents in their own languages. (Chanda, 2017). Further research can be conducted to build different ICT models specific to the different states of North Eastern part of the country. Such research can assist stakeholders and policy makers of the country to evaluate the existing ICT projects in agriculture and allied sectors to develop an effective and demand driven model relevant to the clients concerned.

## References

1. Age, A., Obinne, C., and Demenongu, T. (2012). Communication for sustainable rural and agricultural development in Benue State, Nigeria. *Sustainable Agriculture Research* 1 **(1)**:118-129.
2. Ani, A. and S. Baba. (2009). Utilization of selected electronic mass media as sources of agricultural information by farmers in Northern part of Taraba state, Nigeria. *Tropical Agricultural Research & Extension* 12 **(1),** 17- 21.
3. Bahl, M. S. (2008). Rural India and Inclusive Growth: ICT in Agricultural Marketing. Retrieved from:http://www.nistads.res.in
4. Bhattacharya, I. and Sharma, K. (2007), 'India in the knowledge economy – an electronic paradigm', *International Journal of Educational Management* 21 (6): 543- 568.
5. Burke, K. and Sewake K (2008) Adoption of computers and internet technology in small firm agriculture: A study of flower growers in Hawaii. *Journal of Extension*. 46: 5 19.
6. Chanda N. (2017). Communication, Technology and Community: Envisaging an ICT Development Model in North-East India. *Intellection: A Bi-annual Interdisciplinary Research Journal* 5**(1):** 2319-8192.
7. Daniels J.S. (2002). Foreword" in Information and Communication Technology in Education– A Curriculum for Schools and Programme for Teacher Development. Paris: UNESCO.
8. Fafchamps, M and Hill R. V. (2005). Selling at Farm gate or Traveling to Market." American *Journal of Agricultural Economics* 87**(3):** 717-734.
9. Joshi H and Ayyangar G. V. (2010). ICT: A boon for fishermen community. *Journal of Gobal Communication* 3**(1):** 8-13.
10. Lee, K. H., and Bellemare, M. F. (2013). Look who's talking: the impacts of the intra house hold allocation of mobile phones on agricultural prices. *The Journal of Development Studies* 49 **(5):** 624-640.
11. Loges, W.E. (1994). Canaries in the coal mine: perceptions of threat and media system dependency relations. *Community Research* 21 **(1)**: 5–23.

12. Mori C. K. and Assumpção R. O. (2007). Brazilian digital inclusion pubic policy: achievements and changes. *Journal of community Informatics*. 3**(3):** 123-128.
13. Murthy, C.S.H.N. (2009). Use of convergent mobile technologies for sustainable economic transformation in the lives of small farmers in rural India. *The Turkish Online Journal of Distant Education* 10 **(3):** 32-4.
14. Muto, M., and Yamano, T. (2011). Mobile Phone Coverage and Market Participation: The Case of Banana Marketing in Uganda Emerging Development of Agriculture in East Africa. *Springer*. 99-113.
15. Nazaril, M., Bin, H., and Hassan, S. (2011). The role of television in the enhancement of farmers' agricultural knowledge. *African Journal of Agricultural Research* 6**(4):** 931-936.
16. Pelgrum, W. J., Law, N. (2003) "ICT in Education around the World: Trends, Problems and Prospects "UNESCO-International Institute for Educational Planning. Available: www.worldcatlibraries.org/wcpa/ow/02d077080fcf3210a19afeb4da09e526.html
17. Rao N. (2007). A framework for implementing information and communication technologies in agricultural development in India. *Technological Forecasting and Social Change*, 74**(4):** 491-518.
18. Ratheeswari K. (2018). Information Communication Technology in Education. *Journal of Applied and Advanced Research* 3**(1):**S45 S47
19. Sadaqath S. and Mariswamy H. K. (2007) Analysis of usefulness and credibility of radio as perceived by iterate farmers. *Journal of Farm Science* 20**(4)**
20. Sanyal, B. C. (2001), 'New functions of higher education and ICT to achieve education for all', Paper prepared for the Expert Roundtable on University and Technology-forLiteracy and Education Partnership in Developing Countries, International Institute for Educational Planning, UNESCO, September 10 to 12, Paris.
21. Sharma, R. (2003), 'Barriers in Using Technology for Education in Developing Countries', IEEE0-7803-7724-9103.Singapore schools', Computers & Education 41 (1): 49--63.
22. Singh S, Ahlawat S. and Sanwal S. (2017). Role of ICT in Agriculture: Policy implications. *Oriental Journal of Computer Science and Technology* 10**(3**): 691-697

23. UN (1999-2000). World communication and information report. Retrieved from:unesdoc.unesco.org
24. UNESCO (2002). Information and Communication Technology in Education–A Curriculum for Schools and Programme for Teacher Development. Paris: UNESCO.
25. USAID (2010). ICT to Enhance Farm Extension Service in Africa, Briefing Paper.

# INNOVATIVE EXTENSION METHODOLOGIES FOR REACHING THE UNREACHED BY KVKS IN NORTH EAST REGION

**Deinichwa Dkhar**

Extension system in the present Indian setting comprises of all those agencies in public, private, PPP, NGO and community based enterprises that give a scope of agricultural advisory services and encourage technology application, transfer and management. Principally, the Department of Agriculture was the main agricultural extension organization in the 60s and 70s. The recent two decades have seen the expanding contribution of private sector, NGO and community based initiatives and mass media driven methods. With the end of T & V (Training and Visit) system of extension in the early 1990s and the external support drying up, states have been left to finance their extension machinery and this has prompted impressive debilitating of public sector extension.

As indicated by the National Sample Survey (NSSO, 2005), 60 percent of farmer households did not access any information on modern technology that year. NSSO (2014) illustrated that 59 percent of the farm households received no assistance from either government or private extension services and of the 41 per cent households who received extension assistance, only 10 per cent of the services came from public extension agencies including extension workers, KVKs and State Agricultural Universities. The key challenges encountered by public extension is the failure to consider farmer's needs, perceptions and location-specific conditions for agricultural extension, prompting to significant gaps between the public sector institutions and farmers (Sulaiman *et al., 2011*). In India, an extension worker to farmer ratio is 1:5000 (Ragasa *et al.,* 2013).

The core of any extension programme is personal contact between farmer and change agent. The term 'extension' itself is more recent; it originates from academia, and it was first used in Britain in the 1840s, in the context of 'university extension' or 'extension of the university'. In a similar manner, the term 'extension education' has been used in the USA since the early 1900s to indicate that the target group for university teaching ought not to be limited to students on campus but ought to be extended to

people living anywhere in the state. Here, extension is seen as a form of adult education in which the teachers are staff members of the university. In Britain the term extension was replaced by 'advisory service' in the 20th century (Musadoto, 2018).

Innovative Methods, by and large, are systematic and effective ways and means of reaching working objectives. Extension method refers to the techniques of communication between extension workers and farmers with the intention of motivating and enabling them to discover means of solving their problems (FAO, 2019). Methods related to influencing processes, and thus determining methods means thinking in terms of phases and consequences and of how it might be best to proceed. Methods utilized must be absolutely adjusted to the conditions, on the grounds that the utilization of any correspondence procedures relies upon the quantity of individuals to be tended to, the problem to solve and the capability of the extension service.

## About KVK

To oblige the necessities of farmers and for transfer of technology from lab to land, Krishi Vigyan Kendras (KVKs) have been set up by different SAUs as well as Government under ICAR framework in all the states. Endeavors have additionally been made by the private organizations (NGOs) with this impact. At present, there are 717 KVKs (ICAR, 2020) which interact with farmers and bestow training and knowledge about the new technologies and practices. The KVKs have two roles: one is training of farmers in new technologies and another is demonstration.

KVKs work on the principle of collaborative participation of scientists, subject matter experts, extension workers and farmers. The main purpose of KVKs is to impart learning through "work experience" to those who are engaged in farming. The syllabus and programme of each KVK is tailor-made to the felt needs of the farmers, resources and potential for agricultural growth in a particular area. The first KVK was established in 1974 in Pondicherry under Tamil Nadu Agricultural University (TNAU).

## Extension Methods

The channels or method of communication is called extension teaching methods. The choice of the method generally depends on the number and location of the target audience and the time available for communication. They are categorized as individual method, group method and mass method. Each of the method has both advantages and limitations. The Extension Agent has to choose a particular method or combination of methods according to the needs of the situation (JICA, 2008).

**Table 1: Categorization of extension methods**

| Category | Events |
|---|---|
| **Individual Extension Methods** | • Individual Farm Visit<br>• Farmers call or office call<br>• Personal letter/telephone call<br>• Adoptive or mini-kit trial<br>• Farm clinic |
| **Group Extension Methods** | • Demonstrations<br>• Field Days or Farmers day<br>• Folk Media<br>• Group Meetings<br>• Motivational Tours<br>• Participatory Technology Development<br>• Training Days<br>• Farmer Field School |
| **Mass Media and Audio Visual Aids** | • Broadcast media (Radio, TV)<br>• Print media (Leaflet, folder, bulletin, newsletter, magazine)<br>• Projected media (Film, video)<br>• Others (Exhibition, campaign, mass meeting, Agricultural festival) |

## Individual methods

In this method, the Extension Agent communicates with the people individually, upholding separate identity for each person. This method is adopted when the number of people to be contacted are few,

are conveniently located close to the Extension Agent and sufficient time is available for communication.

**Farm clinic** is a facility established and stretched out to the farmers for diagnosis and treatment of farm problems and to provide some expert advice to individual farmers. The extension agency may set up farm clinics in the village and/or in the organizations head-office and sub-centers in collaboration of with the Extension Agents. Here, farmers get the opportunity to meet with the relevant Subject Matter Officer to obtain solutions for their problems directly. This may be coupled with field visits, on-the-spot examination and diagnosis with guidance or follow up. This method is suitable for treatment and prevention of health problems relating to crops and livestock.

According to NHM (2012) a **Plant Health Clinic** was established at Krishi Vigyan Kendra, Akola under National Horticulture Mission in 2012-13 for diagnosis of the disease samples and suggesting remedies. The Plant Health Clinic advice farmers on pests and diseases in the way a health centre does for humans. Farmers come with samples of diseased plants to get the problem identified and to learn what to do about it. It will help to increase their crop yields with less expenditure on expensive pesticides/fungicides increasing their average household income. Plant health clinics will help the farmers of the area to deal with endemic pests and diseases and also help to create an early warning system for those that are spreading.

## Advantages

i) Helps the Extension Agent in building rapport.
ii) Facilitates gaining first-hand knowledge of farm and home.
iii) Helps in selecting demonstrators and local leaders.
iv) Helps in changing attitude of people.
v) Helps in teaching complex practices.
vi) Facilitates transfer of technology.
vii) Enhances effectiveness of mass and group methods.
viii) Facilitates getting feedback information.

## Limitations

i) Time consuming and relatively expensive.

ii) Has low coverage of audience.

iii) Extension Agent may develop favoritism or bias towards some persons.

## Group methods

A group is an aggregate of small quantity of people in mutual communication and interaction around some common interest. In group method, the Extension Agent interacts with the people in groups and not as individual persons. The method is used when it is necessary to communicate with a number of people simultaneously who are located not too far off from the communicator and time available for communication is reasonably adequate. Group participation and the formation of group opinions are two crucial factors for success of this method. In a group situation there may be may sometimes involve more than one communicator such as the Extension Agent and Subject Matter Specialists. The size of a small group may vary from 10-20, a medium group from 20-40, and a large group over 40 persons.

In a radical departure from the earlier agricultural extension programs, a group based learning process is adopted in the Farmers Field School (FFS) approach. In the FFS, farmers carried out experimental learning activities that helped to understand the ecology of their crop fields. Knowledge gained through these activities enabled farmers to make their own locally-specific decisions rather than adopt generalized recommendations that had been formulated from outside the community.

## Advantages

i) Enables Extension Agent to have face-to-face contact with a number of people at a time.

ii) Enables the Extension Agent to reach a select part of the target group.

iii) Facilitates sharing of knowledge and experience and thereby strengthen learning of the group members.
iv) Reach fewer people, but offer more opportunities for interaction and feedback.
v) Satisfies the basic urge of people for social contacts.
vi) Motivate people to accept change due to group influence.
vii) More effective than mass method in stimulating action.
ix) Less expensive than individual method owing to wider coverage.

## Limitations

i) Wide diversity in the interest of group members may create a difficult learning situation.
ii) Holding the meeting may be regarded as an objective itself.
iii) Vested interests, power groups and village factions may hinder free interaction and decision making by group members.

## Mass methods

In this method, the Extension Agent interacts with a huge and heterogeneous mass of people, without taking into account their individual and group identity. The method is used when a large and widely dispersed audience is to be communicated within a short time. There may be a few communicators and Subject Matter Specialists involved. The size of the audience may vary depending on the technique used.

Two of the techniques are explained briefly to highlight their relevance in agricultural extension.

## Farm Publication

Farm publication is a series of publications prepared by the extension agency in printed form, containing information relating to the improvement of farm and home. Farm publications can be of several types and they may be used singly or in combination with other extension methods.

a) **Leaflet**: usually a single printed sheet of paper of small size, containing preliminary information relating to a topic.

b) **Folder**: a single sheet of printed sheet of paper of big size, that is folded once or few times, giving essential information relating to a particular topic.

c) **Bulletin**: a printed, bound booklet with a number of pages, containing wide-ranging information about a topic.

d) **Newsletter**: a miniature newspaper printed in good quality paper, containing information relating to the activities and achievements of the organization. It has a fixed periodicity of publication.

e) **Journal, Magazine:** Periodicals containing information related to various topics of interest not only for the farmers but also for the extension agents.

Farm publications are very useful to the literate farmers. Even illiterate farmers can make use of them with the help of literate members of their family. They may be used in most of the individual, group and mass methods.

## Exhibition

An exhibition is a methodical display of prototypes, samples, charts, pictures, posters, information, etc., in a series around a theme to create awareness and interest in the community. They are held at many different levels, ranging from village to international.

## Advantages

i) Suitable for creating general awareness amongst people.
ii) Helps in transferring knowledge and, forming and changing opinions.
iv) Large number of people may be communicated within a short time.
v) Facilitates quick communication in times of emergency.
vi) Reinforces previous learning.
vii) Cost effective due to large coverage.

## Limitations

i) Less intensive method.

ii) Little scope for personal contact with the audience.

iii) Little opportunity for interaction with and amongst the audience.

iv) Generalized recommendations hinder their application by individuals.

v) Little control over the responses of audience.

vi) Difficulty in getting feedback information and evaluation of results.

## Appropriate Extension methods used by KVKs

**Radio and TV:** About 67 million (35.1%) households have Radio or Transistor, Television is available to 61 million (31.6%) households in the country (Census, 2001). Extension staff can encourage radio listening group for farmers and farm women, and can also encourage radio staff to air programmes about innovations in areas of agriculture for which women are responsible.

**Group Activities**: Discussions, meetings or village level training days can be implemented with groups of women and rural youth. Working with groups of women gave male field staff greater access to women farmers. Many NGOs are now forming small women's groups for the purpose of savings and credit, or health programmes. KVK extension staff can approach these organizations for permission to work with their affiliated groups.

**Demonstrations**: Demonstration can be established related to management of own homestead, with occasional visits by extension staff.

**Fairs and Field days**: Extension staff can provide farmers, farm women as well as rural youth with opportunities to attend extension events outside the homestead in groups or with their spouse. Extension events with families can often be highly effective, as any sequence of agricultural operations is implemented by both men and women. Joint events can also promote the role of women in agricultural decision making.

Extension staff can also use extension methods and audio visual aids which do not require literacy. These include folk drama, song, puppets and other traditional media, and drawings and cartoons on flash cards.

## Importance of adoption process in selection of extension methods

Farmers have different information requirements at each stage of the adoption process. This indicates that extension staff must understand which stage farmers are at before planning subject matter and extension methods. Questions to help understand this process include:


Fig.1. Adoption processes

- **Should information be delivered to make farmers' aware of a new idea?**
  If yes, maybe radio and posters, or folk drama and folk song might be the most effective methods.
- **Should detailed information be provided when farmers have become aware and are interested?**
  If yes, maybe leaflets with thorough technical information should be printed and distributed, or arranging a group discussion meetings, or field days held at a demonstration site, or published the articles in local newspapers.
- **Should information be provided to intensify specific skills in the use of new techniques that farmers can make a complete evaluation?**
  If yes, maybe method demonstrations and formal training days would be the most suitable extension method.

- **Should information and support be provided to farmers when they are trying new idea for the first time?**

  If yes, maybe individual farm visits and group discussions would be the most convenient extension method and extension staff could also meet with the whole farm family to discuss the new idea.

- **Should support be provided to farmers to reinforce the benefits of a new idea which has been adopted?**

  If yes, perhaps group discussion meetings should be arranged, or a radio interview with the farmer, or the farmer could be invited as a resource person to any extension event.

(DAE, 2016)

## Emerging Extension Methodology

Extension professionals must be aware of the changing tools and approaches to extension and be able to assess and select the appropriate tools and approaches to suit the conditions they work in and deal with many challenges such as supporting farmers to adapt to climate change, helping farmers to access high-value markets, organizing farmers into groups, dealing with issues related to natural resource management and marketing.

## Innovative extension approaches/ methodologies

1. NGO-Vrutti
2. Agro world
3. KVK-Pathanamthitta
4. Farmers group: Whatsapp
5. KVK Mobile App
6. Intelligent Advisory System for Farmers
7. ICT mediated extension approach

## NGO-Vrutti

Vrutti is a non-profit social enterprise for enhancing people's well-being through knowledge, innovation and transformative actions. It was established in 2002 in Madhya Pradesh under SRA 1960 and FCRA, GOI (VLRC, 2015).

**Passion**: To bring about solutions at a scale that eliminates inequities and marginalization, and creates wealth for the marginalized.

**Vision**: To establish a center for excellence for livelihood promotion& quality life of disadvantaged group.

**Mission**: To stimulate livelihoods of communities with development associates; towards developing effective strategies, processes, support systems; through participatory action research, management services and sector level support.

## Various roles

- Farmer's Producer Organization
- Agriculture Enterprise Facilitation Centre (AEFC)
- KNH Community Farm
- Adaptation to Climate Change in Rural Areas of India
- National Rural Livelihoods Mission
- Poverty Reduction Through Sustainable Agriculture
- Revitalization of Rain-fed Agriculture
- Small Grant Facility

## Agro world: The Gateway to Global Market and Agribusiness

To make known modern agriculture and agri-allied sectors with technologies, best practice, processing and marketing that can help countless farmers and platforms vendors, Indian Council of Food and Agriculture (ICFA) with the support of the GoI and several States and in technical collaboration with a large number

of industry associations and international bodies, organized an Agro World 2019 from November 5 to 8, 2019 at the sprawling campus of ICAR, New Delhi. Additionally this event encompasses industry oriented topics, opportunities for startups, international participation and much more (ICFA, 2019)

## Initiatives of KVK, Pathanamthitta

- The KVK website contains e-marketing facility.
- Exclusive technology portal for jackfruit in the form of a blog (www.panasamwonders.blogspot.com) wherein people have interactions.
- Social networking site 'facebook' (www.card.pathanamthittakeralaindia.com) to link people around the world to get feedback on the activities of the KVK.


- Other Initiatives of CARD-KVK include Krishi Dooth (a short Message service), E-Publication (E-newsletter, technology capsules in the form of CD's and DVD's), Krishi Jakalam a community Radio Programme).

(Robert *et al*., 2016)

## WhatsApp group for farming solutions

KVKs ATARI Zone VII during the lockdown period due to COVID-19, the Director of ICAR-ATARI Zone VII initiated the online interaction through WhatsApp group for KVKs under the zone for quick dissemination of information and advisories to farmers in local languages. The 43 KVKs of the state of Manipur, Meghalaya, Mizoram, Nagaland and Tripura has created 717 WhatsApp group benefitting 60710 farmers.

**Table 2: Dissemination of WhatsApp group to farmers during lockdown period due to COVID-19**

| State | No. of KVKs | No. of groups | No. of farmers |
|---|---|---|---|
| Manipur | 9 | 208 | 6728 |
| Meghalaya | 7 | 76 | 5305 |
| Mizoram | 8 | 258 | 28368 |
| Nagaland | 11 | 69 | 14069 |
| Tripura | 8 | 106 | 6240 |
| **Total** | **43** | **717** | **60710** |

## KVK Mobile app

KVK Mobile App is an android-based mobile application design and developed by Division of Computer Application ICAR-Indian Agricultural Statistics Research Institute (IASRI) in collaboration with Extension Division, ICAR to facilitate farmers by providing vast amount of knowledge generated at KVKs. Farmer has to register into this app and select the KVK which is located in their district. The registered farmers can access package of practices for crops and animals developed by the KVK and can also send any farm related query to the experts available in the KVK and receivea resolution of their problem. The mobile app contains details of information on amenities available at KVK for farmers. It also provides information on past and future events of KVK. There are also provisions to access agro meteorological advisory and market price of agricultural commodities. This mobile app can be very useful particularly for the farmers who often find difficulty in reaching to the KVK physically due to geographical


**Fig. 2.KVK head Dr. Bharath Kumar with farmers who have reared chicken in Mudigere**

constraint. This app is available in Google Play Store (https://play.google.com/store/apps/details?id=com.icar.iasri.kvkapp&hl=en) and can also be used as an adds-on to the extension system established between KVK and farming communities for enhanced communication (Pal *et al.*, 2019).

## Intelligent Advisory System for Farmers (IASF)

IASF is an expert advisory system aims at answering queries related to farming activities carried out in North-East states of India. It was launched by the Department of Electronics and Information Technology, Ministry of Information Technology, Government of India; C-DAC (Centre for Development of Advanced Computing), Mumbai in alliance with the Department of Agriculture, Meghalaya on 29th November 2012. The project shelters four major agricultural activities (Disease Management, Insect Management, Weed Management and Fertilizer Management) for providing specialist's advice relating to diagnostic and corrective measures in localized content and languages. The system uses web-services with the continuous integration to National Mobile Service Delivery Gateway (MSDG) through push and pulls services, thereby linking farmers with agricultural experts on real time basis from the agricultural departments and Subject Matter Specialists of the KVKs. A distinctive feature of the service is the "Mobile Crop Doctor wherein the registered farmer can send a direct query related to any farming activity supported by IASF in the form of Short Messaging Service (SMS) to 51969. In addition, the system act as a knowledge repository for major crops produced in the North-Eastern States of India (IASF, 2014).

A study conducted by Syiem *et al*. (2016) on Perceived benefits of IASF revealed that 80 per cent of the respondents perceived that IASF has increased their knowledge of agricultural practices through periodic advisory service being sent. Nearly 20 per cent of the farmers perceived that IASF has help in cost and time saving since agricultural information and advisory service is being delivered right at their door step. Likewise, 27 per cent of the farmers reported that the 'Mobile Crop Doctor' has enabled them to influence their decision making ability in their farm by providing expert advisory service through direct queries.

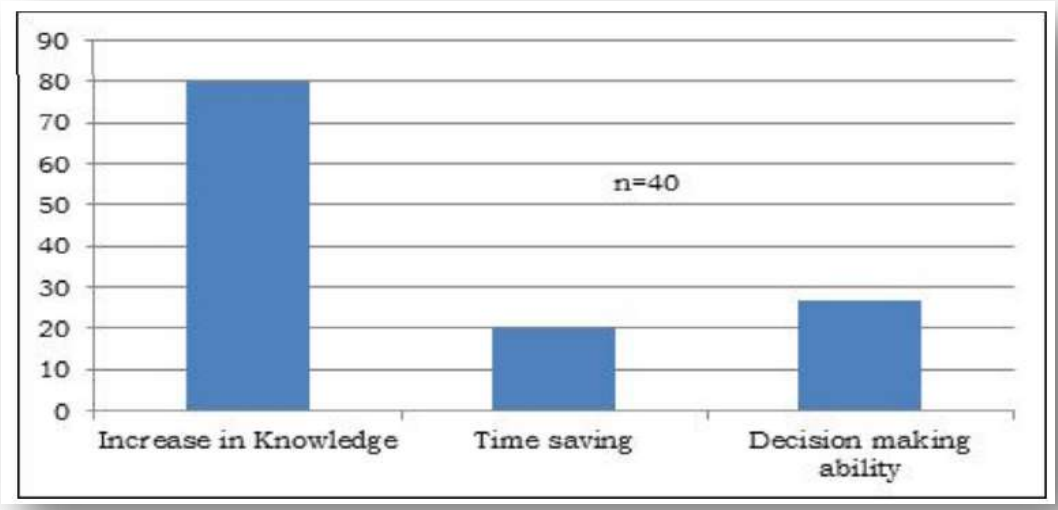



**Fig. 3. Perceived benefits of Intelligent Advisory System for farmers**

## ICT mediated extension approach

Mobile phone based agro-advisory framework was developed with an objective to empower the farmers by providing right information at right time through ICT mediated extension approach (Lahiri *et al.*, 2017). The major features of the system to deliver the farm advices (Pull Based) and information services (Push Based) through toll free Interactive Voice Response System (IVRS), Smart Phone Application, Mobile phone and Web based agriculture advisory system.

Study conducted by Lahiri *et al.* (2017) revealed that:

- Every month almost 200 advisories were provided.
- In the peak Kharif seasons almost 300 calls were provided per month.
- Majority (17.32%)of the advisories were on fishery management practices followed by source of seed (9.95%), livestock management (9.18%), disease and pest management of crops (8.75%), training information (9.35%), rural development schemes (7.76%) and so forth.

- The inclusion of need based training component and convergence with different extension functionaries helped to develop an ICT based Stakeholder Interface (Experts-Line Departments-Agripreneurs-Farmers) in the field of agriculture in the region.
- It also helped to develop better rapport with the farmers and can be replicated in other hilly region of the world.

**SUCCESSSTORY**

**Popularization of CAU R1 paddy variety Through ICT Mediated Extension Approach in Garo Hills of Meghalaya**

**Issues**: Paddy is the most cultivated cereal crop in Garo Hills. Farmers are mostly habituated in cultivating some of the traditional varieties and some HYVs popularized by ICAR. But most of these varieties take relatively longer time to harvest, which left the farmers with little or almost no opportunity for taking vegetable and other Rabi crops due to standing rice crops. Moreover, the yields of those varieties are relatively less (on an average 20-25 q $ha^{-1}$) due to lack of proper management practices and relatively low potential of those varieties. Also, the timely supply of HYVs is another issue to the farmers.

**Initiatives**: CAU R1 was introduced for the first time in Garo Hills under m4AgriNEI Project. ICT mediated extension approach was taken through IVRS based Mobile Extension Initiative under m4AgriNEI Project to popularized the CAU R1 variety. Proper training and demonstration of package of practices for the variety was organized under the project. A continuous monitoring and supervision were also done by the Agro- Associates and Field Coordinators.

**Outcomes**: On an average yield increase to 30-35 q $ha^{-1}$ which is higher than that of earlier cultivated variety

**Impact**: Relatively faster growing habits and maturity of CAU R1 provide the farmers enough time for Rabi cropping, which successfully helped in a gainful increase in farmers'income.

**(Lahiri *et al.*, 2019)**

## Future strategy

- Encourage diverse extension innovation that reacts adaptively to local progressing situations.
- Recognizing the importance of innovations evolved locally
- Pilot testing and demonstration of success stories
- Timely services, customer driven, outstanding quality in competitive pricing for sustainability
- Proper Knowledge database for future reference
- Multicultural approaches in farmer centric

## Conclusion

The core of any extension programme is a personal contact between the farmers and extension agent and KVK is one of the agricultural institutions which is available in close proximity to the farmers. The roles of the KVKs are training of farmers in new technologies and demonstration. To achieve the mandates of KVK, the extension agent needs to choose a proper channel as well as techniques of communication. There are three types of extension method namely, individual, group and mass method. The choice of the method generally depends on the number of farmers and location of the target audience and the time available for communication. Due to the changing scenario, the extension professionals must also be aware of the changing tools and approaches to extension. They should be able to access and select the appropriate tools and approaches to suit the conditions they work in. They must be able to help the farmers to adapt to the changing climatic condition, access high-value markets, organizing farmers into groups, dealing with issues related to natural resource management and marketing.

## References

1. Census. (2001). Availability of Eminities and Assets, Office of the Registrar General & Census Commissioner, India Ministry of Home Affairs GOI [on-line]. Available: https://censusindia.gov.in/Census_and_You/availability_of_eminities_and_assets.aspx [15 April 2020]

2. DAE [Department of Agricultural Extension]. (2016). *Agriculture Extension Manual* [on-line].Available:https://dae.portal.gov.bd/sites/default/files/files/dae.portal.gov.bd/publications/435fe031_883a_43af_864c_1240c7da0fbf/Extension_Mannual_Chapt9.pdf [15 April 2020].
3. FAO [Food and Agricultural Organizations].(2019). *Agricultural extension manual for Extension Workers* [on-line]. Available: http://www.fao.org/3/ca5007en/ca5007en.pdf [15April 2020].
4. IASF [Intelligent Advisory System for Farmers]. (2014). Intelligent Advisory System for Farmers [on-line]. Available: http://iasf.cdacmumbai.in/ias/index.jsp [13 May 2020].
5. ICAR [Indian Council of Agricultural Research]. (2020). Krishi Vigyan Kendra Knowledge Network [on-line]. Available: https://kvk.icar.gov.in/aboutkvk.aspx [10 May 2020].
6. ICFA [Indian Chamber of Food and Agriculture]. (2019). Agro world: The gateway to Global Market and Agribusiness [on-line]. Available: http://www.agroworldindia.com/index.php [02May 2020].
7. JICA [Japan International Cooperation Agency]. (2008). *Agricultural Extension Methodology: a reference manual* [on-line]. Available: https://ershad.moa.pna.ps/ downloads/reports/20130728122608.pdf [16 April 2020].
8. Lahiri, B., Anurag, T. S., Borah, S., Marak, N. R. and Sangma, A. K. (2019). Popularization of CAU R1 paddy variety through ICT mediated extension approach. *CAU Farm Magazine*. 9(1): 24-25.
9. Lahiri, B., Borah, S., Marak, N. R. and Anurag, T. S. (2017).Development of mobile phone based agro- advisory system through ICT mediated extension approach in North-eastern Himalayan region of India. *J. Applied Natural Sc*. 9(3): 1808-1814.
10. Musadoto. (2018). *Extension methods* [Lecture notes].College of Agriculture, Sokoine University of Agriculture, Tanzania, 22p.
11. NHM [National Horticulture Mission]. (2012). Plant Health Clinic [online]. Available: https://www.kvkakola.org/projects.html# [20 April 2020].
12. NSSO [National Sample Survey Organisation]. (2005). Situation Assessment Survey of Farmers: Access to Modern Technology for Farming, 59th round (January–December 2003),
13. Report No. 499(59/33/2), Ministry of Statistics and Programme Implementation, New Delhi.

14. NSSO [National Sample Survey Organisation].(2014). Key Indicators of Situation of Agricultural Households in India, 70th Round (January–December 2013), Ministry of Statistics and Programme Implementation, New Delhi.
15. Pal, S., Marwaha, S., Arora, A., Choubey, A., Singh, A., Poswal, R., Adhiguru, P., Islam, S. N., Kumar, H., Gupta, C. and Kumar, S. (2019). KVK Mobile App: an ICT tool to empower farmers. *Indian J. Agric. Sci.* 89:1362-1365.
16. Robert, C. P., Sadanandan, S. and John, B. (2016).Cyber dissemination approach of KVK Pathanamthitta. *J. Global Commun*. 9: 307-312.
17. Sulaiman, V. R., Kalaivani, N. J., Mittal, N. and Ramasundaram, **P. (**2011). ICTs and Empowerment of Indian Rural Women: What can we learn from on-going initiatives? CRISP Working Paper 2011-001 [on-line]. Available: http://www.crispindia.org/docs/CRISP%20Working%20PaperICTs%20and%20Empowerment%20of%20Women.pdf [01 May 2020].
18. Syiem, R., Marak, B. R. and Bandyopadhyay, A. K. (2016). Innovative extension practices in East Khasi Hills district of Meghalaya: a case study. *Indian J. Agric. Res*. 50 (6): 579-583.
19. VLRC [Vrutti Livelihood Resource Centre]. (2015). *Vrutti Annual Report 2014-2015* [on-line]. Available: https://letzchangefiles.s3-ap-southeast-1.amazonaws.com/229fa467-cba7-47dd-974a-03059eea68d0.pdf [02 May 2020].

# WEB BROWSING BY THE FARMING COMMUNITY FOR BENEFICIAL PURPOSES

**Sumit kr. Hajong**

An internet browser, also known as a web browser or simply a browser, is a software program that allow user to send, receive and interact with the Internet. The user can locate, retrieve and display content on the World Wide Web commonly known as Internet, which includes web pages, images, video and other files. The information is transferred using the Hypertext Transfer Protocol, which defines how text, images and video are transmitted on the web. It is based on a client/server model, the browser is the client that runs on a computer or mobile device that contacts the Web server and requests information. The web server sends the information back to the browser which displays the results on the Internet-enabled device that supports a browser.

The primary function of a web browser is to render HTML, the code used to design or "mark up" webpages. Each time a browser loads a web page, it processes the HTML, which may include text, links, and references to images and other items, such as cascading style sheets and JavaScript functions. The browser processes these items, then renders them in the browser window.

Some of the most popular internet browsers are Mozilla Firefox, Google Chrome, Microsoft Edge (formerly Internet Explorer) , Apple Safari (Download Safari), Opera which are readily available on the Internet free of cost but, there are many such others browsers available in the net.

## How Internet Browsers Work:

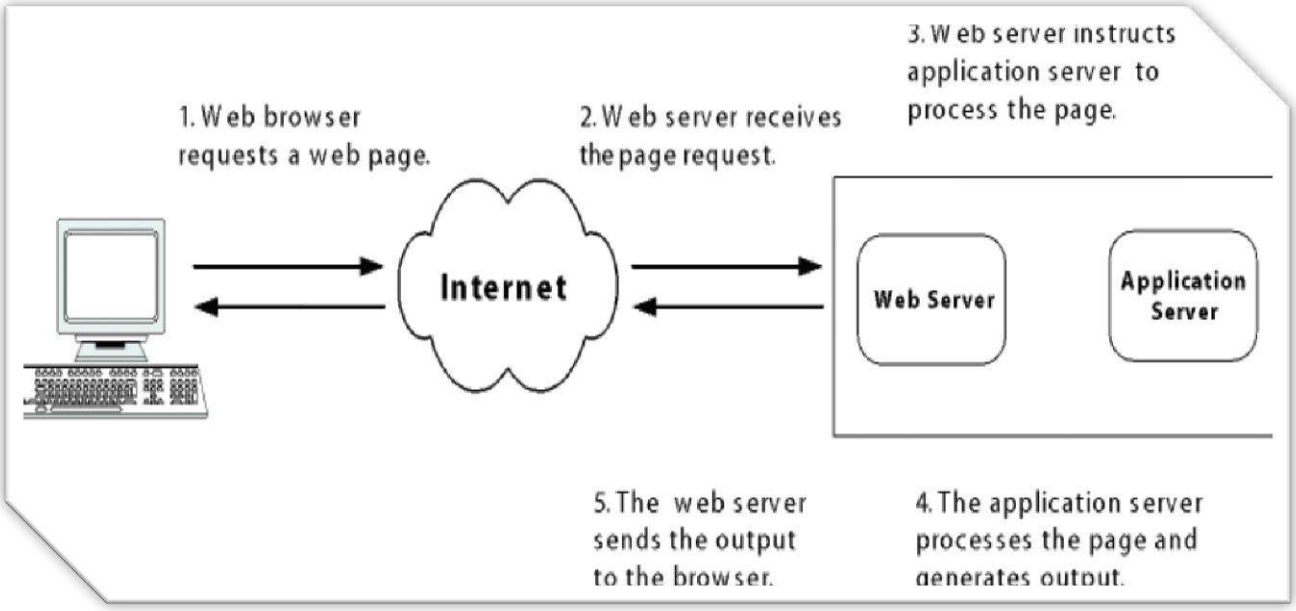
### Over view of how browsers work

1. Type in a website's URL into your browser's address bar: “www.icarzcu3.gov.in" is an example of a URL.

2. The browser locates and requests that page's information from a web server.

3. The browser receives a file in a computer code like HTML or Javascript, which includes instructions about how to display the information on that page.

4. The browser interprets that file and displays the page for you to read and interact with and it does all of this in just a few seconds.




## Requirement for web browsing:

In order to surf through Internet a user will require a personal computer or a mobile device with active Internet connection to connect to the Internet, and web browser application software which is to be installed in the device.

## First Time User:

When a user first opens the web browser application, you're taken to the home page. That could be your cellular provider's home page or a home page you've set. To visit a web page, type its address i.e. website's URL (Uniform Resource Locator) into your browser's address bar like "www.icar.org.in" is an example of a URL in the address box, one can also type a search word, if you don't know the exact web page address.

## Advantages of Web Browsers:

**Google Chrome**: Google Chrome is a relatively accessible browser that has many advantages, including a feature that allows the user to close slow or frozen pages without restarting the entire browser. Google Chrome also has a translation feature, which means that if a user runs across a page written in a foreign language, Google Chrome recognizes the language and will offer to translate it in a matter of seconds. The translations are executed through Google Translate, and while that may not always provide the best translation, it can give a basic gist of the content.

**Firefox**: Firefox has a huge library of available add-ons for download – more so than any of its major competitors. This allows the user unrivaled browser customization. But the default minimalist aesthetic can quickly give way to a barrage of add-ons, causing Firefox to run slowly. Firefox also allows users to save frequently used pages like Gmail or Pandora as permanent tabs. One of the browser's biggest flaws is its slow load time on image-heavy pages.

**Internet Explorer**: While Internet Explorer can be a bit on the slow side, may not have a lot of features, and is not always the easiest to use, it does have great security features. Internet Explorer allows the user to block sites from cataloguing browsing habits. The security panel also allows the user to block sites individually or to rely on a Microsoft-assembled list of sites with a history of tracking users.

**Safari**: Safari comes as the pre-loaded web browser on all Apple products, such as the iPhone and iPad. While this means that Safari is integrated into the Apple experience, it's not so great for Microsoft products and lacks customization options. Like Explorer, Safari benefits from immense security features. Safari has default pop-up blocking, which can help enhance a user's browsing experience. In addition, Safari makes private browsing easy. With the press of a button, the browser blocks all cookies and allows the user to explore the Internet without fear.

**Opera:** Opera is a web browser that is quite widely used by mobile users. The advantages contained in this one web browser is not large memory so that the use of lighter and faster. In addition, security is

more guaranteed to ward off viruses from the internet, so that computer data is safe from theft and damage.

**Some basic browser education:**

**Know your browser.** Look at the very far-upper-left corner of your screen. You'll see the name of your browser.

**Get the latest version.** Browsers get updates and updated regularly, usually because computers and technology change fast also. You can check what version of your browser you're currently using by going to whatbrowser.org.

**Try a different browser.** You can switch to another browser at any time. It won't affect your computer and it will give you an idea of how they are different.

**Read browser reviews.** You can compare features of the different browsers on websites like http://internet-browser-review.toptenreviews.com. You'll learn what kind of features browsers offer and what to look for.

**Few tips to follow to secure any browser:**

**1. Configure privacy and security settings**

The point here is to disable features that can cause vulnerabilities introduced through third-party cookies as well as plug-ins, add-ons and extensions. The fewer of these features you enable, the less likely they are to be exploited by hackers.

**2. Choose your warnings**

Disabling features helps secure computers but also potentially prevents users from getting at resources they might need. For instance, cookies help load pages faster at often-visited websites but they can also direct users into compromised sites. To prevent that, set up cookie warnings so users are alerted before navigating to unknown sites.

### 3. Don't save passwords

Allowing browsers to save passwords may be convenient but creates security risks. Malware that captures keystrokes can steal the information. Also, if a laptop falls into the wrong hands, it doesn't take much for a savvy hacker to find the stored password information.

### 4. Select plug-ins carefully

Java, Flash, JavaScript, ActiveX and myriad other plug-ins have all been exploited by hackers to break into computers and networks. Use these only if you have a reason to; otherwise, disable them.

### 5. Update browsers regularly

Browsers, just like any other software, need to be updated regularly to plug security holes. Out-of-date software is a favorite way for hackers to break into networks. Updates not only address security but also make browsers run better.

### 6. Install and update endpoint security

Robust endpoint security is an absolute necessity. Threats that can elude browser privacy settings can still be blocked by an endpoint security solution that helps prevent ransom ware and other types of malware, and detects zero-day threats.

### URL links helpful for the Farming community:

| Sl no. | Name of Departmets | Website URL |
|---|---|---|
| 1 | **Pradhan Mantri Fasal Bima Yojana** | www.pmfby.gov.in |
| 2 | **National Agriculture Market (eNAM)** | www.enam.gov.in |
| 3 | **Pradhan Mantri Kisan Samman Nidhi (PM-KISAN)** | www.pmkisan.gov.in |
| 4 | **KVK Network** | www.kvk.icar.gov.in |
| 5 | **Tractor Buyers Guide** | www.tractorbuyersguide.in |

| | | |
|---|---|---|
| 6 | **Krishijagran** | www.krishijagran.com |
| 7 | **AGMARKNET portal** | www.agmarknet.gov.in |
| 8 | **National Bank for Agriculture and Rural Development** | www.nabard.org/ |
| 9 | **National Housing Bank** | www.nhb.org.in/ |
| 10 | **Coffee Board of India** | www.indiacoffee.org/ |
| 11 | **Coconut Development Board** | www.coconutboard.nic.in/ |
| 12 | **Tea board of India** | www.teaboard.gov.in/home |
| 13 | **Rubber Board** | www.rubberboard.org.in/public |
| 14 | **Ministry of rural development** | www.rural.nic.in/ |
| 15 | **Ministry of Water Resources, River Development and Ganga Rejuvenation** | www.mowr.gov.in/ |
| 16 | **Department of Animal Husbandry and Dairying (AH&D)** | www.dahd.nic.in/ |
| 17 | **Department of Fishries** | www.dof.gov.in/ |
| 18 | **List of Icar Institutes** | www.icar.org.in/ICAR-Institutes |
| ***19*** | **Ministry *of* Food Processing Industries *(MOFPI)*** | www.mofpi.nic.in/ |
| 20 | **Ministry of Commerce and Industry** | www.commerce.gov.in/ |
| 21 | **Ministry of Agriculture & Farmers' Welfare, Government of India** | www.agriculture.gov.in/ |
| 22 | **Ministry of labour & Employment** | www.labour.gov.in/ |
| 23 | **DEPARTMENT OFAGRICULTURAL RESEARCH AND EDUCATION** | www.dare.nic.in/ |
| 24 | **Department of Fertilizers** | www.fert.nic.in/ |

| | | |
|---|---|---|
| 25 | **Department for Promotion of Industry and Internal Trade** | www.dipp.gov.in/ |
| 26 | **Department of Agriculture, Cooperation & Farmer welfare** | www.agricoop.nic.in |
| 27 | **Agricultural and Processed Food Products Export Development Authority (APEDA)** | www.apeda.gov.in |

## STATE AGRICULTURE DEPARTMENTS

| S No. | Name of States | Website URL |
|---|---|---|
| 1 | A and Islands | http://agri.and.nic.in |
| 2 | Andhra Pradesh | http://www.apagrisnet.gov.in |
| 3 | Arunachal Pradesh | http://arunachalpradesh.nic.in |
| 4 | Assam | https://agri-horti.assam.gov.in/ |
| 5 | Bihar | http://krishi.bih.nic.in, http://krishimis.in |
| 6 | Chandigarh | http://agripb.gov.in |
| 7 | Chhattisgarh | http://agridept.cg.gov.in |
| 8 | Dadra and Nagar Haveli | http://dnh.nic.in/Departments/Agriculture.aspx |
| 9 | Daman and Diu | http://www.daman.nic.in/websites/zonal_agriculture_daman/index.asp |
| 10 | Delhi | http://agricoop.nic.in/ |
| 11 | Goa | http://agri.goa.gov.in |
| 12 | Gujarat | https://agri.gujarat.gov.in/ |
| 13 | Haryana | http://agriharyana.gov.in/ |

| | | |
|---|---|---|
| 14 | Himachal Pradesh | http://www.hpagriculture.com/ |
| 15 | Jammu & Kashmir | http://www.jkapd.nic.in/ |
| 16 | Jharkhand | http://www.jharkhand.gov.in/agri |
| 17 | Karnataka | http://raitamitra.kar.nic.in/KAN/index.asp |
| 18 | Kerala | http://www.keralaagriculture.gov.in/ |
| 19 | Lakshadweep | http://lakagri.nic.in/ |
| 20 | Madhya Pradesh | http://mpkrishi.mp.gov.in/ |
| 21 | Maharashtra | http://krishi.maharashtra.gov.in |
| 22 | Manipur | http://agrimanipur.gov.in/ |
| 23 | Meghalaya | http://www.megagriculture.gov.in/ |
| 24 | Mizoram | http://agriculturemizoram.nic.in/ |
| 24 | Nagaland | http://agringl.nic.in/ |
| 25 | Odisha | http://agriodisha.nic.in/ |
| 26 | Puducherry | http://agri.puducherry.gov.in/ |
| 27 | Punjab | http://agripb.gov.in/ |
| 28 | Rajasthan | http://www.krishi.rajasthan.gov.in, http://agriculture.rajasthan.gov.in/ |
| 29 | Sikkim | http://www.sikkimagrisnet.org |
| 30 | Tamilnadu | http://www.tn.gov.in/department/2 |

| | | |
|---|---|---|
| 31 | Telangana | http://agri.telangana.gov.in/ |
| 32 | Tripura | http://agri.tripura.gov.in/ |
| 33 | Uttar Pradesh | http://upagripardarshi.gov.in/StaticPages/UttarPradesh4.aspx |
| 34 | Uttarakhand | http://agriculture.uk.gov.in/ |
| 35 | West Bengal | https://wb.gov.in/portal/web/guest/agriculture |

# List of contributors

| NAME | DESIGNATION | EMAIL ID | ADDRESS |
|---|---|---|---|
| **Bidyut C. Deka** | Director | bidyutdeka@yahoo.com | ICAR-ATARI, Umiam, Meghalaya |
| **Dr. A.K. Singha** | Principal Scientist | aksingha0101@gmail.com | ICAR-ATARI, Umiam, Meghalaya |
| **Divya Parisa** | Scientist | divya3233@gmail.com | ICAR-ATARI, Umiam, Meghalaya |
| **Amrutha P** | Scientist | amruthakbh@gmail.com | ICAR-ATARI, Umiam, Meghalaya |
| **Pijush K. Biswas** | Senior Scientist & Head | kvk.tuensang@gmail.com | KVK Tuensang, Nagaland |
| **S K Baishya** | Senior Scientist & Head | kvkwokha2013@gmail.com | KVK Wokha, Nagaland |
| **H M Sangtam** | SMS (Animal Science) | kvkwokha2013@gmail.com | KVK Wokha, Nagaland |
| **Biswajit Debnath** | SMS (Fisheries) | kvksouthtripura@gmail.com | KVK South Tripura, Tripura |
| **Diganta Sharmah** | SMS (Plant Protection) | kvksouthtripura@gmail.com | KVK South Tripura, Tripura |
| **Biswajit Bal** | SMS (Fisheries) | pcdkdnorth@gmail.com | KVK North Tripura, Tripura |
| **Azriel M. Tariang** | SRF (NICRA) | azrieltariang@gmail.com | ICAR-ATARI, Umiam, Meghalaya |
| **Sarah Wahlang** | SRF (FFP) | sarahwahlang34@gmail.com | ICAR-ATARI, Umiam, Meghalaya |
| **Careen Nongrum** | SRF (CFLD Pulses) | nongrumcareen@gmail.com | ICAR-ATARI, Umiam, Meghalaya |
| **Emika K. Kyndiah** | SRF (CFLD Oilseeds) | emikakyndiah@gmail.com | ICAR-ATARI, Umiam, Meghalaya |
| **Anik Lyngdoh** | YP-I | anik01lyngdoh10@gmail.com | ICAR-ATARI, Umiam, Meghalaya |
| **Lawanrisha Lyngdoh** | SRF (ARYA) | lawanlyngdoh33@gmail.com | ICAR-ATARI, Umiam, Meghalaya |
| **Mesaya Rangsa Marak** | YP-II(DAMU) | mesayamarak22@gmail.com | ICAR-ATARI, Umiam, Meghalaya |
| **Deinichwa Dkhar** | SRF (NEMA) | deinichwa@gmail.com | ICAR-ATARI, Umiam, Meghalaya |
| **Sumit kr. Hajong** | OA (ARYA) | hgsumit@gmail.com | ICAR-ATARI, Umiam, Meghalaya |