TEN YEARS OF

DRYLAND AGRICULTURAL RESEARCH

ALL INDIA COORDINATED RESEARCH PROJECT FOR DRYLAND AGRICULTURE

BISWANATH CHARIALI CENTRE
BISWANATH COLLEGE OF AGRICULTURE (AAU)

(AAU/DR/17(mono)/141/2016-17)

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Ten years of Dryland Agricultural Research

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Agriculture has always been a gamble with nature without the assured supply of water. Nearly 60% of the cultivated area in India is solely dependant upon rain which is mostly erratic in behaviour leading to unstable production. The rainfed areas face technology starvation for effective management of the most scarce resource of water. The issues relating to soil and crop management under rainfed situation are a challenge before the agriculture scientists as the unfavourable consequences of climate change as observed by unpredictable and erratic distribution of rainfall, intermittent dry spells, occasional flood etc. are compounding with time. Most of the eastern India particularly North-Eastern zone is under rainfed farming. Now were are in dire need of a farmer ready technology basket for rainfed areas of the state keeping in view the crop productivity factors like climate change, resource conservation, crop productivity optimization, farm income enhancement and livelihood security.

The All India Coordinated Research Project for Dry land Agriculture has completed a decade of its implementation in Assam Agricultural University. The Centre has shouldered the responsibility of generating and disseminating appropriate technology to the farmers of the rainfed areas which predominantly epitomise agriculture of Assam as well as other North-Eastern states. The Centre has a dedicated team of scientists and it has been able to make remarkable in roads to the disadvantageous farmer groups enhancing their coping up mechanism through the generated technology injection. Their efforts are already acclaimed through the Best Center Award at the National level for the biennium 2012-13 and 2013-14.

It is a matter of immense pleasure that the team of scientists of AICRDA, Biswanath Chariali Center is bringing out a compendium of the decade-long activities carried out at Biswanath Chariali and Jorhat centers. This publication will be a valuable contribution to the field of rainfed agriculture farmers, scientists and extension specialists. The team deserves applause for their spirit of work and sincere efforts in compiling and brining out this document in a lucid manner. I congratulate Or Pallab Kumar Sarmah, the team leader and his partners in the team for the kind of recognition they have brought to the University through their committed work.

I wish the Center all success in future activities.

(K.M. Bujarbaruah)

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FOREWORD

The All India Coordinated Research Project for Dryland Agriculture (AICRPDA), since its inception in 1972, has been addressing the emerging issues of rainfed agriculture of the country through its network centers. The AICRPDA groups of scientists serving in the centres have significantly contributed in generation of site specific and economically affordable technologies in different thematic areas of rainfed agriculture of the country. In view of the impending impacts of climate change, poor soil quality on rainfed agriculture and wider yield gaps in rainfed crops, there has been the growing need for prioritizing research for sustainable intensification, augmentation of integrated farming systems, strategies for adaptation and mitigation of climate change and enhancing soil health and livelihoods of rainfed farmers.

Like any other centers of AICRPDA, Biswanath Chariali centre under AAU, erstwhile established at Jorhat in 2005 and shifted to its present location in 2010 has also been contributing significantly to the cause of rainfed agriculture of the state of Assam in particular and NE region in general. It is worth mentioning that within a very limited span of time of its activities, the centre has been Able to earn the "Best centre" award for the biennium 2012-13 and 2013-14. The centre has been doing excellent job for upscaling of rainfed technologies through the joint activities of AICRPDA- NICRA, with active involvement of the upscaling centres set up by themselves in various parts of the state in collaboration with KVKs under AAU.

I am happy to know that the All India Coordinated Research for Dryland Agriculture (AICRPDA), Jorhat and Biswanath Chariali Center have succeeded in documenting the achievements, experiences and success stories of its one decade of active research in the form of a report "Ten Years of Dryland Agricultural Research". I hope the document will serve as a guide to policy makers, scientists, extension workers, farmers and other stake holders involved in development of dryland agriculture and as an inspiring force for further advanced research on the emerging issue to be taken up at the centre.

I congratulate the project team for their commendable effort in bringing out this report.

Date: 01.09.2016

(Ch. Srinivasa Rao)

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Foreword

All India Co-ordinated Research Project for Dryland Agriculture, Biswanath Chariali centre under Assam Agricultural University has six domain districts *viz* Biswanath, Sonitpur, Lakhimpur, Dhemaji, Darrang and Udalguri under its jurisdiction. The research under AICRPDA network has a primary focus on location specific problem considering agro-ecological characteristics, predominant rainfed production systems and socio–economic settings with special emphasis on rain water management, soil conservation, contingency crop planning, alternate land use system, agroforestry and integrated farming system.

AICRPDA centre was launched during the year 2005 at Jorhat campus and subsequently shifted to Biswanath College of Agriculture (BNCA), a constituent college under the university during 2010 to fulfill the dryland research needs of North Bank Plains Zone of Assam in particular and the state in general. During its ten years of existence, BNCA centre has shown considerable progress in long term dryland research activities in major production systems like Nutrient Management, Rain water management, Cropping systems, Resource Characterization and technology upscaling bagging the prestigious "Best Centre" award for the biennium 2012-13 to 2013-14 alongwith "Best Farmer" award for outstanding contribution in adoption and popularization of crop diversification in rainfed uplands for higher productivity and profitability. Moreover, 7 participant famers (including one woman farmer) from NICRA and NICRA upscaling villages (*Chamua, Ganakdoloni, Bornadi and Jinjia*) located at different districts of Assam were honored and awarded with the ***best dryland farmer award*** by CRIDA, Hyderabad during XV Working Group Meeting of AICRPDA held at BN College of Agriculture, Biswanath Chariali from 24 to 27 December, 2016 for contribution in adoption and populaization climate resilient technoloigies. The centre in collaboration with the KVKs, has initiated programme under tribal sub plan to benefit the tribal farmers of the region as well as various NICRA upscaling programmes and contingency measures.

I am immensely happy to learn that the team of scientists of AICRPDA, Biswanath Chariali centre is going to publish "**Ten Years of Dry land Agricultural Research"** showcasing their activities, results and experiences of the last ten years of dry land research at Jorhat and BNCA. I do firmly believe that the information provided in this publication would prove to be a milestone in dryland research and would be of immense help not only to the scientists involved in the field but also to the farmers/stakeholders and agricultural students.

I wish the team all success and do encourage them for further similar endeavours.

(G.N. Hazarika)

Preface

The Assam state has 28.1 lakh hectares of net cropped area accounting for nearly 35.1 % of the total geographical area. The state receives an average rainfall of 1968.1 mm with intermittent dry spells. Majority of area in Assam comes under rainfed area. The rainfed areas are endowed with wide range of constraints with respect to soil and crop management and socio economic issues.

The All India Coordinated Research for Dryland Agriculture(AICRPDA) center which was initially established at Jorhat in 2005 was shifted to Biswanath Chariali during 2010. Since its inception, the center has generated significant amount of database and good number of technologies on rain water management, nutrient management, cropping system, energy management, resource characterization, evaluation of improved varieties, IFS and alternate land use systems etc. for increasing the productivity of dryland agriculture on sustainable basis. These technologies have been demonstrated in the farmers' field with their participation under the NICRA project, NICRA upscaling programmes, TSP programmes and success stories have been documented.

This publication includes research result of AICRPDA for the past one decade. The information provided in this publication would help the researchers, farmers/stake holders, extension workers and all those involved in development of rainfed agriculture furthering the cause of dryland research and for upscaling the different dryland technologies for increasing the productivity. I appreciate the efforts of the team of Scientists of AICRPDA, Biswanath Chariali and Jorhat center and congratulate them for bringing out the publication entitled " Ten Years of Dryland Agricultural Research". I wish them all success in future research and development endeavor.

Editors

CONTENTS

1. SALIENT FEATURES OF THE AICRPDA CENTRE

1.1. History of establishment of the centre The Jorhat Centre of All India Coordinated Research Project for Dryland Agriculture which was in operation since 10th January 2005 in the Department of Soil Science, Assam Agricultural University, Jorhat-785013 was shifted to B. N. College of Agriculture, Biswanath Chariali on 12th February 2010. The location of the centre is B.N College of Agriculture, Assam Agricultural University, Biswanath Chariali, Sonitpur, Assam-784176.

1.2. Agro-climatic zone of AICRPDA Centre, Biswanath Chariali The centre represents the North Bank Plain Zone of Assam. The Domain districts are Darrang, Sonitpur, Lakhimpur, Dhemaji, Udalguri. The centre is situated at 26°84′ N Latitude and 93º13′E Longitude and at an Altitude of 86.7 m above MSL.

1.3. Climate of Jorhat and Biswanath Chariali centre:

Climate: The climate of Assam is primarily humid and sub-humid. During 2005-09, the annual rainfall of Jorhat was below the normal in four years except in 2008 when it was normal. The highest deficit of rainfall was observed during 2009. During this period 3-8 dry spells were observed with a total of 115 to 159 days. High intensity rainfall was observed on 30th September, 2005; 17th July, 2006 and 8th June, 13th August, 10th September, 2009.

The climate of Biswanath Chariali is characterized by hot and humid summer and dry and cool winter. The station is receiving average annual rainfall of 1968 mm (1971-2014) while during post-monsoon (October-November) and winter (December-February) period the average rainfall is only 146 and 59 mm respectively. The rainy season starts in March and quantum of rainfall as well as number of rainy days increases gradually and reaches maximum in the month of July and then decline to minimum during December. Monthly morning relative humidity of the station always remains above 80% whereas monthly evening relative humidity varies from 47% to 73% throughout the year. The monthly average maximum temperatures varies from 23.5 ^{0}C to 32.3 ^{0}C. The length of growing period is 240 to 270 days. Seasonal flooding and water logging is common which demands special attention for normal crop husbandry.

Normal onset of monsoon (Date & Month)	: 1st week of June
Annual mean rainfall (mm)	: 1968.0 mm
Mean Crop seasonal rainfall (mm) during *kharif* and *rabi*	
Kharif (June – September)	: 1282.1 mm
Rabi (Oct-Feb)	: 205.2 mm

1.4. Soil of Jorhat and Biswanath Chariali centre:

The soils of the Instructional-cum Research farm of AAU, Jorhat belong to Oxyaquic Dystrudepts (32.63 ha), Aeric Endoaquepts (16.66 ha), Typic Endoaquepts (6.95 ha) and Typic Endoaquents (1.77 ha). These soils are derived from alluvium and are acidic in nature (pH 4.5-4.9), medium to high in organic matter (0.67-1.91%), medium in texture (15.4-26.9% clay), low in CEC (4.3-7.8 cmol/kg) and base saturation (27.7-66.2%)

The NBPZ Zone is characterised by recent and old alluvium soil with sandy to loamy and clay texture and slightly to moderate acidic soil reaction with low CEC. The moisture regime in the zone is udic and soil is imperfectly drained to well drained.

1.5. Crops and cropping system:

North Bank Plain Zone of Assam comprising of five districts namely Darrang, Sonitpur, Lakhimpur, Dhemaji, Udalguri covering an area of 16,171 sq. km (16.17 lakh ha) predominanatly under rainfed cropping system. Rice is the main crop during Kharif grown primarily under transplanted condition. However, rice is grown in varied eco-systems in the zone viz. rainfed/irrigated upland, lowland, flood-free and flood-prone, medium land and deep water eco-system. The other crops grown during Kharif are maize, green gram, black gram, sesamum, jute etc besides cultivation of summer vegetables. During rabi season crops like rape and mustard, potato, lentil, lathyrus, peas etc. Along with different rabi vegetables Kharif rice-rape and mustard, Kharif rice-potato are the main crop sequences followed in the rice-based production system. The cropping intensity in different districts of North Bank Plains Zone varies from 140-180 %.

1.6. Natural Vegetation:

Natural vegetation of the area is mostly moist sub-tropical semi-evergreen forest. In some area, the dominancy of moist deciduous forest has been observed. The common species of trees, shrubs and weeds found in nearby areas are Pipal, Baniyon, Mango, Jackfruit, Neem, Bogori, Bamboo,Thatch, Germany bon, Mekenia, Carpet grass, Gahori bon etc.

Rainfed area statistics of North Bank Plains Zone:

Classification	Area (in Hacters)			
	Darrang	Sonitpur	Lakhimpur	Dhemaji
Geographical area	3,48,100	5,32,036	2,27,700	3,23,700
Forests	28,540	1,54,977	35,878	63,930
Land put to Non-Agril. uses	31675	164686	49971	82395
Barren and uncultivable land	35,812	21,814	37558	49,603
Permanent pastures and other Grazing land	7923	11902	4331	15,818
Land under misc tree crops etc.	15,035	7820	1307	18,502
Cultivable waste	7,458	227	2030	17,064
Other fallow land	6339	1823	1465	6069
Current fallows	16,401	4010	2315	7813
Net area sown	1,98,917	1,65,141	1,00,169	62,506
Gross cropped area	2,67,100	2,74,552	1,76,113	105430
Net Irrigated area (2006)	16,650	11,880	820	8.27

1.7. Socio-Economic status:

Agriculture is the main occupation of the most of the people of the villages. Majority of the farmers belong to marginal to small category having 1 to 2 ha of land. Rice is the major food crop grown in the area. Besides rice, pulses, oilseeds and different kinds of vegetables are extensively grown. The villages are well known for the production of various summer and winter vegetables. A substantial amount of income is generated by the villagers from vegetables.

All crops in the area are cultivated under rainfed conditions. A few numbers of farmers have their own wells to irrigate their land through lift irrigation. Few farmers have diesel pumpset to irrigate their land through lift irrigation. Due to lack of irrigation facility and few other factors, majority of the farmers grow only one crop a year that results in low cropping intensity in the area. The main crop rotations followed are:

1. Paddy-Fallow
2. Paddy-Paddy
3. Paddy-Mustard
4. Paddy-Vegetables

Major constraints related to crop production in the area are as follows:

1. The adoption of modern technology by the farmers is very poor inspite of the presence of an agricultural college.
2. Lack of irrigation facility is another important factor as soil moisture stress during the *rabi* season is a common phenomena.
3. Certified HYV are not readily available either from market or from government agency and sometimes these are not reliable.
4. Decline in the soil fertility has been reported by the farmers. Application of fertilizers is not based on the soil test values. Besides, use of organic manure is also very limited because of its unavailability. Though soil testing facility is available in the BNCA, farmers in general are not approaching the college for advice.
5. No practice of mechanised farming has been observed. The farmers have less number of livestock to meet their own requirement of animal power. Moreover, the bullocks are mainly of local breed with low draft capability.
6. Plant protection measures are not scientific. The lack of technical know-how among the farmers is noticed in this respect.
7. Attitude and willingness of the people towards adoption of scientific farming is also a major factor to be considered for overall development of the socio-economic condition.

2. WEATHER OF BISWANATH CHARIALI

The climate of Biswanath Chariali is characterized by hot and humid summer and dry and cool winter. The station is receiving average annual rainfall of 1971.8 mm (1971-2015) while during post-monsoon (October-November) and winter (December-February) period the average rainfall is only 149.0 mm and 60.3 mm respectively. The rainy season starts in March and quantum of rainfall as well as number of rainy days increases gradually and reaches maximum in the month of July and then decline to minimum during December. Monthly morning relative humidity of the station always remains above 80 % whereas monthly evening relative humidity varies from 48 % to 73 % throughout the year. Monthly distribution of weather parameters at Biswanath Chariali presented in table below and also discussed below.

Table : Monthly average of weather parameters for 16 years (2000-2015) and rainfall (1971-2015) recorded at B.N. College of Agriculture, Biswanath Chariali, Sonitpur

Month	Av. Temperature(^{0}C)		Av. RH (%)		Rainfall (mm)	No of rainy days	BSSH (hr)	Pan evaporative (mm)
	Max T	Min. T	Mor	Eve				
Mar	28.4	15.7	80	48	56.3	6.6	6.2	3.4
Apr	28.4	18.8	82	62	181.4	13.9	5.2	3.8
May	30.8	22.0	85	66	247.7	15.7	5.7	4.1
Jun	31.3	24.4	89	72	354.9	19.1	3.9	3.9
Jul	31.9	25.5	89	73	367.9	20.6	4.7	3.9
Aug	32.3	24.9	89	72	313.5	16.6	4.6	3.4
Sep	31.6	23.8	87	73	240.8	14.4	4.7	3.2
Oct	30.0	20.2	85	68	129.8	6.4	5.9	3.0
Nov	27.4	14.4	81	57	19.2	1.9	7.1	2.2
Dec	24.7	9.2	87	54	10.5	1.0	6.0	1.7
Jan	23.4	8.2	87	54	19.2	2.0	5.7	1.7
Feb	25.8	12.1	84	49	30.6	2.9	5.8	2.4
Average	28.8	18.3	85.4	62.3	164.3	10.1	5.5	3.1

2.1Air Temperature:

The monthly maximum temperatures varied from 23.4^{0}C to 32.3^{0}C The highest monthly maximum temperature is recorded during the month of August while the lowest maximum temperature is in the month of January. Likewise monthly minimum temperatures varied from 8.2^{0}C to 25.5^{0}C. The monthly minimum temperature is found to be highest during the month of July while the lowest minimum temperature is recorded during January. The weekly variation of both maximum and minimum temperatures of Biswanath Chariali in presented in the Fig. The weekly maximum and minimum temperatures varied from 23.2^{0}C to 33.2^{0}C and 7.7 to 25.3^{0}C, respectively. The 32nd week (6 Aug to 12 Aug) was the hottest week, while 3rd Week (15 Jan to 21Jan) was the coldest week at Biswanath Chariali.

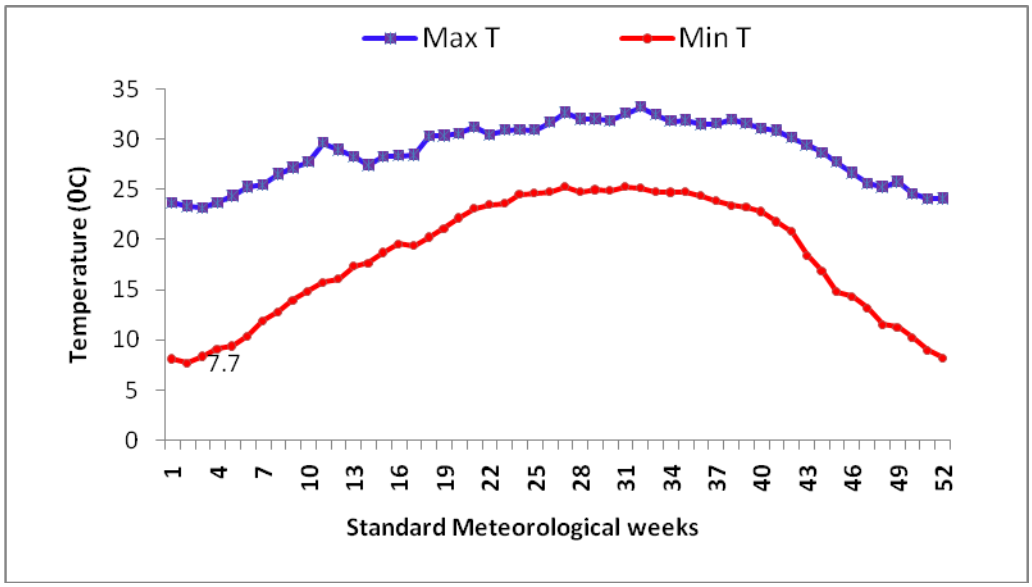


Fig. Weekly variation of Maximum and minimum temperature at Biswanath Chariali

2.2. Rainfall

The long term average total rainfall of Biswanath Chariali is 1971.8 mm. The monthly rainfall in the locality varied from 10.5 mm to 367.9 mm. The highest rainfall is found in the month of July and the lowest is in the month of December. Seasonal distribution of rainfall varied from 60.3 (3.0%) mm to 1277.1 (65.0%) mm which is depicted in the Fig. below.

1. Pre-monsoon (March-May) : 485.4 mm (25.0 %)
2. Monsoon (June-September) : 1277.1 mm (65.0 %)
3. Post-monsoon (October-November) : 149.0 mm (7.0 %)
4. Winter (December-February) : 60.3 mm (3.0%)

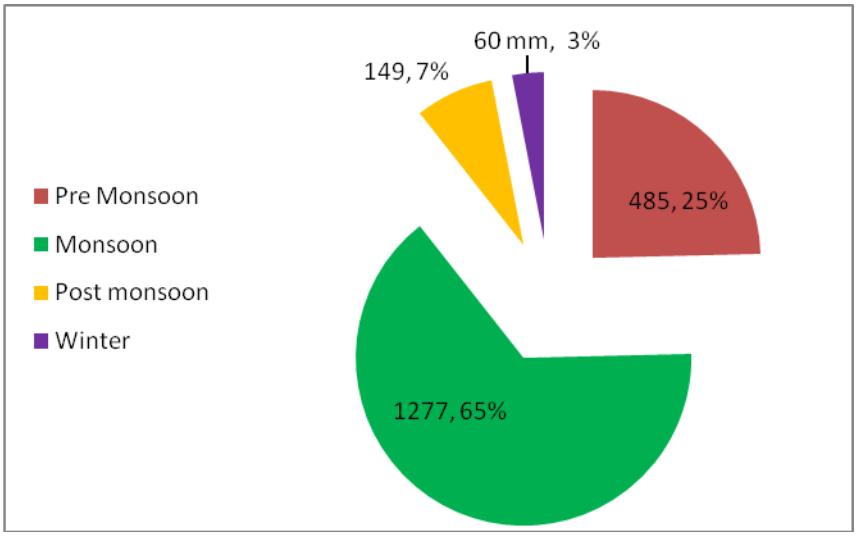


Fig.Seasonal distribution of Rainfall at Biswanath Chariali

The weekly normal rainfall at Biswanath Chariali varied from 1.1 mm to 84.6mm which is depicted in the Fig. below the weekly highest rainfall of 84.6mm was found in 27th week (2 July to 8 July) and the lowest was on 45th week (5 Nov to 11 Nov).

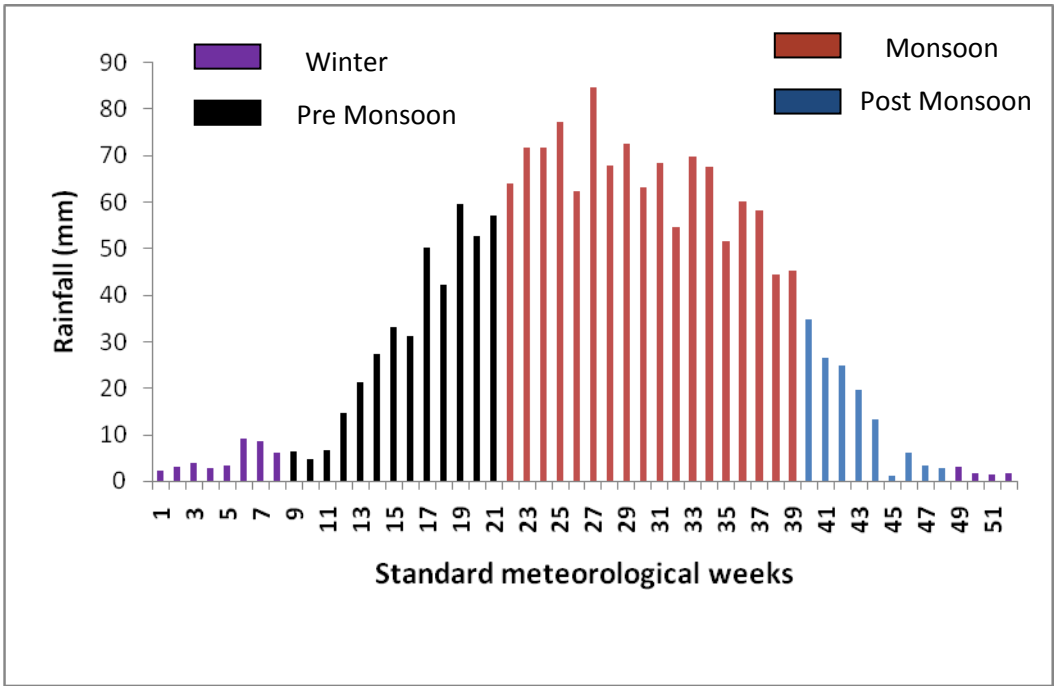


Fig. Weekly variation of Rainfall at Biswanath Chariali

2.3. Pan Evaporation

The monthly pan evaporation varied from 1.7 mm to 4.1 mm, while total pan evaporation is 36.7 mm in the locality. The highest monthly pan evaporation is recorded during the month of May while lowest is in the month of December and January. Likewise, weekly pan evaporation was found to be highest on 17th week (23 April to 29 April) and lowest was on 2nd week (8 Jan to 14 Jan). The weekly pan evaporation is presented in the Fig. below

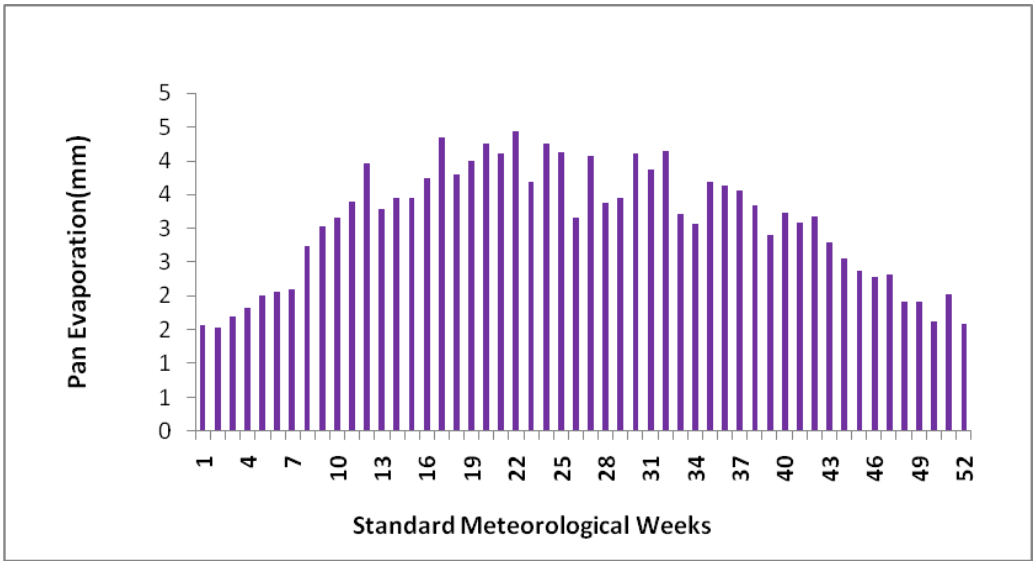


Fig. Weekly variation of Pan Evaporation at Biswanath Chariali

2.4. Relative Humidity:

The monthly morning relative humidity remained above 80 % in all the month and the evening relative humidity varied from 48% to 73%. The highest evening humidity is recorded during the month of July and September and the lowest is in the month of March. The weekly normal relative humidity varied from 77% (12 March to 18 March) to 91 % (13 August to 19 August) in the morning and 43% (12 March to 18 March) to 74% (18 June to 24 June) in the evening.

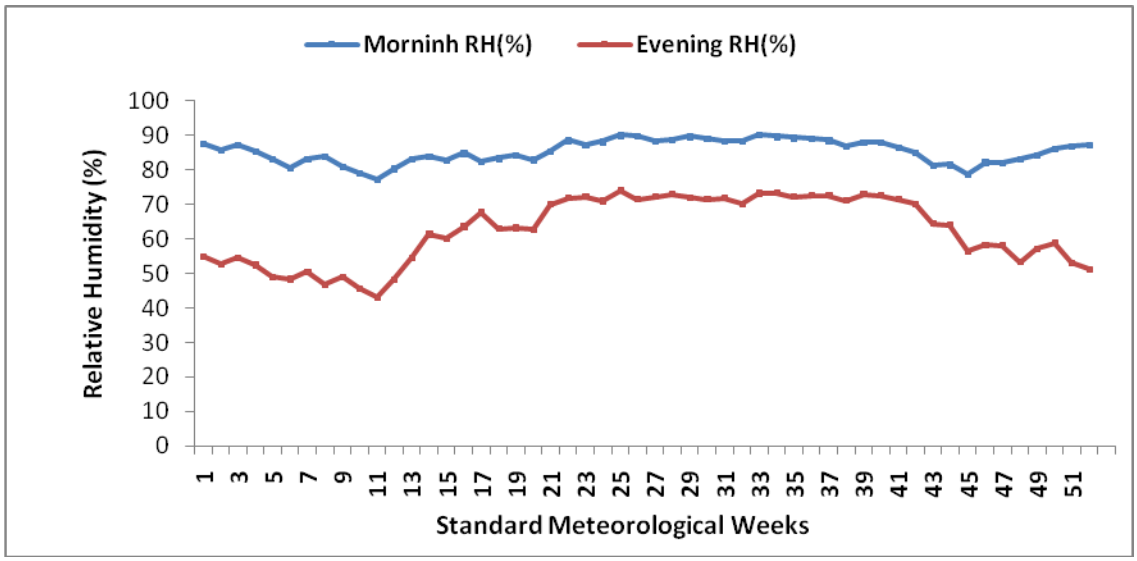


Fig. Weekly variation of Morning & Evening Relative Humidity at Biswanath Chariali

2.5. Bright Sunshine Hours

The monthly BSSH of Biswanath Chariali is varied from 3.9 hr to 7.1 hr The highest monthly BSSH is recorded highest in the month of November; the lowest is recorded in the month of June. In monsoon season (June to September), the average BSSH in the area is only 4.76 hr, however during other part of the year the average weekly BSSH is more than 6 hrs. The highest weekly BSSH of 8.02 hours is recorded in 44th week (29 Oct to 4 Nov) and the lowest sunshine hours of 3.7 hours is recorded in 33rd week (13 Aug to 19 Aug).

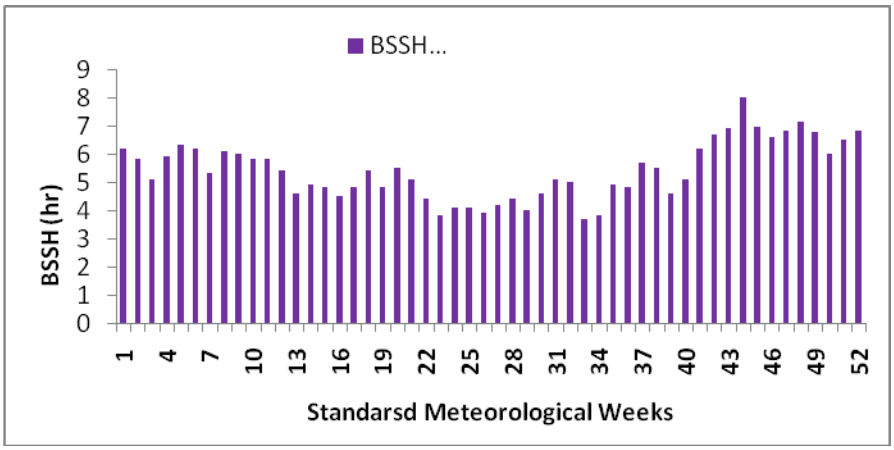


Fig. Weekly variation of BSSH at Biswanath Chariali

2.6. Wind Speed

The weekly normal wind speed varied from 1.5 km/hr to 5.2 km/hr. Wind speed increases suddenly from the month of March and become maximum in April and May. June onwards wind speed decreases becomes minimum in the month of January. The wind speed was found to be highest in 14th week (2 April to 8 April) and lowest was on 1st week (1 Jan to 7 Jan).

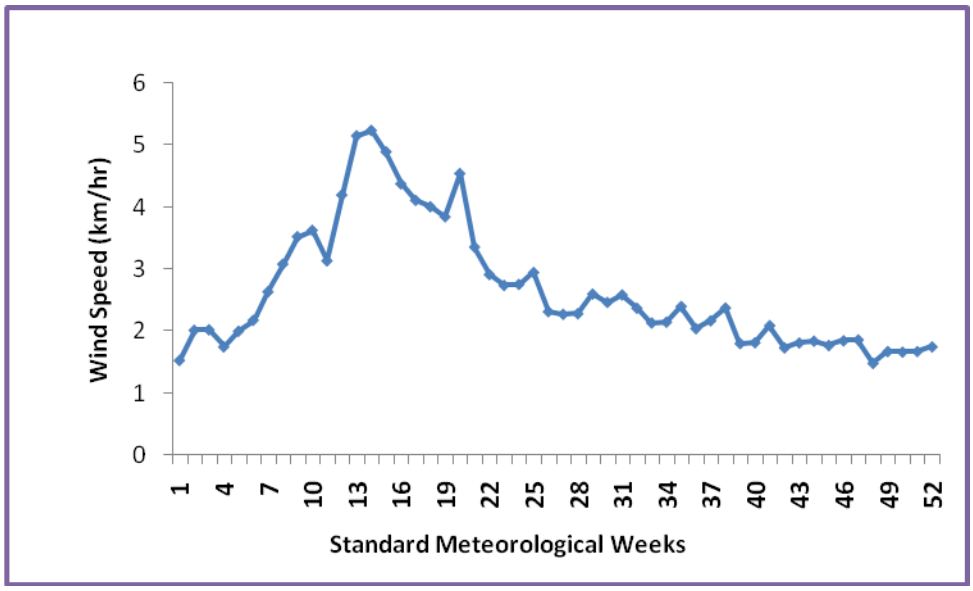


Fig. Weekly variation of Wind Speed at Biswanth Chariali

3. RAIN WATER MANAGEMENT

3.1. Efficiency of harvested rainwater on potato under rainfed condition

Rain water harvesting in agriculture is an integrated technological system designed to improve the availability of water and to provide supplementary irrigation to crops. It consists of three main components: collection of surface water, water storage tanks and supplemental irrigation system. Rain water harvesting and management can ensure optimal crop production in an area with inadequate rainfall. Rain water harvesting structures offer farmers an opportunity to improve agricultural production, especially bridging intra-seasonal dry spell. Therefore, the present study is carried out to study the fficiency of harvested rainwater on potato under rainfed condition.

Table : Effect of treatments on Potato (Kufri Jyoti) yield and economics

Treatment	Yield (t/ha)			Cost of cultivation (Rs./ha)	Net return (Rs./ha)	B:C ratio	RWUE (kg/ha/mm)
	Tuber yield in 2014-15	Mean tuber yield (two years)	Stalk yield				
IR_0OC_0 (Control , No Irrigation+ No organics)	9.51	8.71	6.48	85,140.00	450.00	1.01	139.44
IR_0OC_1 (Control , No Irrigation+ With organics, vermicompost @2 t/ha)	12.25	12.11	8.46	95,140.00	15,110.00	1.16	179.62
IR_1OC_0 (One Irrigation at 25 days+ No organics)	13.81	14.20	9.69	87,140.00	37,150.00	1.43	94.29
IR_1OC_1 (One Irrigation at 25 days+ With organics, vermicompost @2 t/ha)	15.92	15.67	11.29	97,140.00	46,140.00	1.47	110.89
IR_2OC_0 (Two irrigation at 25 and 60 days+ No organics)	18.16	22.01	12.98	89,140.00	74,300.00	1.83	80.79
IR_2OC_1 (Two irrigation at 25 and 60 days+ With organics, vermicompost @2 t/ha)	18.65	22.54	13.43	99,140.00	68,710.00	1.69	82.29
IR_3OC_0 (Three irrigation at 25, 60 and 80 days+ No organics)	22.00	20.99	15.86	91,140.00	1,06,860.00	2.17	72.95
IR_3OC_1 (Three irrigation at 25, 60 and 80 days+ With organics, vermicompost @2 t/ha)	23.39	22.55	16.98	1,01,140.00	1,09,370.00	2.08	77.38

- With a rainwater harvest potential of 2.45 ha cm of the cement lined tank 2.07 ha cm harvested rainwater can be used for irrigation of potato covering 0.99 ha, 0.31 ha and 0.21 ha by one, two and three times irrigation at 25 ; 25 & 60; and 25, 60 & 80 days after planting, respectively .

- ❖ Irrigation had a marked effect on tuber yield. The irrigation frequency increased yield significantly, and the highest yield was recorded at three irrigations at 25, 60 &80 days after planting (IR_3) with organics.

- ❖ Application of harvested rainwater at 25, 60 and 80 days after planting with organics may be suitable for obtaining high yield in potato.

- ❖ A harvest potential of 2.45 ha cm cement lined tank maximum 0.21 ha potato land can be irrigated by applying 99.9 mm irrigation at 25, 60 & 80 days after planting without application of vermicompost @ 2 t ha^{-1} may be economically suitable for obtaining higher tuber yield of potato under prevailing situations.

Photo of best treatment

Photo of control

3.2. Studies on effectiveness of different lining materials on rain water storage in farm pond

Rain water harvesting in agriculture is an integrated technological system designed to improve the availability of water and to provide supplementary irrigation to crops. It consists of three main components: collection of surface water, water storage tanks and supplemental irrigation system. Rain water harvesting and management can ensure optimal crop production in an area with inadequate rainfall. Rain water harvesting structures offer farmers an opportunity to improve agricultural production, especially bridging intra-seasonal dry spell. Therefore, the present study is carried out.

- Low cost-Locally available Polythene sheet lining materials was the highest efficient lining material than Control(No lining), Cow dung+ Soil Plaster(2:5), Cement+Soil Plaster(2:10).

- Seepage and percolation loss was highest in Control(No lining) followed by Cow dung+ Soil Plaster(2:5), Cement+Soil Plaster(2:10) and Polythene sheet lining material.

Polythene sheet lining

Cement+Soil Plaster (2:10).

4. NUTRIENT MANAGEMENT:

4.1. Permanent manurial trial for Rice–Greengram-Toria system under rainfed situation in NBPZ

Now a day, the fertilizer requirements are increasing due to adoption of new high yielding hybrids in intensive cultivation. Therefore, to maintain crop productivity, the use of chemical fertilizers in balanced quantity is important. But looking into the continuous increasing prices of fertilizers, it becomes necessary to minimize the expenses of fertilizers by using alternative sources like vermicompost, FYM, crop residues, green manuring crop for sustaining the crop yields and soil fertility. These practices not only increase the crop yield but also improve the physico-chemical properties of soil. The long term integrated application of chemical fertilizers with organic manures improves soil physical and chemical properties and soil fertility and crop yields. When integrated nutrient management through chemical fertilizers and different organic sources are applied on long term basis, they show beneficial impact on soil quality Therefore, the present investigation was carried out to find out the effect of intrgrated nutrient management on sustaining toria productivity, physical and chemical properties of soil and identify the most suitable nutrient managment practice under rainfed upland condition

Table : Yield and Economics of Rice-Greengram-Toria cropping sequence (Five years pooled data, 2010-11 to 2014-15)

Treatment	Ahu Rice (var.Dehangi)			Greengram (var.Pratap)				Toria (TS-38)			
	Grain Yield (qha^{-1})	RWUE ($kg\ ha^{-1}\ mm^{-1}$)	B:C ratio	Grain Yield (qha^{-1})	RWUE ($kg\ ha^{-1}\ mm^{-1}$)	REY (qha^{-1})	B:C ratio	Grain Yield (qha^{-1})	RWUE ($kg\ ha^{-1}\ mm^{-1}$)	REY (qha^{-1})	B:C ratio
T_1: Control	6.98	1.05	1.67	6.80	3.29	17.00	1.92	3.57	8.87	10.71	0.95
T_2: 100%Recommended dose of fertilizer (RDF)	10.57	1.45	1.44	8.87	4.28	22.18	2.21	6.51	16.60	19.53	1.54
T_3: 75% RDF (inorganic) + 3 ton/ha Vermicompost	13.53	1.80	1.80	12.05	5.74	30.13	2.62	7.81	19.20	23.43	1.78
T_4: 75% RDF (inorganic) + 5 ton/ha Vermicompost	13.82	1.94	1.88	11.89	5.73	29.73	2.68	8.23	20.61	24.69	1.84
T_5: 75% RDF (inorganic) + *in situ Sesbania aculeata*	10.47	1.45	1.40	8.64	4.10	21.60	2.18	7.00	16.80	21.00	1.67
T_6: 50% RDF (inorganic) + 3 ton/ha Vermicompost	10.97	1.55	1.51	10.38	4.93	25.95	2.40	6.46	15.83	19.38	1.57
T_7: 50% RDF (inorganic) + 5 ton/ha Vermicompost	11.23	1.58	1.54	10.56	5.02	26.40	2.39	6.44	15.87	19.32	1.60
T_8: 50% RDF (inorganic) +*in situ Sesbania aculeata*	9.30	1.35	1.28	8.49	4.01	21.23	2.18	5.95	14.67	17.85	1.53
T_9: 3 ton/ha Vermicompost	9.16	1.33	1.30	8.75	4.25	21.87	2.16	4.50	11.75	13.50	1.21
T_{10}: 5 ton/ha Vermicompost	9.80	1.37	1.32	8.89	4.32	22.23	2.15	4.82	12.43	14.46	1.28
T_{11}: *in situ Sesbania aculeata*	8.24	1.21	1.17	7.24	3.41	18.10	2.02	4.50	11.40	13.50	1.16
CD (0.05)	3.04			2.83	-		-	1.60		-	

Table: Effect of treatments on soil physico-chemical properties (Five Years pooled data) and initial values of soil

Treatment	BD (Mg/m^3)	FC	PWP	AWC	pH	Organic C (%)	Av. nutrients (kg/ha)		
							N	P_2O_5	K_2O
T_1: Control	1.31	19.55	5.70	13.85	4.87	0.55	295	25	145
T_2: 100% Recommended dose of fertilizer (RDF)	1.18	20.28	4.85	15.44	5.05	0.71	429	49	192
T_3: 75% RDF (inorganic) + 3 ton/ha Vermicompost	1.02	21.15	4.37	16.78	5.56	0.82	450	51	231
T_4: 75% RDF (inorganic) + 5 ton/ha Vermicompost	**0.97**	**21.85**	**4.22**	**17.63**	**5.87**	**0.89**	**454**	**52**	**234**
T_5: 75% RDF (inorganic) + *in situ Sesbania aculeata*	1.11	20.13	4.91	15.22	5.75	0.75	427	49	197
T_6: 50% RDF (inorganic) + 3 ton/ha Vermicompost	1.12	20.05	5.30	14.75	5.32	0.88	428	49	197
T_7: 50% RDF (inorganic) + 5 ton/ha Vermicompost	1.05	19.97	5.64	14.33	5.45	0.81	431	50	199
T_8: 50% RDF (inorganic) +*in situ Sesbania aculeata*	1.03	20.94	4.44	16.50	5.24	0.83	415	46	194
T_9: 3 ton/ha Vermicompost	1.15	19.62	5.65	13.97	5.31	0.86	413	41	188
T_{10}: 5 ton/ha Vermicompost	1.12	19.61	5.72	13.89	5.42	0.87	412	43	189
T_{11}: *in situ Sesbania aculeata*	1.10	20.42	4.84	15.58	5.22	0.69	416	41	189
Initial values (at the start of expt.)	**1.33**	**16.94**	**5.54**	**11.40**	**5.05**	**0.34**	**385**	**28**	**178**

*Moisture retention at field capacity (FC) and permanent wilting point (PWP), AWC: Available water capacity, BD:Bulk Density

Salient Findings :

- The maximum grain yield and Rain Water Use Efficiency of 13.82 q ha^{-1} and 1.94 kg $ha^{-1}mm^{-1}$ respectively was registered by the application of 75% RDF with 5 t ha^{-1} vermicompost (T_4) in *rice*. This was followed by the application of 75% RDF + 3 t ha^{-1} vermicompost (T_3) which recorded grain yield and Rain Water Use Efficiency of 13.53 q ha^{-1} and 1.80 kg $ha^{-1}mm^{-1}$, respectively.
- In *greengram* highest grain yield (12.05 q ha^{-1}) and Rain Water Use Efficiency (5.74 kg $ha^{-1}mm^{-1}$) was recorded under the treatment T_3, which was followed by the treatment T_4. In case of *toria* highest grain yield of 8.23 q ha^{-1} and RWUE 20.61 kg ha^{-1} mm^{-1} was observed in T_4 treatment and this was followed by T_3 treatment (7.81 q ha^{-11} and 19.20 kg ha^{-1} mm^{-1} respectively).

- Rice Equivalent Yield (REY) for *Greengram* (30.13 q ha^{-1}) was recorded maximum in T_3 treatment, and REY for *Toria* (24.69 q ha^{-1}) registered highest under treatment T_4 where applied 75% recommended fertilizer dose along with 5 t ha^{-1} vermicompost.

- Highest B:C ratio was recorded under T_4 treatment

- Increasing fertilizer trend was observed under the treatment T_4 where applied 75% recommended fertilizer dose along with 5 t ha^{-1} vermicompost over the initial value.

	
Best Treatment of Toria	Control Treatment of Toria
	
Best Treatment of Greengram	Control Treatment of Greengram
	
Best Treatment of Rice	Control Treatment of Rice

4.2. Effect of Foliar application of Selenium on drought tolerance and nutrient use efficiency in *toria.*

Selenium (Se) is a trace element that is both an essential nutrient for humans and plants. Se is important in the metabolism of cyanobacteria and some plants, being involved in their antioxidative processes. The essentiality of Se to higher plants, however, is still under debate. Although it is harmful for plants in high concentrations, it can exert beneficial effects at low concentrations. It can increase the tolerance of plants to UV-induced oxidative stress, delay senescence, and promote the

growth of ageing seedlings. Recently it has been shown that Se is able to regulate the water status of plants under conditions of drought. It is widely distributed on the earth's surface and available for plants in at least small traces. Cultivation of plants enriched with Se could be an effective way of producing Se-rich foodstuffs which can be beneficial to health. Basal application of selenium may result in fixation of selenium and leaching loss. Adequate amount and proper method of application of selenium will increase the drought tolerance and nutrient use efficiency.

Table : Effect of treatments on toria (variety : TS-38) yield and economics (Two years pooled data, 2013-14 and 2014-15)

Treatment	Days to 50% flowering	Pods Per plant	Grain Yield (qha^{-1})	Straw Yield (qha^{-1})	RWUE ($kg\ ha^{-1}\ mm^{-1}$)	B:C Ratio
T_1 : Control	45	50.58	3.01	7.38	58.84	1.16
T_2 : 100% NPK (RDF)	43	56.23	5.61	12.34	109.34	1.64
T_3 : RDF + Water spray	43	58.36	5.82	12.63	114.11	1.65
T_4 : RDF + 0.5% Selenium spray before flowering	42	62.29	5.91	12.93	115.72	1.66
T_5 : RDF + 0.5% Selenium spray at siliqua formation	44	63.54	6.03	14.07	117.46	1.69
T_6 : RDF + 0.5% Selenium spray before flowering and at siliqua formation	42	62.14	6.09	14.53	118.87	1.68
T_7 : RDF + 1.0% KNO_3 spray before flowering	43	63.59	6.35	15.02	124.01	1.69
T_8 : RDF + 1.0% KNO_3 spray at siliqua formation	44	66.85	6.31	14.86	123.23	1.69
T_9 : RDF + 1.0% KNO_3 spray before flowering and at siliqua formation	42	67.76	6.42	14.99	125.06	1.71
T_{10} : RDF + 2.0% KNO_3 spray before flowering	40	75.38	7.49	16.75	145.38	1.81
T_{11} : RDF + 2.0% KNO_3 spray at siliqua formation	43	70.55	6.93	15.62	135.14	1.72
T_{12} : RDF + 2.0% KNO_3 spray before flowering and at siliqua formation	42	68.42	7.04	15.83	137.38	1.73
T_{13} : RDF + 2.0% KCl spray before flowering and at siliqua formation	40	83.53	7.57	16.86	147.68	1.92
CD (0.05)	1.14	4.54	2.06	3.08	-	-

Salient Findings :

- The result revealed significant difference in seed yield of toria over control (3.01 q ha^{-1}). Application of Recommended Dose of Fertilizer (RDF) + 2.0% KCl spray before flowering and at siliqua formation (T_{13}) affect the yield of toria significantly (7.57 q ha^{-1}) when compared with other treatments and which was at par with the treatment T_{10} : RDF + KNO_3 spray before flowering i.e 7.49 q ha^{-1}. Maximum seed yield (7.57 q/ha) with B:C ratio of

1.92 was recorded in the treatment T_{13} : RDF +2.0% KCl spray before flowering and at siliqua formation.

- The same treatment i.e T_{13} also recorded highest rain water use efficiency (RWUE) of 147.68 kg $ha^{-1}mm^{-1}$. Highest pods per plant was observed under the treatment T_{13} (83.53) which was followed by T_{10} (75.38).

Best Treatment

Control Treatment

4.3. Effect of Foliar application of potassium on drought tolerance and nutrient use efficiency in *toria.* (Three years pooled data, 2010-11 to 2012-13)

Potassium is one of the major nutrient elements which is required by the plant in large amount. Deficiency of potassium will result in yield loss and as a result nutrient use efficiency of the crop will decrease. Basal application of potassium may result in fixation of potassium and leaching loss. Adequate amount and proper method application of potassium will increased the drought tolerance and nutrient use efficiency of the crop.

Table : Yield, Rain water use efficiency and B:C ratio of Toria var. TS-38

Treatment	Grain Yield (q ha^{-1})	Straw Yield (q ha^{-1})	RWUE (kg $ha^{-1}mm^{-1}$)	Number of siliqua $plant^{-1}$	100 Seed weight (g)	B:C ratio
T_1 : Control	2.21	4.48	8.48	66.87	1.87	1.01
T_2 : 100% NPK (RDF)	5.04	9.58	14.86	76.58	2.01	1.90
T_3 : 100% N & P + 75% K as basal	5.16	9.87	14.56	78.16	2.04	1.95
T_4 : 100% N & P + 50% K as basal	4.39	8.75	12.77	76.06	2.00	1.69
T_5 : T_3 + 2% KCl spray before flowering	5.45	10.23	15.63	79.16	2.12	2.00
T_6 : T_4 + 2% KCl spray before flowering	5.32	9.93	15.01	78.23	2.10	1.89
T_7 : T_5 + 2% KCl spray at siliqua formation	5.66	10.82	16.23	81.15	2.13	2.15
T_8 : T_6 + 2% KCl spray at siliqua formation	5.55	10.58	15.93	80.19	2.12	2.05
CD (P=0.05)	1.09	1.49	8.48	2.43	NS	-

Salient Findings :

- The grain and straw yields were significantly influenced by different treatments. The highest grain yield (5.66 qha^{-1}) and straw yield (10.82 qha^{-1}) was recorded in T_7 treatment (2% KCl spray before flowering + 2% KCl spray at siliqua formation along with 100 % N & P + 75% K as basal). The same treatment i.e. T_7 also recorded highest Rain Water Use Efficiency (16.23 kg $ha^{-1}mm^{-1}$), siliqua per plant (81.15 no.s) B:C ratio (2.15:1). This was followed by T_8 where applied 100% N & P + 50% K as basal+2% KCl spray before flowering+2% KCl spray at siliqua formation.

General view of the experimental

High yielding treatment

4.4. Integrated nutrient management in Rice based cropping system under rainfed condition.

Integrated use of organic and inorganic sources of nutrients is very much essential to sustain crop yield in rainfed agriculture. Organic sources not only increase nutrient use efficiency of crops but also improve soil physical properties. Organic matter enables more soil water retention and better root growth and maintains soil-water-air quality. Most of the works in Assam on the use of INM was carried out in single rice crop or in rice-rice sequence. Information on the use of INM on other crop sequences is still lacking.

Table: Effect of treatments on toria (variety: TS-38) yield and economics (Two years pooled data, 2013-14 and 2014-15)

Treatment	Grain Yield (qha^{-1})	Straw Yield (qha^{-1})	RWUE ($kg\ ha^{-1}\ mm^{-1}$)	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	B:C Ratio
T_1 : Control	1.77	2.24	3.89	4987	5075	1.01
T_2 : RDF	6.44	12.26	46.06	8426	20575	2.44
T_3 : 25% N (Inorganic) + 75% N (Vermicompost)	2.44	5.16	12.92	8326	8546	1.03
T_4 : 50% N (Inorganic) + 50% N (Vermicompost)	3.04	6.71	25.00	8255	9250	1.12
T_5 : 75% N (Inorganic) + 25% N (Vermicompost)	3.19	6.52	27.92	8169	9775	1.19

T_6 : 50% N (Inorganic) + 50% N (Vermicompost) + PK	3.51	7.66	39.03	8356	11775	1.41
T_7 : 100% N (Vermicompost)	2.27	3.89	13.75	6544	7425	1.13
CD (0.05)	0.98	0.33	-	-	-	-

Yield of Rice: 65.26 q ha^{-1}

Salient Findings :

- The result revealed significant difference in seed yield of toria over control. The maximum grain yield of 6.44 q $ha^{-1}$was registered by the application of Recommended Dose of Fertilizer (RDF) (T_2) in *toria*. The same treatment i.e T_2 also recorded highest B:C ratio (2.44 : 1). This was followed by the application of 50% N (inorganic) + 50% N (Vermicompost) + PK (T_6).

Toria cultivation in Research Field

Rice cultivation in Research Field

5. CROPPING SYSTEM:

5.1. Effect of seed priming on growth and yield of *Toria* :

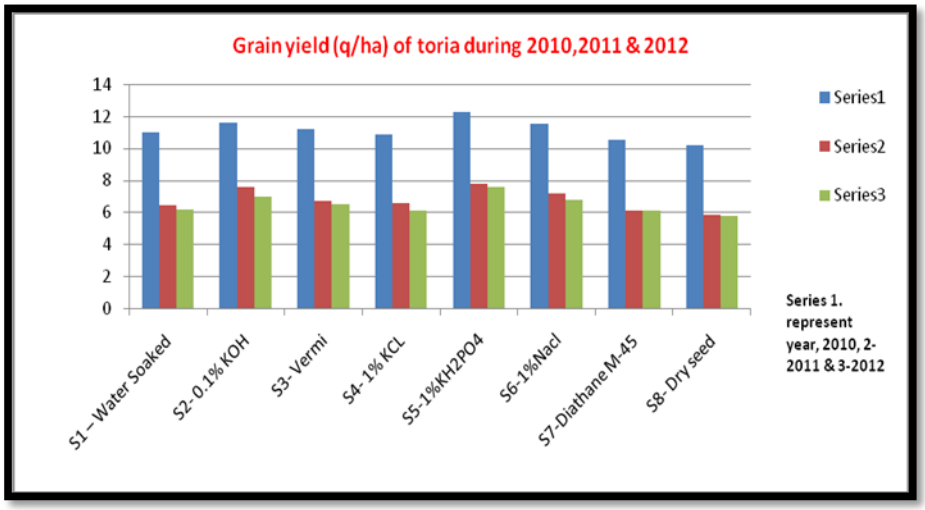
The Practice of seed priming is known for decreasing the time necessary for seed germination and for subsequent emergence and for improving stand uniformity under moisture stress condition. Moisture stress at the time of sowing and also during its crop growth periods, light textured soils with low water retention capacity and low fertility status are some of the common problems encountered by farmers resulting in low and unstable yield. Optimum stand establishment and subsequent maintenance of its growth and development are the key factors for getting assured yield under these conditions Therefore, rapid seed germination and stand establishment are the most important consideration for getting optimum yield under such conditions. Several investigations confirmed that seed priming has many benefits including early and rapid emergence, stand establishment, higher water use efficiency, deeper roots, increasing in root growth, uniformity in emergence, germination in wide range of temperature, break of seed dormancy, initiation of reproductive organs, better competition with weed, early flowering and maturity, resistance to environmental stresses like drought and salinity. Seed Priming is a traditional practice in agriculture to improve plant establishment for centuries. Researchers have also showed that priming of seeds with different salts is one of the methods for inducing drought tolerance in crop plants.

Table: Grain yield, RWUE, Net Returns and B:C Ratio of *toria* as affected by seed priming treatment during 2010-11 2011-12 and 2012-13 (pooled of 3 years)

Treatments	Grain Yield (q/ha)	RWUE (kg/ha/mm)	Net Return (Rs.)	B:C Ratio
S_1 –Water Soaked	7.78	48.87	5094	1.37
S_2- 0.1% KOH	8.72	55.66	7039	1.51
S_3- Vermi	8.15	51.56	4774	1.32
S_4- 1% KCL	7.83	42.91	4862	1.35
S_5-1%KH_2PO_4	**9.10**	**53.29**	**8067**	**1.58**
S_6-1%Nacl	8.48	53.00	6472	1.47
S_7-Diathane M-45	7.59	48.26	4297	1.31
S_8- Dry seed	7.26	45.80	3951	1.29
CD (P0.05)	0.492	---	---	---

Salient Findings :

- The pooled data of three years indicated that the 1% KH_2PO_4 treated seeds (S_5) recorded the highest grain yield of 9.10 q/ha which was significantly superior to rest of the treatments (Table.1)
- The highest RWUE (53.29kg/ha/mm) was found in 1%KH_2PO_4 which was statistically superior over S_1, S_4, S_7 and S_8 and the lowest RWUE was recorded by dry sowing.
- The highest net return of Rs14,316.00,Rs.5174.00 and Rs.4709.00 was recorded by 1%KH_2PO_4 (S_5) during 2010, 2011 and 2012 respectively, with a mean value of Rs.8067/- and the lowest was noticed in control i.e. Dry seed. Similarly, seed priming with 1%KH_2PO_4 maintained higher values of Benefit : Cost ratios during all the years of experimentation being the highest mean of 1.58 and the lowest under Dry seed(control).



Seeds of toria treated with KH_2PO_4 found to be the best in terms of yield

A toria crop without seed treatment (Dry seed) resulted in lowest grain yield and RWUE

5.2. Intercropping studies in sesame with greengram and blackgram

The practice of intercropping is a more refined concept than mixed cropping, by providing "biological insurance" and an increase in the cropping intensity, thereby increasing productivity and income per unit area per unit time. Sesame (*Sesamum indicum* L.) is an

oilseed crop popularly grown in Assam and it occupies an important place in oilseed scenario of the country next to rapeseed and mustard. However, the productivity of sesame is very unstable in the state as it is cultivated mainly in rainfed upland situation which is highly susceptible due to vagaries of monsoon. It is hardly disputed that productivity and cropping intensity of upland ecosystem cannot be raised to a desired level unless the existing production system is diversified through low duty high value crop. Pulses are considered to be an ideal crop for their suitability in different intercropping systems. Intercropping in sesame with pulses showed encouraging results not only in increasing productivity but also improving soil health. Legumes like green gram/black gram being short duration crops may constitute potential intercrop for sesame in rain fed upland condition. The aim of research was to compare the productivity and feasibility of intercropping with sole cropping and also to determine the Rain Water Use Efficiency by sole and intercropping system under rain fed upland situation.

Table : Growth and Yield attributing characters as influenced by treatments (Pooled data of 3 years)

Treatments	Plant height (cm)		No. of capsule/pod per plant		No. of Branches/plant of		Test weight (gm)	
						Intercrops	Sesame	
T1 - Sesame (Sole)	120	--	43.0	--	5.70	--	3.05	--
T2 - Green gram (Sole)	--	63.0	--	17.7	--	4.67	--	385.57
T3 - Black gram (Sole)	--	48.0	---	22.3	--	4.00	--	40.21
T4 - S+GG(1:1)	117	62.0	29.3	18.3	6.00	3.67	3.00	38.95
T5 - S+GG(2:1)	111	57.6	29.0	16.0	5.60	4.67	3.02	39.03
T6 - S+GG(2:2)	98.3	57.3	30.3	19.3	5.70	4.67	3.07	39.85
T7 - S+GG(3:1)	110	54.3	30.0	17.3	6.00	3.67	3.02	38.12
T8 - S+BG (1:1)	79	38.0	28.3	13.0	6.00	6.67	3.10	40.85
T9 - S+BG (2:1)	86	37.3	28.7	13.0	5.60	6.33	3.08	40.20
T10 -S+BG (2:2)	96	40.3	32.7	12.0	5.30	5.67	3.07	40.39
T11 S+BG (3:1)	100	36.0	25.0	11.0	5.50	6.33	3.03	40.26
CD(P0.05)	**11.55**	**NS**	**5.74**	**NS**	**NS**	**1.19**	**NS**	**NS**

Table : Grain Yield (q/ha) of sesame, greengram and blackgram as influenced by treatments (pooled data of three years)

Treatments	Grain Yield (q/ha)		SEY(q/ ha)	LER	RWUE (kg/ha/mm)	Net Returns (Rs./ha)	B:C ratio
	Sesame (POOLED)	Intercrops (POOLED)					
T1 - Sesame (Sole)	**6.16**	---	6.16	1.00	2.57	14718	2.48
T2 - Green gra(Sole)	-	8.19	13.35	1.00	5.68	38956	3.91
T3 - Black gram(Sole)	-	**11.50**	12.92	1.00	5.78	37309	3.90
T4 - S+GG(1:1)	4.40	5.27	12.30	1.35	6.28	34134	3.88
T5 - S+ GG(2:1)	4.45	3.84	10.17	1.28	5.14	27388	3.47
T6 - S+ GG(2:2)	4.54	5.59	12.62	1.41	7.25	36667	4.09

T7 - S+ GG(3:1)	4.74	3.52	9.82	1.16	5.21	25736	3.34
T8 - S+BG (1:1)	4.19	8.59	**13.85**	**1.42**	**7.42**	**39374**	**4.40**
T9 - S+BG (2:1)	4.73	6.99	12.60	1.36	7.07	35861	4.26
T10 - S+BG (2:2)	4.28	7.30	12.50	1.34	6.66	35480	4.06
T11 S+BG (3:1)	4.78	4.66	10.00	1.19	5.87	28620	3.63
CD(P0.05)	**0.98**	**2.11**	**2.83**				

Price of Sesame : Rs.4000/- per q,
Price of Green gram : Rs.6000/- per q
Price of Black gram : Rs. 4500/- per q
SEY: Sesame Equivalent Yield,
LER: Land Equivalent Ratio

S = Sesame , GG = Green gram , BG = Black gram

Sesame intercropped with GG 2:2 and Sesame intercropped with BG 1:1 produced highest SEY

Salient Finding:

- It was observed that Pooled data of growth and yield attributing characters recorded significant variations in plant height, number of capsules/plant of sesame due to intercropping
- The highest plant height was recorded in sole sesame and was found to be significantly superior over all the intercropping treatments with blackgram irrespective of treatments. Similarly, number of capsules/plant was statistically higher in case of sole sesame irrespective of intercropping with greengram or blackgram. However, number of branches/plant and test weights due to treatments were not significant.
- The pooled data of three years recorded the highest sesame yield of 6.16q/ha in sole sesame (T_1) which was statistically superior over rest of the intercropping treatments. Within the rest of the intercropping system the grain yields were at par.
- From the pooled data, it was found that the highest grain yield 11.50q/ha was registered under of sole blackgram. Among the intercropping treatments highest grain yield of blackgram was noticed under T_8 i.e, S + BG (1:1) which was statistically superior over other intercropping treatments.
- It was found from that sesame equivalent yields differed significantly due to treatments. Intercropping of sesame either with greengram or blackgram in any ratio recorded higher SEY over sole sesame during all the years of experimentation and also in pooled. The highest SEY of 13.85q/ha was registered under T_8 which was statistically at par with T_2, T_3, T_4, T_6, T_9 and T_{10}.

- The Land Equivalent Ratio (LER) was always higher over sole cropping of Sesame, Greengram and Blackgram during 2010, 2011, 2012 and also on pooled.
- The Rain water Use Efficiency (RWUE) was statistically higher in all the intercropping systems over sole sesame , the pooled data recorded the highest RWUE of 7.42 Kg/ha/mm in $T_{8.}$
- Among the years, highest net return(Rs. 39,254) was achieved in T_8 i.e. S + BG(1:1) during 2012 with the B :C ratio of 4.99.The pooled data for three years recorded highest net return of Rs.39,374 by S + BG (1 :1) followed by Sole Greengram. The lowest net return was obtained in T_1 (Sole sesame). Similarly the highest B: C ratio was recorded in S+BG (1:1) with the value of 4.40 followed by S+ BG(2:1).
- Intercropping system of sesame + black gram (1:1) followed by sesame + green gram (2:2) proved superiority over mono cropping and other intercropping treatments. Hence, it can be concluded that sowing of 1 rows of sesame with 1 row of green gram var. T_9 is biologically and economically sustainable intercropping system for rainfed conditions of Assam.

5.3. Rice - based cropping systems under rainfed upland situation of Assam

Rice occupies prominent position in most of the agro climatic zones of Assam. Other than rice, different rabi crops viz. *toria, mustard, niger, rajmah, buckwheat, potato* etc are also important crops. Average yield of these crops are fluctuating and very low due to various reasons among which moisture stress during the crop period is the vital one. Therefore, it is important to find out suitable rice based cropping system to increase its productivity and economics. Moreover, response of crops is also dependent on the adoption of the previous crops. Cropping sequences will follow to use the land efficiently and crops can be raised throughout the year so that the farmers will get maximum return and also helps in increasing the soil status thus helps in improving overall physical properties of soil and crop. Therefore, to sustain high yield, suitable crop rotation should be followed with balance application of fertilizer and organic manures. Keeping in view the study of rice based cropping systems under rainfed upland situation in Sonitpur district and will be also tried to find out the suitable rice based cropping system in terms of yield and economics

Table: Grain yield of different crops, Rice Equivalent Yield (REY), RWUE and B:C Ration of Rice- based cropping sequence (pooled data of three years)

Treatments	Grain Yeid (q/ha)		REY(q/ha)	Net Returns (Rs./ha)	B:C Ratio
	Rice	Rabi crops			
T_1- Rice –Toria	13.57	5.55	28.9	6250.00	1.26
T_2- Rice – Lathyrus	13.61	5.62	27.1	6493.00	1.31
T_3 – Rice – Pea	13.80	5.07	24.1	2181.00	0.43
T_4 – Rice - Lentil	13.64	6.67	31.4	6808.00	0.62
T_5 – Rice - Linseed	13.83	4.73	27.8	4965.00	1.22
T_6- RicBuckwheat	13.60	10.7	24.7	4301.00	1.21
T7- Rice - Mustard	13.96	7.22	34.4	10926.00	1.46
T_8 – Rice - Niger	13.99	5.23	28.3	8210.00	1.41
T_9- Rice - Chickpea	13.75	3.80	21.9	675.00	0.36
T_{10}- Rice- Rajmah	13.59	12.0	66.1	43425.00	**2.93**
T_{11}- Rice- Potato	**14.59**	**81.0**	**104.1**	55026.00	2.13
T_{12}RiceHorsegram	14.16	3.57	20.39	1881.00	0.76
CD (P 0.05)					

Salient Finding:

- From the pooled data of three years it has been observed that the among all the cropping sequences potato showed better result in terms of yield.
- It was reported that highest tuber yield of 81.0q/ha of potato was obtained with rice - potato cropping sequence as compared to others followed by Rice-rajmah i.e 12.00q/ha and Rice – Buckwheat i.e 10.7 q/ha.
- Maximum rice equivalent yield (104.1 q/ha) was recorded under rice – potato cropping sequences followed by Rice-Rajmah i.e 66.61q/ha and Rice-Mustard i.e 34.4 respectively.
- The highest Benefit: Cost Ratio was obtained in the sequence Rice-Rajmah 2.93 with net returns of Rs. 43425.00 followed by the sequence Rice-Potato of 2.13 B:C Ratio.

Rice (ahu) sequence with Potato are found to be best in term of yield

Niger crop following rice (ahu) in rice based cropping sequence

5.4. Comparative study on Maize based - double cropping systems under North bank plain zone of Assam.

Maize is an important crop of the NBPZ of Assam. However, systemic study of this crop under the cropping sequence is not yet done. Upland direct seeded rice (ahu) during summer season generally gives very low yield due to tremendous weed growth. And other related problems like moisture stress at various stages, poor yielding local varieties are generally suitable for direct seeding etc. Therefore it becomes necessary to find out alternate cropping sequences involving summer/kharif and rabi cropping sequences. Therefore the present study is being conducted by growing maize in summer/kharif followed by different rabi crops.

Table: Grain yield (q/ha), MEY (Maize Equivalent Yield and B:C Ratio during 2013-14, 2014-15 and 2015-16 (Pooled of three years)

Treatments	MEY (q/ha)				B:C Ratio			
	2013	2014	2015	mean	2013	2014	2015	mean
T_1- Maize –Toria	48.90	78.40	64.44	63.9	1.74	2.78	2.29	2.27
T_2- Maize – Lathyrus	51.06	79.43	64.82	65.1	1.13	3.31	1.70	2.05
T_3 – Maize – Pea	50.60	78.33	69.00	65.9	1.01	3.12	2.75	2.29
T_4 - Maize – Lentil	58.49	87.47	77.35	74.4	1.08	3.11	2.74	2.31
T_5 – Maize – Linseed	50.14	79.15	54.96	61.4	1.83	2.88	2.00	2.24

T_6- Maize – Buckwheat	48.48	77.27	65.43	63.7	1.90	3.03	2.57	2.50
T_7- Maize – Mustard	58.56	82.19	72.75	71.2	2.09	2.93	2.6	2.54
T_8 – Maize – Niger	60.37	84.34	74.05	72.9	2.29	3.21	2.82	**2.77**
T_9- Maize- Maize	80.19	93.81	73.24	**82.4**	1.86	2.18	1.7	1.91
T_{10}- Maize – Rajmah	64.39	99.44	78.19	80.7	2.36	3.65	2.87	**2.96**
T_{11}– Maize – Horsegram	54.25	80.72	70.94	68.6	2.14	3.19	2.8	2.71
T_{12} – Maize –Potato	96.24	103.0	90.74	**96.7**	1.85	1.98	1.74	1.86
CD (P 0.05%)	**3.14**	**2.99**	**2.98**	**7.20**	**--**	**---**	----	

A general view of the experimental plot of Maize-based double cropping system

Salient Finding:

- From the pooled data of three years (2013, 2014, 2015) the maize grain yield was found to vary between 50.28 – 56.53 q/ha.
- Among the 12 cropping sequences followed, Maize-Potato showed highest Maize Equivalent Yield (96.7) followed Maize–Maize of (82.40 q/ha).
- However, Benefit: Cost Ratio was highest in Maize- Rajmah of 2.96 followed by Maize –Niger of 2.77 respectively.

5.5. Effect of planting time on local small tubers potato varieties to improved varieties under rainfed condition of Assam.

Local small tuber Potato is popularly grown in the NBPZ of Assam due to its better palatability along with common improved varieties. Further local small tuber varieties are said to be more drought tolerant than improved varieties with low inputs. However, systematic study of this crop in comparison to improved varieties is not yet done. Under these circumstances the experiment was designed with two local small tuber varieties with one improved varieties as check.

Table: Effect of planting time of local small tubers potato varieties to improved varieties on yield under rainfed condition of Assam during 2013,2014 and 2015

Treatments	Tuber yield (q/ha)				B:C Ratio			
Dates of planting	**2013**	**2014**	**2015**	**mean**	**2013**	**2014**	**2015**	**mean**
D_1: 1st October	81.0	79.29	73.98	78.09	1.86	3.06	2.85	2.59
D_2: 16th October	85.2	86.26	83.38	**84.95**	1.96	3.33	3.19	**2.83**
D_3: 1st November	84.1	83.67	80.44	**82.74**	1.93	3.23	3.11	**2.76**
D_4:16th November	78.8	69.55	66.88	71.74	1.77	3.05	2.59	2.47
CD (P 0.05%)	**---**	**13.03**	**16.33**	**---**	---	---	---	
Varieties								
V_1:Local improved small tuber (red eyed)	67.2	71.04	67.1	68.45	2.77	3.69	3.49	3.31
V_2:Local improved small tuber (white eyed)	88.0	77.82	75.1	80.31	2.31	3.90	3.76	**3.32**
V_3: Recommended Check variety (*Kufri Pokhraj)*	---	90.22	86.4	**88.31**	--	2.23	1.89	1.37
	---	**11.29**	**11.54**	--				

A general view of the experimental plot of potato in different of sowing

Salient Finding:

- Two local small tuber potato varieties (white eyed and red eyed) were tested against recommended improved variety *Kufri Pokhraj* in 4 sowing dates.
- From the pooled data of three years it was observed that the highest tuber yield of 84.95 q/ha was recorded by D_2 (16th October) followed by D_3 (1st November) of 82.74 q/ha with corresponding B: C ratio of 2.83 and 2.76 respectively.
- Among the varieties, the recommended check variety i.e (*Kufri Pokhraj)* yielded maximum tuber yield of 88.31 q/ha. However highest B:C ratio of 3.32 was recorded by local small tuber white eyed variety followed by local small tuber variety red eyed of 3.31 against the recommended variety *Kufri pokhraj* (1.37)

5.6. Effect of Fertility levels on yield and economics of sesame based intercropping system.

From the last few years of experimentation at AICRPDA, BNCA on intercropping, it was found that growing of greengram and blackgram with sesame at 1:1 or 2:2 row ratios produced highest grain yield in terms of sesame equivalent yield and return over sole cropping of Sesame. These findings were accepted by DTCM and also in TCM at AAU, Jorhat and recommended for OFT within the domain districts of NBPZ through KVKs.

Though, in intercropping application of fertilizer dose of the base crop is the general rule it is important to ascertain the optimum dose when two crops are grown together in 50% replacement. Therefore, the present study is conducted on the basis of the last three years of findings with the best intercropping systems for finding out the optimum fertility levels for sesame based intercropping systems.

Table: Effect of Fertility levels on SEY and Economics of sesame based intercropping system. (pooled data of three years)

Treatments	SEY(q/ha)				B:C Ratio(Rs./ha)			
	2013	2014	2015	mean	2013	2014	2015	mean
F_1S_1(S+GG 1:1)	9.10	10.51	9.70	9.77	2.65	3.06	4.53	3.41
F_1S_2(S+GG 2:2)	9.46	12.96	9.85	10.76	2.76	3.77	4.60	3.71
F_1S_3(S+BG 1:1)	8.30	12.77	13.47	11.51	2.47	3.82	6.43	4.24
F_1S_4(S+BG 2:2)	10.12	10.36	9.83	10.09	3.03	3.09	4.72	3.61
F_2S_1(S+GG 1:1)	8.27	9.02	7.86	8.38	2.42	2.65	3.70	2.92
F_2S_2(S+GG 2:2)	5.58	9.80	8.78	8.05	1.63	2.87	4.12	2.87
F_2S_3(S+BG 1:1)	8.26	7.1	6.33	7.23	2.5	2.15	3.07	2.57
F_2S_4(S+BG 2:2)	7.69	6.85	7.23	7.26	2.29	2.05	3.46	2.60
F_3S_1(S+GG 1:1)	6.94	8.38	8.75	8.02	1.99	2.41	4.03	2.81
F_3S_2(S+GG 2:2)	6.22	9.63	8.92	8.26	1.78	2.76	3.09	2.54
F_3S_3(S+BG 1:1)	7.89	8.36	9.27	8.51	2.37	2.52	4.46	3.11
F_4S_4(S+BG 2:2)	9.98	6.00	6.69	7.55	2.97	1.79	3.19	2.65
Sesame(Sole)	---	6.91	8.78	7.84	---	2.58	4.25	3.41
Greengram (Sole)	---	8.30	8.94	8.62	--	2.23	3.84	3.03
Blackgram (Sole)	---	7.77	7.34	7.55	--	2.92	4.40	3.66
CD (P 0.05%)		2.99	1.43	1.54				

Sesame intercropped with greengram (2:2) and sole crops

Salient Finding:

- It has been observed that intercropping of sesame with green gram and blackgram were significantly different in respect of the Sesame Equivalent Yield (SEY) and gave highest Benefit: Cost Ratio than Sole.
- From the pooled data of three years it was found that intercropping of green gram and blackgram with sesame were significantly different in respect of the Sesame Equivalent Yield (SEY) and Benefit: Cost Ratio due to treatments.
- Among the different treatment tested Sesame intercropped with Blackgram 1:1 of 11.51q/ha followed by sesame intercropped with Greengram 2:2 of 10.76 q/ha was found to be best. However, Among the fertility levels F_1 i.e 30:20:20 kg NPK/ha produced highest SEY (10.50 q/ha) with highest mean B:C Ratio of 4.24

5.7. Relay cropping of Rabi pulses with kharif rice under rainfed medium low land situation of NBPZ, Assam (OFT Result)

Rice based cropping system is the major cropping sequence in the state of Assam. However, after harvest of kharif rice (Sali) the land is generally kept fallow. This fallow land can be used by suitable relay crops to harness residual soil moisture and fertility of preceding Sali crop. Therefore, the present experiment was designed with quick growing rabi pulses (Lathyrus and pea) as relay crop with different treatment combinations.

Table : Grain yield (q/ha) of different relay crops of *Rabi* pulses *in kharif* rice during 2015-16

Treatments	Grain yield (q/ha)	Stover yield (q/ha)	Total Dry matter (q/ha)	B:C Ratio (Rs./ha)
T_1: Sowing of pea 15 days before rice harvest with 100% seed	1.75	2.47	4.22	2.37
T_2: Sowing of pea 15 days before rice harvest with 150% seed rate	**4.74**	6.19	10.9	**4.54**
T_3: Sowing of pea at rice harvest with 100% seed rate	1.64	2.12	3.76	2.23
T_4: Sowing of pea at rice harvest with 150% seed rate	1.67	2.14	3.81	1.60
T_5: Sowing of pea after rice harvest by zero till machine with 100% seed rate.	1.49	1.81	3.31	1.77

T_6: Sowing of pea after rice harvest by zero till machine with 150% seed rate.	1.57	2.02	3.60	1.37
T_7 Sowing of lathyrus 15 days before rice harvest with 100% seed rate	1.27	1.60	2.88	1.80
T_8: Sowing of lathyrus 15 days before rice harvest with 150% seed rate	1.70	2.03	3.74	1.69
T_9: : Sowing of lathyrus at rice harvest with 100% seed rate	1.31	1.58	2.89	1.85
T_{10}: Sowing of lathyrus at rice harvest with 150% seed rate	1.49	1.74	3.23	1.48
T_{11}: Sowing of lathyrus after rice harvest by zero till machine with 100% seed rate.	1.02	1.25	2.27	1.37
T_{12}: Sowing of lathyrus after rice harvest by zero till machine with 150% seed rate	1.20	1.44	2.65	1.79
CD (P 0.05%)	2.43	--	--	--

Salient Finding:

From the first year of experimentation among the 12 relay cropping treatment over Kharif rice (Ranjit), Pea relayed with 150 per cent Recommended Seed Rate at 15 Days Before Harvest of Rice recorded the highest grain yield (4.74 q/ha) and also recorded the highest B:C Ratio of 4.54 Rs./ha. Data showed that pea is better than lathyrus as relay crop with rice.

A General view of experimental plot and Best treatment (Pea with 150% seed rate as relay crop in rice)

5.8. Intercropping of ginger and pigeon pea under different microclimate

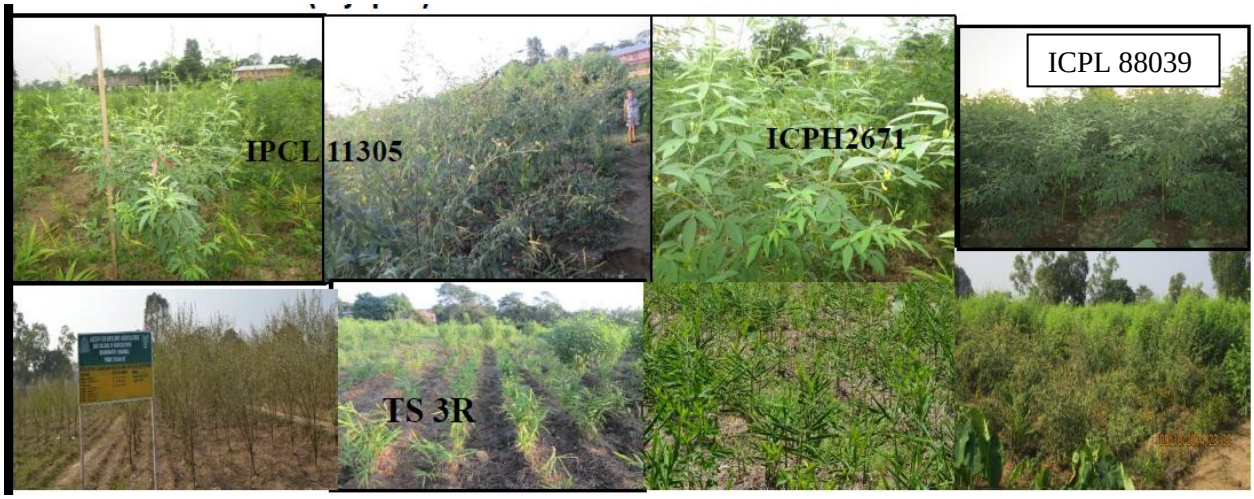
Ginger is an important spice and medicinal crop which is plant of very ancient cultivation and the spice has long been used in Assam. Agricultural production of ginger in Assam is primarily dependent on climatic environment in spite of various recent technological advancements. It is highly sensitive to weather, showing quite

diverse patterns of growth and development to different sets of environmental conditions. Climatic factors as well as pest and diseases may affect the productivity of ginger. Prevailing weather conditions play an important role in growth and development of ginger. It is a shade loving crop. Crop diversification as displayed by intercropping has long being a prominent feature of small holder crop production. This is further promoted by the farmers concerned not only for enhancing farm productivity per unit land but also to ensure security against potential risks of monoculture alongside creating a platform for stabilizing the diversified needs of farming households whose production is greatly influenced by varieties of nature.

Salient Findings : (Two years pooled information, 2013-14 and 2014-15)

- Yield of improved varieties of Pigeonpea (ICPL 11305, ICPL11330, ICPL 88039, Maruti, ICPH 2671 and TS3R) collected from different parts of the country was lower as compared to the local cultivar.
- ICPL 11305 and ICPL11330 short duration cultivars, first open flower appeared at 60 and 80 DAS, respectively. Yield of ICPL 11305 is higher than ICPL 11330.
- ICPL 88039 is more spreading type whose flowering starts on 110 DAS. Yield (4.57 q/ha) are more than superfast cultivars, but less than TS-3R and Local-2.
- Both TS 3R and LOCAL -2 bold seeded cultivars and high yielder. Local –2 is more spreading type canopy coverage is more as compared TS-3R.
- Ginger yield was reduced drastically in all treatments which might be due severe infestation and poor growth of the Ginger crop.
- Poor crop growth and heavy infestation (>80%) with Rhizome rot disease of Ginger was might be resulted from delay in sowing, no or less shading in the early months (June, July and August) and more rainfall during the active growing period.

Photographs



5.9. Modelling crop growth parameters and yield of rice and potato in a rice potato sequence

Potato (*Solanum tuberosum*) is an important food crop of the Assam. Agricultural production of potato in Assam is primarily dependent on climatic environment in spite of various recent technological advancements. It is highly sensitive to weather, showing quite diverse patterns of growth and development to different sets of environmental conditions. Climatic factors as well as pest and diseases may affect the productivity of potato. Prevailing weather conditions play an important role in growth and development of potato.

The experiment was carried out in BNCA for potato as *rabi* crop. For generation of crop data in rice potato cropping sequence, experiment was carried out for *Sali* rice (short, medium and long duration) as *kharif* crop followed by potato (two variety) as *rabi* crop at the RARS, North Lakhimpur. The data generated is used to run the crop simulation model "Decision Support System for Agrotechnology Transfer (DSSAT)" version 4.5 which are listed below in tabular form.

(a) Data generated for running CERES- RICE model in DSSAT v4.5
Station – RARS, Lakhimpur

S. No	Parameters	Date / Value / Text		
1	Variety name	Kanaklata	Gitesh	Luit
2	Type of variety (Short / medium / long duration)	Medium	Long	Short
3	Duration of variety (in days)	135	150	100
4	Previous season crop	*Ahu* rice	Toria	Ahu rice
5	Experimental design	0	0	0
6	Sowing method (Transplanted / direct seeded)	Transplanted	Transplanted	Transplanted
7	Sowing depth (If, direct seeded)	0	0	0
8	Puddling (Yes / No)	Yes	Yes	Yes
9	Seed rate	40	40	50
10	Row to row spacing	20 x 20	20 x 20	15 x 15
11	Age of seedlings at transplanting day	32	38	19

12	No of seedlings / hill			2 to 3		2 to 3			2 to 3	
13	Plant population (No of hill/m^2)			25		25			44	
14	Sowing date			19-Jun-14		23-Jun-14			19-Jul-14	
15	Transplanting date			21-Jul-14		31-Jul-14			6-Aug-14	
16	Panicle Initiation stage			2-Sep-14		25-Sep-14			29-Aug-14	
17	Heading stage			3-Sep-14		26-Oct-14			25-Sep-14	
18	50% flowering / Anthesis			6-Oct-14		29-Oct-14			29-Sep-14	
19	Beginning of grain filling			16-Oct-14		10-Nov-14			10-Oct-14	
20	End of grain filling			26-Oct-14		12-Nov-14			21-Oct-14	
21	Physiological maturity date			7-Nov-14		30-Nov-14			29-Oct-14	
	Physiological maturity day (dap)			116		128			91	
22	Harvesting			14-Nov-14		6-Dec-14			5-Nov-14	
23	*No of effective tillers / m^2	181	197	205	153	160	146	181	185	177
24	*No of grains / ear	225	222	219	264	248	278	113	117	109
25	*No of grains / m^2	40725	43734	44895	40392	39680	40588	20453	21645	19293
26	*Single grain weight (g)	16.8	16.2	15.6	19.5	19.9	19.7	23.4	22.9	23.9
27	*Straw yield (Kg / ha)	4800	5520	5080	6720	7320	9580	4080	4280	3980
28	*Biomass yield	8425	9535	8900	11829	12518	14867	8113	8430	7896

	(Kg/ha)									
29	*Grain yield (Kg / ha)	3625	4015	3820	5109	5198	5287	4033	4150	3916
30	Harvest index	0.43, 0.42, 0.43		0.43, 0.41, 0.36			0.50, 0.49, 0.50			
	Irrigation details									
31	Irrigation amount (mm)	0		0			0			
32	Date of irrigation (in DAT)	0		0			0			
33	Irrigation method	*Rainfed*		*Rainfed*			*Rainfed*			
	Fertilizer management									
34	Date of fertilizer (N, P and K) application (DAT)	Basal on 20/07/2014; N top dressing on 22/08/2014		Basal on 30/07/2014; N top dressing on 30/08/2014			Basal on 05/08/2015; N top dressing on 30/08/2015			
35	Amount of fertilizer (N, P and K) application	Half of N, full dose of P and K as basal; Remaining half of N as top dressing (40:20:20 kg of N,P and K per ha)		Half of N, full dose of P and K as basal; Remaining half of N as top dressing (40:20:20 kg of N,P and K per ha)			Half of N, full dose of P and K as basal; Remaining half of N as top dressing (40:20:20 kg of N,P and K per ha)			
36	Type of fertilizer (N,P and K)	N= Urea, P= SSP and K= MOP		N= Urea, P= SSP and K= MOP			N= Urea, P= SSP and K= MOP			
37	Depth of fertliser	3 cm		3 cm			3 cm			

	application			
38	Fertilizer application method	Basal and Top dressing	Basal and Top dressing	Basal and Top dressing
	Farmyard manure/ green manure applied, if any			
39	Name of green manure crop	0	0	0
40	Application date	0	0	0
41	Amount	0	0	0

*Data are presented replication-wise

(b) Data generated for running CERES- POTATO model in DSSAT v4.5
Station – RARS, Lakhimpur Cultivar type: Pokhraj (V_1)

Parameter	**1st DOP**			**2nd DOP**			**3rd DOP**			**4th DOP**		
Sowing date	20-Nov-14			27-Nov-14			4-Dec-14			11-Dec-14		
Emergence date	26-Nov-14			3-Dec-14			9-Dec-14			16-Dec-14		
Physiological maturity date	28-Feb-15			6-Mar-15			14-Mar-15			23-Mar-15		
Tuber initiation day	15-Jan-14			22-Jan-14			29-Jan-14			6-Feb-15		
*Tuber dry weight (kg/ha)	2627	2780	2916	2504	2520	2638	1990	1614	1747	2022	2142	1903
*Tuber fresh weight (kg/ha)	17280	18293	19187	16473	16580	17353	13093	10620	11494	13302	14089	12520
*Yield-Total wt. harvest (kg/ha)	17280	18293	19187	16473	16580	17353	13093	10620	11494	13302	14089	12520

*By-product harvest (Fresh) (kg/ha)	10382	10990	11527	9899	9961	10426	7866	6380	6905	7992	8465	7522
*By-product harvest (Dry) (kg/ha)	1318	1396	1464	1257	1265	1324	999	810	877	1015	1075	955
Maximum leaf area index	-			-			-			-		
By product harvest-kg/ha	-			-			-			-		
Tuber N at harvest-kg/ha	-			-			-			-		
Tuber+ stem + leaf N at harvest (kg/ha)	-			-			-			-		
Tops N at maturity-kg/ha	-			-			-			-		
Tuber N at harvest (%)	-			-			-			-		
Management practices Planting depth	3 cm - 5 cm			3 cm - 5 cm			3 cm - 5 cm			3 cm - 5 cm		
Row spacing & plant population (plant/m^2)	50 cm (12 plants/m^2)			50 cm (12 plants/m^2)			50 cm (12 plants/m^2)			50 cm (12 plants/m^2)		
Plant method & distribution	Sprouted tubers were planted in furrows with sprouts facing upward			Sprouted tubers were planted in furrows with sprouts facing upward			Sprouted tubers were planted in furrows with sprouts facing upward			Sprouted tubers were planted in furrows with sprouts facing upward		
Type of fertilizer (N,P and K)	N= Urea, P= SSP and K= MOP			N= Urea, P= SSP and K= MOP			N= Urea, P= SSP and K= MOP			N= Urea, P= SSP and K= MOP		
Fertilizer- . amount & time	Entire quantity of fertilizers was applied in furrows as basal application and covered with a thin layer of soils so that			Entire quantity of fertilizers was applied in furrows as basal application and covered with a thin layer of soils so that tubers do not come			Entire quantity of fertilizers was applied in furrows as basal application and covered with a thin layer of soils so that tubers do not come			Entire quantity of fertilizers was applied in furrows as basal application and covered with a thin layer of soils so that tubers do not come		

	tubers do not come into direct contact with the fertilizers (60:100:100 kg of N,P and K per ha as irrigated crop)	into direct contact with the fertilizers (60:100:100 kg of N,P and K per ha as irrigated crop)	into direct contact with the fertilizers (60:100:100 kg of N,P and K per ha as irrigated crop)	into direct contact with the fertilizers (60:100:100 kg of N,P and K per ha as irrigated crop)
Irrigation- . amount & time	Three irrigations was applied, first at 25 days (stolon formation stage), second at 60 days (tuber formation stage) and third at 80 days (tuber development stage) after emergence of sprouts	Three irrigations was applied, first at 25 days (stolon formation stage), second at 60 days (tuber formation stage) and third at 80 days (tuber development stage) after emergence of sprouts	Three irrigations was applied, first at 25 days (stolon formation stage), second at 60 days (tuber formation stage) and third at 80 days (tuber development stage) after emergence of sprouts	Three irrigations was applied, first at 25 days (stolon formation stage), second at 60 days (tuber formation stage) and third at 80 days (tuber development stage) after emergence of sprouts

*Data are presented replication-wise

(c) Data generated for running CERES- POTATO model in DSSAT v4.5 Station RARS, Lakhimpur Cultivar type: Kufri Jyoti (V_2)

Parameters	**1st DOP**			**2nd DOP**			**3rd DOP**			**4th DOP**		
Sowing date	20-Nov-14			27-Nov-14			4-Dec-14			11-Dec-14		
Emergence date	26-Nov-14			3-Dec-14			9-Dec-14			16-Dec-14		
Physiological maturity date	27-Feb-15			5-Mar-15			12-Mar-15			20-Mar-15		
Tuber initiation day	18-Jan-14			24-Jan-14			31-Jan-14			8-Feb-15		
*Tuber dry weight (kg/ha)	1948	2170	2397	1313	1085	1058	1612	1696	1490	1004	833	1000
*Tuber fresh weight (kg/ha)	12817	14276	15769	8640	7140	6960	10605	11160	9800	6606	5480	6580
*Yield- Total wt. harvest (kg/ha)	12817	14276	15769	8640	7140	6960	10605	11160	9800	6606	5480	6580

*By-product harvest (Fresh) (kg/ha)	6320	7039	7776	4260	3521	3432	5229	5503	4832	3257	2702	3244
*By-product harvest (Dry) (kg/ha)	803	894	987	541	447	436	664	699	614	413	343	412
Maximum leaf area index	-			-			-			-		
By product harvest-kg/ha	-			-			-			-		
Tuber N at harvest-kg/ha	-			-			-			-		
Tuber+ stem + leaf N at harvest (kg/ha)	-			-			-			-		
Tops N at maturity-kg/ha	-			-			-			-		
Tuber N at harvest (%)	-			-			-			-		
Management practices Planting depth	3 cm - 5 cm			3 cm - 5 cm			3 cm - 5 cm			3 cm - 5 cm		
Row spacing & plant population (plant/m^2)	50 cm (12 plants/m^2)			50 cm (12 plants/m^2)			50 cm (12 plants/m^2)			50 cm (12 plants/m^2)		
Plant method & distribution	Sprouted tubers were planted in furrows with sprouts facing upward			Sprouted tubers were planted in furrows with sprouts facing upward			Sprouted tubers were planted in furrows with sprouts facing upward			Sprouted tubers were planted in furrows with sprouts facing upward		
Type of fertilizer (N,P and K)	N= Urea, P= SSP and K= MOP			N= Urea, P= SSP and K= MOP			N= Urea, P= SSP and K= MOP			N= Urea, P= SSP and K= MOP		

Fertilizer- . amount & time	Entire quantity of fertilizers was applied in furrows as basal application and covered with a thin layer of soils so that tubers do not come into direct contact with the fertilizers (60:100:100 kg of N,P and K per ha as irrigated crop)	Entire quantity of fertilizers was applied in furrows as basal application and covered with a thin layer of soils so that tubers do not come into direct contact with the fertilizers (60:100:100 kg of N,P and K per ha as irrigated crop)	Entire quantity of fertilizers was applied in furrows as basal application and covered with a thin layer of soils so that tubers do not come into direct contact with the fertilizers (60:100:100 kg of N,P and K per ha as irrigated crop)	Entire quantity of fertilizers was applied in furrows as basal application and covered with a thin layer of soils so that tubers do not come into direct contact with the fertilizers (60:100:100 kg of N,P and K per ha as irrigated crop)
Irrigation- . amount & time	Three irrigations was applied, first at 25 days (stolon formation stage), second at 60 days (tuber formation stage) and third at 80 days (tuber development stage) after emergence of sprouts	Three irrigations was applied, first at 25 days (stolon formation stage), second at 60 days (tuber formation stage) and third at 80 days (tuber development stage) after emergence of sprouts	Three irrigations was applied, first at 25 days (stolon formation stage), second at 60 days (tuber formation stage) and third at 80 days (tuber development stage) after emergence of sprouts	Three irrigations was applied, first at 25 days (stolon formation stage), second at 60 days (tuber formation stage) and third at 80 days (tuber development stage) after emergence of sprouts

*Data are presented replication-wise

(d) Data generated for running CERES- POTATO model in DSSAT v4.5
Station – BNCA Cultivar type: Pokhraj (V_1)

Parameter	1st DOP	2nd DOP	3rd DOP	4th DOP
Sowing date	12-11-2014	19-11-2014	26-11-2014	03-12-2014
Emergence date	24-11-2014	28-11-2014	04-12-2014	10-12-2014
Physiological maturity date	13-02-2015	18-02-2015	19-02-2015	21-02-2015
Tuber initiation day	11-12-2014	15-12-2014	20-12-2014	28-12-2014
Tuber dry weight (kg/ha)	10392.2	6478.0	15128.0	5077.8
Tuber fresh weight (kg/ha)	11260.0	12780.0	10940.0	8500.0
Yield- Total wt. harvest (kg/ha)	11260.0	12780.0	10940.0	8500.0
Fresh By-product harvest (kg/ha)	14000	15500	13900	10500

Maximum leaf area index	-	-	-	-
Dry Biproduct harvest- kg/ha	2350	4400	3000	2100
Tuber N at harvest- kg/ha	-	-	-	-
Tuber+ stem + leaf N at harvest (kg/ha)	-	-	-	-
Tops N at maturity- kg/ha	-	-	-	-
Tuber N at harvest (%)	-	-	-	-
Management practices Planting depth	3 cm - 5 cm	3 cm - 5 cm	3 cm - 5 cm	3 cm - 5 cm
Row spacing & plant population (plant/m2)	15cm & 18(plant)/ m2	15cm & 17(plant)/ m2	15cm & 16(plant)/ m2	15cm & 18(plant)/ m2
Plant method & distribution	In furrows with sprouts facing upward	In furrows with sprouts facing upward	In furrows with sprouts facing upward	In furrows with sprouts facing upward
Fertilizer- . amount & time	N:133 kg/ha P:624 kg/ha K:168 kg/ha At the time of planting	N:133 kg/ha P:624 kg/ha K:168 kg/ha At the time of planting	N:133 kg/ha P:624 kg/ha K:168 kg/ha At the time of planting	N:133 kg/ha P:624 kg/ha K:168 kg/ha At the time of planting
Irrigation- . amount & time	30 DAS, 60 DAS	30 DAS, 60 DAS	30 DAS, 60 DAS	30 DAS, 60 DAS

(e) Data generated for running CERES- POTATO model in DSSAT v4.5
Station – BNCA Cultivar type: Kufri Jyoti (V_2)

Parameter	1st DOP	2nd DOP	3rd DOP	4th DOP
Sowing date	12-11-2014	19-11-2014	26-11-2014	03-12-2014
Emergence date	25-11-2014	30-11-2014	06-12-2014	12-12-2014
Physiological maturity date	11-02-2015	15-02-2015	20-02-2015	25-02-2015
Tuber initiation day	09-12-2014	14-12-2014	18-12-2014	27-12-2014
Tuber dry weight (kg/ha)	1401	1514	1635	1155
Tuber fresh weight (kg/ha)	9216.0	9960.0	10752.0	7596.0
Yield- Total wt. harvest (kg/ha)	9216.0	9960.0	10752.0	7596.0
Fresh By-product harvest (kg/ha)	10400	11000	14000	9000

Maximum leaf area index	-	-	-	-
Dry Biproduct harvest- kg/ha	2800	3400	2500	2000
Tuber N at harvest- kg/ha	-	-	-	-
Tuber+ stem + leaf N at harvest (kg/ha)	-	-	-	-
Tops N at maturity- kg/ha	-	-	-	-
Tuber N at harvest (%)	-	-	-	-
Management practices Planting depth	3 cm - 5 cm	3 cm - 5 cm	3 cm - 5 cm	3 cm - 5 cm
Row spacing & plant population (plant/m2)	15cm & 16(plant)/ m2	15cm & 18(plant)/ m2	15cm & 16(plant)/ m2	15cm & 17(plant)/ m2
Plant method & distribution	In furrows with sprouts facing upward	In furrows with sprouts facing upward	In furrows with sprouts facing upward	In furrows with sprouts facing upward
Fertilizer- . amount & time	N:133 kg/ha P:624 kg/ha K:168 kg/ha At the time of planting	N:133 kg/ha P:624 kg/ha K:168 kg/ha At the time of planting	N:133 kg/ha P:624 kg/ha K:168 kg/ha At the time of planting	N:133 kg/ha P:624 kg/ha K:168 kg/ha At the time of planting
Irrigation- . amount & time	30 DAS, 60 DAS	30 DAS, 60 DAS	30 DAS, 60 DAS	30 DAS, 60 DAS

Photographs

(2005-2010, Jorhat)

5.10. Crop intensification under rainfed situation of Assam

Table : Rice equivalent yield and B:C ratio in rice based crop sequences

Sl. No.	Treatments	Rice Equivalent Yield in different cropping sequences						Mean B:C ratio of all products
		2005-06	2006-07	2007-08	2008-09	2009-10	Mean	
1.	Rice - Niger	43.48	38.11	35.76	35.05	41.06	38.69	2.46
2.	Rice – Lathyrus	44.35	41.72	43.32	41.88	43.14	42.88	2.43
3.	Rice – Pea	41.12	39.39	54.75	45.85	50.79	46.38	2.33
4.	Rice- Lentil	49.27	45.80	52.92	39.25	44.70	46.39	2.53
5.	Rice – Linseed	45.99	39.85	37.26	38.7	46.75	41.71	2.49
6.	Rice – Buck wheat	41.85	34.78	31.08	33.68	42.79	36.84	2.36
7.	Rice – Toria	45.51	40.14	35.40	39.32	43.39	40.75	2.42
	Mean	44.51	39.97	41.50	39.10	44.66	41.95	-
	SEm/CD 0.05			8.35		7.26	5.25	-
	CV (%)					9.14	9.59	-

Salient Findings:

Total rice equivalent yield of different crop sequences were found to be highest in rice–pea and rice-lentil sequences and were closely followed by rice lathyrus and rice – linseed which remained at par with the experimental mean yield. The other sequences resulted less REY than the experimental mean value. However, the mean BC ratio was highest in rice – lentil and was followed by rice – linseed, rice – niger, rice – lathyrus, rice – toria, rice – buckwheat and rice – pea.

6. IMPROVEMENT OF CROP VARIETIES/ EVALUATION OF IMPROVED VARIETIES:

Activities during 2005-2010:

6.1.Genetic improvement of direct seeded upland *ahu* rice

Farmers' perception of suitable upland 'Ahu' rice varieties

The study was undertaken to understand farmers' choice perception of suitable varieties for direct seeded upland 'Ahu' rice ecosystem. For the study, two distinct approaches were employed in the study to extract the relevant information. In the first approach, PRA tools such as focus group discussions and key informant interviews were employed in two villages. In the second approach, altogether 20 rice varieties of different duration, plant architecture and grain quality attributes were grown in the farmers' field on April 8, 2005. Equal number of farmers randomly chosen from two different communities (6 from each group on the first two dates of observations and 3 from each group on the last date of observation) were asked to choose separately three best varieties from the 20 varieties grown in the field after 60, 90 and 110 days of sowing and allocate to the selected varieties 1st, 2nd, and 3rd position according to their preference. The three varieties, thus selected by using preference ranking, were assigned with the scores of 3, 2 and 1 for being adjudged as 1st, 2nd and 3rd, respectively. The total score for a selected variety was calculated as:

Farmers participating in PRA

Ahu rice varieties found in a village

Total score = $A_1 \times 3 + A_2 \times 2 + A_3 \times 1$ Where, A_1, A_2 and A_3 were the number of farmers assigning 1st, 2nd and 3rd position, respectively to the variety**.**

Results

Major problems of upland 'Ahu' rice

- Weeds, rice gandhi bug (*Leptocorisa oratoria*), stem borers, pre- and post-harvest sprouting, rodents, leaf spot (brown spot and blast) are the major problems of upland 'Ahu' rice according to the farmers.
- Among all the problems, weed infestation was rated to be the most important one.
- Farmers did not talk about the problem of intermittent drought which is, normally, considered to be a serious constraint of upland 'Ahu' rice cultivation. However, the problem was clearly noticeable during experimentation in the site and the farmers talked about less rainfall received during the year and the problem of drought only at the time of discussion on the field experiment. Apparently, some degree of moisture stress during the upland 'Ahu' rice growing period is an acceptable fact and, most probably, that is why the farmers did not perceive it as a serious problem to mention during discussion.

Farmers' perception on suitable upland 'Ahu' rice varieties

- Information obtained from group discussion and key informant interviews indicated that any variety to be ideally fitted to the direct seeded upland 'Ahu' rice culture should possesses the characteristics i) high yield, ii) better early vigour to compete with weeds, iii) pre- and post-harvest sprouting resistance, iv) semi-tall plant stature (≅120 cm), v) lodging resistance (*via* better culm strength than dwarf plant stature), vi) resistance against rice *gandhi* bug and stem borers, vii) white pericarp and viii) little sticky, coarse grains with or without aroma for *Mising* farmers, and non-sticky, fine grain with or without aroma for *Bihari* farmers.
- Some farmers pointed out that more the plant height more was the possibility of lodging while some others indicated that more the plant height better was the panicle length and, consequently, better yield. In both the cases, the farmers reflected their keen observation on the crop, as both were technically correct considering the positive association of plant height with both lodging susceptibility and panicle length. However, the difference of emphasis reflected the variation among the farmers on their outlook. Such observations buttress the need of seeking active participation of the farmers in research programs.
- The observations of the farmers are summarized in Table 2.4.1.1-4. From the field study it became evident that any variety to be ideally suited to the upland 'Ahu' rice

ecosystem of the study area should be high yielding, non-lodging, semi-tall (≅120 cm), early maturing (≅100 days) with quick early vigor to suppress weed growth, deep green leaves, well-exerted long and heavy panicles, desired degree of seed dormancy to escape pre- and post-harvest sprouting, resistance against rice bug, stem borers, blast and brown spot, and grain quality traits suiting to the ethnic preferences.

- Even while there was considerable similarity of need perceptions, the two different ethnic groups differed in their emphasis on their requirement of various plant attributes suggesting the need to consider ethno-cultural diversity over wide geographical coverage to objectively determine the breeding goals for development of direct seeded upland 'Ahu' rice varieties.

Table: Farmers' choice of direct seeded upland 'Ahu' rice varieties 60 days after sowing

Variety	No. of farmers (N = 6)								
	Mising				*Bihari*				Total Score
	1st	2nd	3rd	Score	1st	2nd	3rd	Score	
Inglongkeri	0	1	2	4	0	1	1	3	7
Dehangi	0	1	2	4	0	0	1	1	5
Ikor guni	1	2	1	8	0	1	1	3	11
Tall sub-group	**1**	**4**	**5**	**16**	**0**	**2**	**3**	**7**	**23**
TTB196-3	5	0	1	16	4	2	0	16	32
Lachit	0	1	0	2	0	1	2	4	6
Luit	0	1	0	2	2	1	1	9	11
Dwarf sub-group	**5**	**2**	**1**	**20**	**6**	**4**	**3**	**29**	**49**

Table: Farmers' choice of direct seeded upland 'Ahu' rice varieties 90 days after sowing

Variety	No. of farmers (N = 6)								
	Mising				*Bihari*				Total Score
	1st	2nd	3rd	Score	1st	2nd	3rd	Score	
Inglongkeri	0	2	1	5	0	1	0	2	7
Dehangi	1	1	0	5	0	0	0	0	5
ALR- 41	2	1	0	8	2	0	1	7	15
Vandana	0	0	1	1	0	1	2	4	5
TTB 331-297-16-1	0	0	1	1	0	0	0	0	1
TTB 306-53-1	0	1	0	2	0	2	0	4	6
Tall sub-group	**3**	**5**	**3**	**22**	**2**	**4**	**3**	**17**	**39**
TTB196-3	0	1	1	3	1	0	2	5	8
Chilarai	0	0	1	1	0	0	0	0	1
Luit	2	0	1	7	3	2	1	14	21
TTB 131-299-1	1	0	0	3	0	0	0	0	3
Dwarf sub-group	**3**	**1**	**3**	**14**	**4**	**2**	**3**	**19**	**33**

Table: Farmers' choice of direct seeded upland 'Ahu' rice varieties 110 days after sowing

Variety	No. of farmers (N = 3)								
	Mising				*Bihari*				Total Score
	1st	2nd	3rd	Score	1st	2nd	3rd	Score	
ALR-41	1	1	0	5	1	1	0	5	10
Dehangi	I	2	0	7	0	0	1	1	8
TTB 331-297-16-1	0	0	1	1	0	0	0	0	1
Vandana	0	0	0	0	1	0	1	4	4
Inglongkeri	0	I	1	3	0	0	1	1	4
Ikor guni	I	0	I	4	0	0	1	1	5
Tall sub-group	**3**	**4**	**3**	**20**	**2**	**1**	**4**	**12**	**32**
Luit	I	0	1	4	1	2	0	7	11
TTB 131-299-1	0	0	0	0	1	1	0	5	5
Dwarf sub-group	**1**	**0**	**1**	**4**	**2**	**3**	**0**	**12**	**16**

Table: Characteristic features of the selected upland 'Ahu' rice varieties and farmers' perceptions on those characters

Variety	Researchers' observations	Farmers' comments	
		Positive	Negative
ALR-41	Semi-tall plant stature, weak straw, fine grain with golden husk, susceptible to brown spot	Acceptable plant height, fine, aromatic grain with golden husk	Weak straw, light panicle, affected by leaf spots
Dehangi	Tall with strong culm, good early vigor, well exerted long panicles	Tall plant stature with strong culm, good early vigor	High spikelet sterility
TTB 331-297-16-1	Tall with medium culm strength, susceptible to leaf sport	Desired plant height, panicle length, grain type	Affected by leaf spots
Vandana	Tall with fairly strong straw	Desired plant height, well exerted long panicle	Weak straw
Inglongkeri	Tall, good tillering ability,	Desired plant height,	High spikelet

	broad droopy leaves	good early vigor	sterility
Ikor guni	Early maturing, tall with long droopy leaves and good early vigor	Desired plant height, good early vigor, short duration	Relatively low yield
Luit	Semi-dwarf, very early maturing, good crop stand and early vigor	Very short duration	Dwarf plant stature
TTB196-3	Modern plant type with semi-dwarf plan stature and erect leaves, very good plant stand and early vigor, long duration	Early vigor, plant stand	Long duration
Chilari	Modern plant type with semi-dwarf plan stature and erect leaves, long duration	Good early vigor and plant stand	Long duration
TTB 131-299-1	Semi-dwarf, poor early vigor	High number of panicles per unit area	Semi-dwarf plant stature
TTB 306-53-1	Tall stature, leaf spot susceptible	Tall stature with more panicles per unit area	Excessive leaf spot
Lachit	Modern plant type with semi-dwarf plan stature and erect leaves, long duration	Good plant stand and early vigor	Semi-dwarf, long duration

6.2. Evaluation of upland rice varieties

In earlier study, weed infestation was identified as the most important problem of upland 'Ahu' rice. Therefore, any variety to be ideally suitable for growing in the upland situation should possess the attributes that help in competing with the weeds and moisture stress tolerance along with other important traits. The rice varieties grown under shifting cultivation (*jhum*) are assumed to possess such desired traits. In view of this, a set of such varieties (SKY-AK-1569, SKY-AK-1556, SKY-AK-1571, ADG-16, ADG-18, ADG-19, ADG-31, ADG-35, ADG-37, ADG-43, ADG-61, ADG-83, IC-526729, IC-526713, SAW-GA-42, SAW-GA-45, SAW-NAZ-TA-14, SAW-NAZ-TA-82, DBC-1, KP-AK-70) collected from the Regional Centre of NBPGR, Shillong were evaluated for their suitability for the upland 'Ahu' situation of Assam. The varieties were sown on 5 April 2006 in two replications. It was observed that the earliest varieties (SKY-AK-1569, SKY-AK-1556), among the lot, took as long as 156 days to 50 per cent flowering (>180 days for maturity).

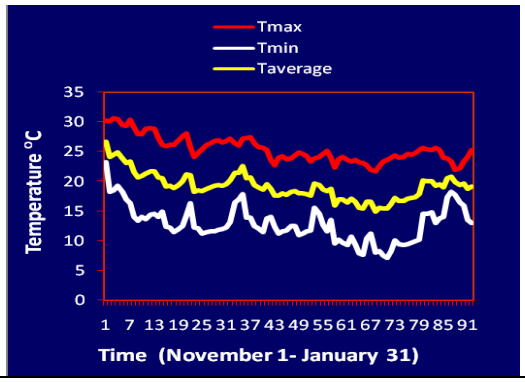
Thus, the varieties were of absolutely no use for the purpose for which evaluated as it is very important for the varieties to be early maturing (≅100 days) to be suitable for the 'Ahu' season. Therefore, varieties were not considered for any further testing.

Breeding upland rice varieties

The breeding objectives for development of direct seeded upland 'Ahu' rice varieties were formulated based on the earlier study conducted with participation of the farmers. Considering earlier records, a number of rice varieties, both modern and traditional, were used as parents in the hybridization programmes. A number of crosses were made using the both modern and traditional varieties. The segregating populations derived from the crosses were carried forward with selection on them.

6.3. Post-flood rice

The traditional photoperiod sensitive *sali* varieties can be sown and transplanted over a wide period of time within the season depending on the rainfall pattern and the time of occurrence and recession of flood. Such flexibility of sowing and transplanting time, congenial time of harvest and fairly stable yield of traditional *sali* rice varieties are the most desired characteristics to make them suitable for rainfed rice culture and, more particularly, for the flood and drought prone areas. It is, however, a fact that sowing of such varieties can't be delayed beyond a limit without significant yield loss. It is, therefore, necessary to identify, from the large rice germplasm stock, some indigenous varieties which are better fitted to staggered sowing over a wide period during the late *sali* season. It is also desirable that such varieties possess cold tolerance in the reproductive phase. With these in consideration, the present study was undertaken to identify/breed rice varieties with cold tolerance at reproductive stage of growth and better fitted to staggered sowing over a wide period during the late *sali* season.



Temperature regime at heading (Nov 1 - Jan 31)

In the first two years, altogether 143 traditional rice varieties were evaluated for low temperature tolerance at reproductive stage of growth measured in terms of spikelet sterility/fertility. Starting from later part of November, the panicles were marked with the date of heading till the later part of December. The panicles thus marked were harvested in December/January and the sterility/fertility of spikelets was measured in per cent of total

spikelets in the panicle. Considering the temperature during this period to be low enough (< 20° C) the sterility/fertility on the panicles coming to heading during this time was taken to assess the low temperature tolerance at reproductive stage of growth.

Subsequently, based on the visual rating, 14 *sali* rice varieties were chosen to evaluate them for their suitability to staggered sowing. These varieties, along with a modern early maturing variety Kolong as check, were grown in a Randomised Block Design with three replications on 3 successive dates using plot size of 8.96 m^2. The first sowing was on 5th August, 2009; the second was on 20th August, 2009 and the third sowing was carried out on 30th August, 2009. The successive three plantings on 28th August, 12th September and 18th September, respectively were carried out using 20-25 day old seedlings.

Result

- No variety was found with the desired degree of cold tolerance at reproductive stage of growth though there was variation among the varieties in their response to low temperature stress. Closer observation of the better fertility recorded in a few varieties in relation to the temperature on the date of their heading indicated that the variation observed among the varieties might have arisen due to the variation in the temperature conditions on the critical stage of growth. As example, performances of few varieties are presented in Table 2.4.1.5.
- It was also observed that many varieties did not flower and some exhibited partial emergence of the panicles with all the spikelets being sterile.

Varieties subjected to low temperature stress at reproductive phase

The important findings obtained from the study carried out to evaluate the varieties' performance under staggered sowing in late *sali* season are summarized as follows:

1. Aghonsali and Guarai-3 recorded high yield consistently over the three dates of sowing and were *at par* with Kolong in all the three dates of sowing indicating the

possibility of finding traditional *sali* rice varieties suitable for staggered sowing in *sali* season (Table 2.4.1.6).

2. Some of the *sali* rice varieties took almost similar duration to flower in all the three different dates of sowing like the photoperiod insensitive check **v**ariety Kolong indicating that the state's indigenous *sali* rice varieties may vary in the degree of photoperiod sensitivity (Table 2.4.1.7).

3. The *sali* rice crop is vulnerable to low temperature induced spikelet sterility when it flowers in the later part of November. The sowing and planting of the *sali* rice must be so managed, according to the duration of the varieties, that the flowering is not delayed beyond 1st week of November (Table 2.4.1.7 and 2.4.1.8).

4. Analysis over three dates of sowing revealed significant positive genotypic correlation of grain yield with biological yield, harvest index and number of effective tillers per plant and significant negative genotypic correlation with panicle length (Table 2.4.1.9).

Table: Response of rice varieties to low temperature stress in late sali season measured in terms of fertility percentage

Variety	Dates of heading	Panicle length (Cm)		No. of filled grains/ panicle		Fertility (%)	
		Range	Av.	Range	Av.	Range	Av.
Aghonsali	28 Nov-27 Dec	15.0-28.0	18.8	0.0-17.0	2.9	0.0-19.5	5.5
Adolia Sali	8 Dec-15 Dec	17.0-19.0	18.0	0.0-4.0	2.7	0.0-6.5	4.0
Bankisali	20 Nov-29 Nov	17.0-23.0	20.1	24-73	50.4	57.1-84.4	70.0
Tarabali	28 Nov-8 Dec	18.0-21.0	19.5	5.0-25.0	12.3	5.6-25.5	16.2
B-15-10	20 N0v-15 Dec	15.0-20.5	18.3	0.0-90.0	44.7	0.0-72.9	46.0
Balam 5	7 Dec-16 Dec	18.0-20.0	19.0	3.0-20.0	10.0	9.1-33.3	21.4
B-24-92	6 Dec-15 Dec	17.0-18.0	17.3	0.0-0	0.0	0.0-0.0	0.0
Bornekera	28 Nov-17 Dec	19.0-22.0	20.3	0.0-5.0	2.7	0.0-7.7	4.7
Betisali 2	25 Nov17 Dec	19.0-22.0	20.5	0.0-10	6.0	0.0-28.6	13.6
Borjhool	1 Dec-17 Dec	14.0-21.0	18.0	0.0-17	4.3	0.0-32.7	8.2
Borsolpona	19 Nov-29 Nov	15.5-23.5	19.1	15.0-80.0	44.3	18.2-84.6	58.5
Betguti	4 Dec-17 Dec	18.0-23.0	19.8	25-80	51.4	44.6-65	53.6
Basbar	17 Nov-23 Dec	15.0-23.0	19.3	0.0-30.0	6.4	0.0-39.0	9.9

Behorisali	8 Dec-23 Dec	10.0-21.0	14.0	0.0-4.0	2.0	0.0-7.4	4.5
Batkopahi1	20 Nov-29 Nov	19.0-32.0	22.9	0.0-49.0	15.1	0.0-62.0	18.5
Batkopahi 2	19 Nov-6 Dec	10.0-23.5	19.1	0.0-26.0	13.4	0.0-28.6	16.2
Co1926	25 Nov-23 Dec	15.0-21.0	18.3	0.0-32.0	12.9	0.0-52.5	22.8
Che-leula	19 Nov-28 Dec	11.0-26.0	19.4	0.0-41.0	12.4	0.0-33.9	13.3
CR-22	20 Nov-23 Dec	15.0-24.5	21.5	0.0-108	38.3	0.0-69.5	30.3
CR-22-R-22	18 Nov-1 Dec	15.5-20.0	18.1	0.0-20.0	8.5	0.0-26.3	10.9
Dholamula-1	15 Nov-23 Dec	14.0-22.0	17.8	0.0-28.0	10.9	0.0-43.0	17.8
Dholamula-3	28 Nov-26 Dec	19.0-24.0	21.9	0.0-80	21.5	0.0-84.2	30.6
Danglisali	21 Nov-6 Dec	16.0-22.0	19.3	0.0-12.0	4.1	0.0-10.0	3.8
Dhomasali	29 Nov-8 Dec	16.0-20.0	18.0	0.0-20	8.7	0.0-36.4	18.6
Goasali	21 Nov-25 Dec	15.0-24.0	20.1	0.0-28.0	14.3	0.0-37.5	21.8
Guarai3	7 Nov-21 Dec	15.0-21.0	18.2	0.0-35	4.4	0.0-51.5	6.9
Hukunisali	27 Nov-6 Dec	17.0-21.0	18.6	10.0-25.0	17.2	14.3-35.7	29.3
Telisali	1 Dec-25 Dec	11.0-19.0	16.5	0.0-10.0	4.0	0.0-25.0	12.5
Jalashree	19 Nov-29 Nov	12.5-16.0	14.1	0.0-50.0	20.0	0.0-65.6	28.4
L49	21 Nov-8 Dec	15.0-19.0	16.8	0.0-12.0	3.8	0.0-21.1	6.3
L74	21 Nov-8 Dec	15.0-19.0	16.8	0.0-12.0	3.8	0.0-21.1	6.3
L110	28 Nov-20 Dec	15.0-22.0	17.8	0.0-60.0	11.3	0.0-70.6	20.4

Table: Performance of rice varieties in respect of yield and yield attributing traits under staggered sowing in *sali* season

Variety	Grain yield (kg/ha)				Biological yield (kg/ha)				Harvest index			
	Aug 5 sown	Aug 20 sown	Aug 30 sown	Av. over three dates	Aug 5 sown	Aug 20 sown	Aug 30 sown	Av. over three dates	Aug 5 sown	Aug 20 sown	Aug 30 sown	Av. over three dates
Basbor	3444	1936	1111	2164	7769	5051	5128	5983	0.44	0.38	0.27	0.37
Borsolpona	3138	1992	722	1951	6450	5584	3495	5176	0.49	0.36	0.21	0.35
Goasali	2825	1944	389	1719	7785	5072	2976	5278	0.38	0.38	0.12	0.29
Behorisali	3306	2611	750	2222	8062	5934	4891	6296	0.41	0.44	0.15	0.33
B15-10	3353	2167	514	2011	9313	5804	3351	6156	0.36	0.37	0.15	0.30
Batkopahi-1	3014	2114	278	1802	7119	6279	4902	6100	0.42	0.34	0.06	0.27
Guarai-3	3364	2486	1208	2353	6912	5566	6591	6356	0.49	0.45	0.18	0.37
Adolia Sali	3138	1525	542	1735	10125	4013	3457	5865	0.31	0.38	0.16	0.28
Borjhool	3236	2011	503	1916	7191	6285	4310	5929	0.45	0.32	0.12	0.30
CR22	3500	1903	694	2032	8333	4116	3360	5270	0.42	0.46	0.21	0.36
Co1926	2230	1722	611	1521	4972	4342	3216	4177	0.40	0.40	0.19	0.33
Batkopahi-2	3597	2055	819	2157	8633	4405	4239	5759	0.42	0.47	0.19	0.36
Betguti	2847	2069	398	1771	8135	5007	1940	5027	0.35	0.41	0.19	0.32
Aghonsali	3930	2417	1236	2528	8189	6144	4262	6198	0.48	0.39	0.29	0.39
Kolong	3230	2056	1292	2193	6093	4004	3348	4482	0.53	0.51	0.37	0.47
CV	12.41	18.04	18.74	-	12.89	22.04	41.06	-	8.48	10.46	25.21	-
$CD_{5\%}$	665	624	229	-	1658	1922	2816	-	0.06	0.07	0.08	-

Table: Performance of rice varieties in respect of yield attributing traits under staggered sowing in *sali* season

Variety	Days to 50% flowering				Plant height (cm)				Effective tillers per plant				1000 grain weight (g)			
	Aug 5 sown	Aug 20 sown	Aug 30 sown	Av. over three dates	Aug 5 sown	Aug 20 sown	Aug 30 sown	Av. over three dates	Aug 5 sown	Aug 20 sown	Aug 30 sown	Av. over three dates	Aug 5 sown	Aug 20 sown	Aug 30 sown	Av. over three dates
Basbor	86	77	75	79	107	94	85	96	9.4	9.9	8.5	9.3	14.7	14.9	12.4	14
Borsolpona	81	76	75	78	135	115	110	120	8.2	7.5	8.1	7.9	26.5	24.3	23.4	24.7
Goasali	84	80	77	80	120	106	89	105	8.5	7.3	7.9	7.9	29.0	26.4	24.9	26.8
Behorisali	80	75	77	77	109	101	81	97	10.6	7.7	8.3	8.9	23.4	21.5	22.0	22.3
B15-10	87	80	77	81	122	108	90	107	9.2	8.0	8.1	8.4	23.8	24.7	22.7	23.7
Batkopahi-1	87	83	84	84	113	102	82	99	9.3	8.9	8.0	8.7	24.2	24.3	23.4	23.9
Guarai-3	87	81	78	82	102	94	83	93	9.5	8.6	9.3	9.1	29.5	29.2	27.6	28.8
Adolia Sali	82	76	73	77	102	80	66	83	10.9	9.1	9.3	9.8	25.1	23.1	23.5	23.9
Borjhool	81	75	77	78	127	118	101	115	9.4	8.6	8.3	8.8	23.7	21.2	20.8	21.9
CR22	83	78	78	79	110	94	82	95	9.7	7.9	9.5	9.0	19.8	21.0	20.7	20.5
Co1926	84	75	75	78	106	92	86	95	7.7	7.6	7.6	7.6	25.1	25.2	21.4	23.9
Batkopahi-2	85	78	77	80	112	99	85	99	9.3	8.2	8.7	8.7	26.9	23.7	23.6	24.7
Betguti	84	76	77	79	102	94	85	94	9.0	7.5	7.5	8.0	19.6	18.8	17.7	18.7
Aghonsali	81	75	75	77	118	101	89	103	10.5	9.2	8.3	9.3	24.5	23.9	22.1	23.5
Kolong	74	73	74	74	78	76	67	74	9.5	7.2	8.4	8.4	25.8	25.5	22.0	24.4
CV	3.14	1.83	2.24	-	2.98	4.09	3.72	-	10.15	11.92	10.97	-	2.86	3.83	3.53	-
$CD_{5\%}$	2	2	3	-	5.5	6.7	5.3	-	1.6	1.6	1.5	-	1.2	1.5	1.3	-

Table: Performance of rice varieties in respect of panicle characteristics under staggered sowing in *sali* season

Variety	Panicle length (cm)				No. of spikelets per panicle				Filled grains per panicle				Spikelet fertility (per cent)			
	Aug 5 sown	Aug 20 sown	Aug 30 sown	Av. over three dates	Aug 5 sown	Aug 20 sown	Aug 30 sown	Av. over three dates	Aug 5 sown	Aug 20 sown	Aug 30 sown	Av. over three dates	Aug 5 sown	Aug 20 sown	Aug 30 sown	Av. over three dates
Basbor	23.5	22.2	21.3	22.3	150	125	144	140	108	105	77	97	72	84	53	70
Borsolpona	25.2	25.7	25.0	25.3	144	139	134	139	97	100	68	88	67	72	51	63
Goasali	26.7	24.9	23.4	25	114	114	103	110	111	89	38	79	98	78	37	71
Behorisali	22.7	22.9	22.0	22.5	115	84	104	101	89	77	71	79	77	92	68	79
B15-10	22.9	22.2	20.0	21.7	137	123	99	120	116	102	51	90	85	83	51	73
Batkopahi-1	25.1	24.8	23.5	24.5	127	116	116	120	118	80	44	81	93	68	38	67
Guarai-3	21.4	22.6	21.7	21.9	102	100	125	109	100	92	82	91	97	93	66	85
Adolia Sali	23.0	21.8	20.5	21.8	92	147	86	108	84	95	69	82	91	65	80	78
Borjhool	25.5	24.5	23.4	24.5	130	125	112	122	98	89	66	85	76	71	59	69
CR22	22.2	22.8	21.9	22.9	138	138	122	133	118	99	73	97	85	72	60	72
Co1926	24.9	22.0	22.6	23.2	114	87	99	100	100	70	59	76	88	80	59	76
Batkopahi-2	25.1	22.3	23.9	23.8	106	125	120	117	96	92	70	86	91	74	58	74
Betguti	22.5	23.5	20.7	22.2	114	102	114	110	112	89	43	81	98	88	38	75
Aghonsali	24.5	19.9	18.5	20.9	133	109	95	112	114	89	67	90	86	81	70	79
Kolong	24.4	23.2	23.3	23.6	117	126	141	128	78	97	67	81	67	77	47	64
CV	5.75	6.89	3.67	-	7.82	4.84	2.82	-	9.42	7.27	9.71	-	9.29	6.70	9.24	-
$CD_{5\%}$	2.3	2.6	1.4	-	16	9	5	-	16	11	10	-	13	9	9	-

Table: Estimates of genotypic correlation coefficient (r_g) (upper diagonal) and phenotypic correlation coefficient (r_p) (lower diagonal) among different traits over the three dates of sowing

Traits	Grain yield	Biological yield	Harvest index	Days to 50% flowering	Plant height	Effective tillers per plant	1000 grain weight	Panicle length	Spikelets per panicle
Grain yield	1	0.80**	0.74**	-0.06	-0.123	0.69**	0.05	-0.62*	0.43
Biological yield	0.54*	1	-0.16	1.24ϒ	0.49	1.59ϒ	0.04	-1.19ϒ	0.02
Harvest index	0.48	-0.38	1	-0.64**	-0.55*	0.21	0.003	-0.19	0.41
Days to 50% flowering	-0.12	0.22	-0.38	1	0.24	0.09	0.21	0.06	-0.22
Plant height	0.07	0.23	-0.29	0.27	1	-0.35	0.06	0.44	0.27
Effective tillers per plant	0.39	0.48	-0.09	-0.07	-0.21	1	-0.22	-0.79**	0.11
1000 grain weight	-0.02	-0.01	-0.03	0.14	0.03	-0.13	1	0.22	-0.33
Panicle length	-0.19	-0.07	-0.14	0.0	0.38	-0.35	0.27	1	0.32
Spikelets per panicle	0.06	-0.07	0.25	0.06	0.19	0.02	-0.50	0.26	1

***** Significant at 5 per cent level of significance

****** Significant at 1 per cent level of significance

ϒ Spurious relation

6.4. Participatory variety selection for *sali* season

As described earlier, it is extremely important to understand the farmers' need perception and criteria of selecting crop and varieties in specific situations for identifying/breeding varieties to suit their specific needs. In the present study attempt was made to get an insight into the farmers' perceptions of suitable rice varieties for *sali* season. Effort was also made to know the farmers' perceptions on sets of varieties grown by them and also attempted to evaluate a number of varieties in the farmers' fields with their participation.

For the present study, relevant information regarding the traits the farmers consider for choosing the rice varieties were collected using various PRA tools. Using the matrix ranking tool, the farmers were, then, guided to rank, as a community, different traits in accordance with their perceived importance. Based on the information gathered, a set of varieties, including traditional as well as modern, was chosen for evaluation in consultation with the farmers. The varieties were grown in ten farmers' fields in the fashion of baby trials of 50-100 sq m each with two varieties in each baby trial. Besides these, a mother trial was also laid out in one farmer's field with single replication of 24 sq m. At maturity of the varieties, a group of farmers, including those who conducted the baby trials, was taken around the mother trial and got the varieties scored in respect of the traits they considered important. The varieties were evaluated for yield in both mother and baby trials.

Results

- The study clearly showed that the major criteria for choosing the rice varieties for *sali* season are yield, adaptability to specific land situations (particularly in relation to moisture regime), resistance to biotic stresses (particularly insect problems), lodging resistance, plant stature and duration (Table 2.4.1.10). Besides these, the traits such as milling recovery, taste, suitability to staggered planting, suitability for preparation of traditional confectioneries and liquor, submergence tolerance and drought tolerance etc. are also considered while choosing rice varieties for *sali* season depending on the growing environments, socio-cultural settings *etc.*
- The traits considered important by the farmers for adoption of rice varieties during the *sali* season are almost similar across the locations. However, there is variation among the villages in respect of the priority assigned to these traits.
- The high yielding improved varieties were generally better than the traditionally grown local varieties in respect of yield performance. The evaluation of varieties clearly exhibited the superiority of the newly developed rice variety Gitesh over the others. The traditional varieties, though, yield low in comparison to the improved varieties, appear to exhibit consistent performance across the farmers' fields. Of course, the replications used in the trial were too few to make conclusive remarks.

Table: Farmers' selection criteria* for *sali* rice varieties at three villages in Golaghat district, Assam

Villages	Yield	Adaptability to land situation	Resistance to disease and insect pests	Duration	Adaptability to flood	Suitability to staggerred planting	Lodging resistance	Grain appearance	Plant height	Milling quality	Rice bear quality	Taste
Puranimati Bhakatgaon	7	6	5	4	-	-	3	2	1	-	-	-
Danichapori	7	6	5	-	-	-	4	-		3	2	1
Bhakatgaon	8	-	7	6	5	4	3	-	2	-	-	1

*Scoring in ascending to the order of priority

Table: Farmers' suitability perception on the rice varieties in respect of important characters at Puranimati Bhakatgaon, Golaghat district

Varieties → Characteristics↓	Ranjit[1]	Bahadur[1]	Mahsuri[1]	Gitesh[1]	Solpona[2]	Manoharsali[2]	Suagmoni[2]	Jahinga[2]	Gethu[2]	Prasadbhog[2]
Yield (7)	4 (28)	4 (28)	4 (28)	5 (35)	3 (21)	2 (14)	2 (14)	3 (21)	1 (7)	2 (14)
Adaptability (6)	2 (12)	2 (12)	4 (24)	3 (18)	5 (30)	2 (12)	4 (24)	3 (18)	3 (18)	2 (12)
Resistance to disease and insect pests (5)	2 (10)	2 (10)	2 (10)	2 (10)	5 (10)	3 (15)	4 (20)	4 (20)	3 (15)	3 (15)
Duration (4)	3 (12)	3 (12)	4 (16)	3 (12)	2 (8)	2 (8)	3 (12)	3 (12)	4 (16)	3 (12)
Lodging resistance (3)	7 (21)	5 (15)	2 (6)	5 (15)	2 (6)	3 (9)	1 (3)	1 (3)	3 (9)	1 (3)
Grain appearance (2)	4 (8)	4 (8)	6 (12)	2 (4)	3 (6)	1 (2)	2 (4)	1 (2)	4 (8)	3 (6)
Plant height (1)	5 (5)	5 (5)	3 (3)	5 (5)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)	2 (2)
Total score	96	90	99	99	83	62	79	78	75	64
Rank	II	III	I	I	IV	IX	V	VI	VII	VIII

[1]Improved varieties; [2]Traditional varieties; Value within bracket indicate the weighted score of the varieties while value outside the bracket indicates the relative score of the varieties in comparison to the others.

Table : Yield and other agronomic traits of the varieties in the Mother Trial at Puranimati Bhakatgaon, Golaghat district, Assam

Varieties→ Characteristics↓	Ranjit	Bahadur	Mahsuri	Gitesh	Solpona	Manoharsali	Suagmani	Jahinga	Gethu	Prasadbhog
Yield (q/ha)	40	38	36	42	24	21	18	27	17	18
Duration (days)	150	150	145	160	155	160	155	155	145	150
Plant height (cm)	100	115	150	116	150	140	135	140	132	145
1000 grain weight (g)	18.0	18.8	17.2	19.0	23.0	29.0	22.8	24.4	23.0	18.8
Panicle no. per hill	9.3	8.2	8.0	9.7	11.2	7.2	6.4	7.6	5.7	10.4
Panicle length (cm)	27.53	27.8	27.3	24.8	29.6	25.5	28.5	28.5	23.7	24.2

Table: Yield performance of the varieties in the Baby Trials at Puranimati Bhakatgaon, Golaghat district, Assam

F-1	F-2	F-3	F-4	F-5	F-6	F-7	F-8	F-9	F-10
Ranjit 33.4 q/ha	Bahadur 31.1q/ha	Mahsuri 28.6 q/ha	Gitesh 40.1 q/ha	Ranjit 18.7 q/ha	Bahadur 18.2 q/ha	Masuri 31.4 q/ha	Gitesh 34.7 q/ha	Ranjit 30.3 q/ha	Mahsuri 27.7 q/ha
Solpona 24.4 q/ha	Prasadbhog 21.1 q/ha	Gethu 17.0 q/ha	Jahinga 24.3 q/ha	Manoharsali 17.2 q/ha	Suagmoni 18.6 q/ha	Solpona 23.6 q/ha	Jahinga 24.9 q/ha	Prasadbhog 19.3 q/ha	Suagmoni 21.6 q/ha

F = Participating farmer in conducting baby trials

Table: Farmers' description of the rice varieties and reasons for preference

Variety	**Description**
Modern varieties	
Ranjit	High yielding, lodging resistant, fine grained with desired plant stature but with a duration which is longer than desired by at least 10 days. The grain fetches good market price.
Bahadur	High yielding, lodging resistant, fine grained with desired plant stature but with a duration which is longer than desired by at least 10 days.
Mahsuri	High yielding, well adapted to diverse land situations, lodging susceptible, fine and preferred quality grained with suitable crop duration. The grain fetches good market price.

Gitesh	High yielding, lodging resistant, fairly well adapted with desired plant stature with acceptable grain appearance but with the duration which is longer than desired.
Traditional varieties	
Solpona	Moderate yielder, resistant to disease and pests, very well adapted to diverse land situations, lodging susceptible, preferred quality grained.
Manoharsali	Moderate yielder, resistant to disease and pests, lodging susceptible.
Suwagmoni	Moderate yielder, resistant to disease and pests, well adapted to diverse land situations, lodging susceptible, preferred quality grained.
Jahinga	Moderate yielder, resistant to disease and pests, well adapted to relatively low lying area, lodging susceptible
Gethu	Moderate yielder, resistant to disease and pests, lodging susceptible with preferred grain quality and duration better suited to multi-crop sequence in comparison to other traditional varieties.
Prasadbhog	Moderate yielder, resistant to disease and pests, lodging susceptible, preferred quality grained.

6.5.Breeding niger varieties for drought prone environment of Assam

Niger is apparently a minor crop in Assam. But, this is a very important crop for a section of farmers of marginal environment with no capital resource or institutional support to arrange irrigation for their crops grown in relatively poor soil with severe problem of moisture stress. Considering the engagement of a section of disadvantaged farmers from marginal environment it is necessary to initiate systematic program for development of suitable varieties and production practices at the earliest possible. The present program aims at breeding high yielding niger varieties suitably fitted to the farmers' conditions. With this, mass selection was performed on the farmers' variety NG-1 for bringing about its improvement in respect of yield. Besides this, three niger varieties *viz.*, NG1 (local of Assam), JNC-6 and GA-10 (collected from Jagdalpur) were evaluated for their performance. After evaluation, the seeds of the varieties were mixed in equal proportion and grown in a large plot (1000 sq m) to allow random mating for three cycles for performing selection to derive improved population. However, improvement in both the cases was not as desired.

Table: Performance of niger varieties

Variety	Av. Grain Yield (q/ha)	Days to 50 % flowering	Plant height (Cm)
NG-1			
JNC-6	2.86	55	60.6
GA-10	2.38	57	60.7

Activities during 2011-2014:

6.6. Identification/development of *ahu* rice varieties for adaptation under periodic moisture stress situation.

Rice is the main crop of Assam. Periodic moisture stress as a result of erratic rainfall patterns is a common feature in this state. Moisture shortage during critical crop growth periods causes yield losses as well as fluctuation in crop yield. *Ahu* rice in Assam is grown during March/April to June /July and is characterized by early maturity, tolerance to moisture stress and weed infestation, poor grain quality and poor grain yield (< 1.0 t/ha). Attempt for improvement of this crop has been very much limited. The present investigation is therefore, attempted with a view to identify and develop suitable *Ahu* rice varieties which are tolerant to moisture stress situations as well as high yielder and improved quality .

Table: Grain yield of ahu rice germplasms over four years

Variety	**Grain Yield (t/ha)**				**Mean GY (t/ha)**
	2011	**2012**	**2013**	**2014**	
Rongadoria	2.76	1.96	1.98	1.04	1.94
Dehangi	3.42	2.52	2.78	1.88	2.65
Pahari dusura	3.19	1.85	2.03	1.56	2.16
Meghi Ahu	2.55	1.80	1.98	1.70	2.01
Malbhog	2.70	1.78	2.05	1.74	2.07
Betguti Ahu	1.94	1.72	1.88	1.46	1.75
Banglami	2.80	1.84	2.15	1.84	2.16

Salient achievement:

The pooled data of four years indicated that Dehangi recorded the highest grain yield of 2.65 t/ha followed by Pahari dusura (2.16 t/ha) and Banglami (2.16 t/ha). Dehangi was recommended for Multi locational trial by Technical Committee of Assam Agricultural University, Jorhat.

6.7. Participatory breeding programme for medium duration high yielding rice varieties under rainfed eco-system of NBPZ of Assam

Among the three main rice seasons viz., Ahu (March/April- June/July), Sali (Normal Aman rice) and Boro (Oct/Nov- April/May), Sali is the main season. Farmers generally cultivate either indigenous photosensitive cultivars or long duration HYVs (viz. Ranjit, Mahsuri etc.), leaving the field vacant during the Rabi season. Owing to non availability of suitable relatively early maturing varieties farmers cannot go for a second crop of oilseed/ pulse/vegetable. Therefore, it is attempted to identify/develop suitable varieties under participatory mode so that farmers can go for a second crop utilizing the residual moisture from Kharif season during early part of Rabi.

Table: Grain yield of medium duration rice germplasms over four years

Variety	Grain Yield (t/ha)				Mean GY (t/ha)
	2011	2012	2013	2014	
TTB 404	…	…	4.94	4.22	4.22
Sahabhagi	…	…	3.86	3.45	3.45
IR 36	…	…	4.64	3.81	3.81
Bihari Ahu	3.75	3.85	4.38	3.15	3.78
Dehangi	3.48	3.78	4.25	3.69	3.80
Satyaranjan	4.16	4.28	4.72	3.45	4.15
Basundhara	4.05	4.19	4.48	3.87	4.15
Naveen	…	…	3.78	3.52	3.65
Abhisek	…	…	3.56	3.87	3.72

Komal (local)	…	…	3.85	3.95	3.90
Chandrama	…	…	3.7	3.26	3.48
Jaya	…	…	4.03	3.38	3.70
Baismuthi/ Basanti (local)	3.95	4.35	4.35	3.52	4.04

Salient findings:

The pooled data of four years indicated that TTB-404 recorded the highest grain yield of 4.22 t/ha followed by Satyaranjan (4.15 t/ha) and Basundhora (4.15 t/ha).

6.8. Evaluation of pigeonpea genotypes for rainfed upland situation of Assam

Pigeonpea is an important pulse crop suitable for growing under upland situation. Traditionally pigeonpea is grown in Assam as a marginal crop. Varieties grown are mostly the tall traditional long duration type. T-21 is the only recommended variety for the region which has already been an obsolete variety at the National level. To bring the crop into commercial scale, there is need for introduction of high yielding early maturing pigeonpea variety in the region. Therefore, with a view to identify suitable variety for the rainfed upland region of the state a pigeon pea genotypic evaluation trial is formulated.

Table: Performance of Pigeonpea genotypes over four years

SL No.	Genotype	Maturity Duration	Seed yield (kg/ha)				Mean yield (kg/ha)
			2011-12	2012-13	2013-14	2014-15	
1	T21	212	2082	2174.32	1978.45	1875.45	2027.56
2	ICPL 88039	148	2041	2081.40	1865.35	1725.59	1928.34
3	SAC1	153	1872	1794.00	1785.40	1758.35	1802.44
4	SAC2	156	1878	1798.30	1835.58	…	1837.29
5	SAC4	159	1849	1813.00	1750.90	…	1804.30
6	**BAC1**	202	2335	2298.40	2140.40	1985.56	2189.84
7	BAC2	196	2278	2285.30	2094.15	1970.21	2156.92
8	BAC3	207	1957	1976.21	1945.30	1854.21	1933.18
9	PTD 4307	204		1743.31	1658.35	…	1700.83
10	BDN 711	205		1875.25	1850.36	…	1862.81
11	Asha	172			1782.54	1623.12	1702.83
12	Maruti	180			2050.65	1789.32	1919.99
13	Bahar	175			2045.40	1845.36	1945.38
14	ICPH 2740	180			1958.50	1752.56	1855.53
15	ICPH 2761	185			1879.10	1652.14	1765.62
16	MAL-13	215			2075.25	1854.69	1964.97

Salient achievement:

The pooled data of four years indicated that among the early maturing genotypes under study, ICPL 88039 recorded the highest grain yield of 1928.34kg/ha. However, BAC-1, a local cultivar recorded highest grain yield of 2189.84 kg/ha.

6.9. Assessment of performance of new and underutilized crop species adapted for dryland agriculture.

Niger, buckwheat and linseed are important crops for a section of farmers of marginal environment with no capital resource or institutional support to arrange irrigation for their crops grown in relatively poor soil. Considering the engagement of a section of disadvantaged farmers' from marginal environment it is necessary to initiate systematic program for development of suitable varieties and production practices at the earliest possible.

Niger is cultivated as an oil seed crop, the seeds yielding about 30% of clear, excellent, edible oil which is slow-drying, used in foods, paints, and soaps, and as an illuminant. A bulk population from the materials selected from available cultivars at Jorhat was developed. With the addition of few more collections at Biswanath Chariali, it is attempted to develop an improved composite out of the available adapted cultivars of the State.

Salient findings: Among the niger varieties evaluated, the highest grain yield was recorded for NB-1 followed by GA-10. Both the cultivars are under Multi Locational Trial as per the recommendation of Technical Committee Meeting.

7. ENERGY MANAGEMENT

7.1. Effect of tillage and INM on soil moisture conservation and yield of groundnut in NBPZ of Assam

Groundnut (*Arachis hypogea* L.) is one of the principal economic crops. The oil content of groundnut is higher than those of soybean (*Glycine max*) and mustard. To make the country self sufficient in edible oil, it is extremely necessary to increase the total production of oil seed crops including groundnut either by increasing their yield per hectare or by increasing their acreage of cultivation or by a combination of them. The productivity of groundnut depends on numbers of factors like proper selection of variety, fertilizer management, energy management etc. Therefore, present experiment is carried out to find out suitable tillage practice and INM for growing groundnut under rainfed situation.

Table : Effect of treatments on crop yield and economics :

Treatments	Yield attributes		Groundnut Yield (pod) (q/ha)	B: C ratio
	Number of Pods/plant	Number of Branches/Plant		
Tillage				
T_1 : Minimum tillage (one harrowing)	65.44	17.44	15.16	1.18
T_2 : Two harrowing + one pulverization by power tiller	96.33	22.89	28.63	2.24
T_3 : Conventional tillage (Three to four ploughing followed by laddering)	59.67	14.67	17.61	1.38
T_4 : Minimum tillage followed by rotavator	92.22	21.89	21.64	1.69
T_5 : Rotavator	56.78	17.44	10.05	0.78
CD (P=0.05)	5.40*	2.23*	2.34*	-
INM				
F_1 : Recommended dose of fertilizer (RDF)	74.07	20.00	20.87	1.63
F_2 : 50% RDF + 50% Organic (Vermicompost)	73.53	18.47	18.73	1.46
F_3 : 75% RDF + 25% Organic (Vermicompost)	74.67	18.13	16.26	1.27
CD (P=0.05)	NS	1.46*	2.10*	
Tillage X INM				
CD (P=0.05)	NS	NS	NS	

Table : Effect of treatments on energy use efficiency:

Treatment	Field efficiency (hr/ha)	Energy (MJ/ha)	Energy use efficiency (percentage)
T_1 : Minimum tillage (one harrowing)	4.25	538.00	2.5
T_2 : Two harrowing + one pulverization by power tiller	15.33	1315.85	2.0
T_3 : Conventional tillage (Three to four ploughing followed by laddering)	28.50	3375.61	0.5
T_4 : Minimum tillage followed by rotavator	12.75	1614.01	1.2
T_5 : Rotavator	8.50	1076.00	0.8

Salient findings:

1. The maximum pod yield of 28.63 q ha^{-1} was observed under the treatment T_2 (Two harrowing + one pulverization by power tiller). Lowest yield of 10.09 qha^{-1} was recorded under the treatment T_5 (Rotavator).

2. Maximum 96 numbers of pods per plant was recorded under the treatment T_2 (Two harrowing + one pulverization by power tiller). Lowest was observed under the treatment T_5 wherein 56 numbers of pods per plant was recorded.

3. In terms of energy use efficiency, highest of 2.5% was recorded under the treatment T_1 (Minimum tillage; one harrowing) and lowest of 0.5% was recorded under the treatment T_3 (Conventional tillage; Three to four ploughing followed by laddering)

Best treatment (T2: Two harrowing + one pulverization by power tiller)	T5: Rotavator

8. RESOURCE CHARACTERISATION

8.1. Survey and soil site suitability evaluation of the soils of AICRPDA Biswanath Chariali of Sonitpur district and NICRA Village Chamua of North Lakhimpur Districts of Assam.

Developing a better land use planning is a very difficult proposition without having thorough knowledge about the inherent characteristics of soils, its variability and behaviour towards different management practices. It is so particularly for the alluvium derived soils due to its stratified nature. Looking to the importance of this need, it is obvious that soil survey is the unique way to achieve the goal, which provides principles and guidelines for the better management of land, through exploiting the potential soil resources in combination with consideration of environmental impact and sustainability of production.

Soil mapping was done at phase level taking in to account the important properties that influence the crop productivity. The drainage condition of the series and texture of series control section (SCS, 25-100 cm) taken for preparation of soil map. At the phase level, five soil characters and conditions namely surface texture, soil reaction in terms of soil acidity, flooding, slope and erodibility of the soils have considered.

Soil Mapping Units of NICRA Village

Sl.No.	Soil Mapping Unit
1	KP5Rr2f_2a1
2	KP5Ry2f_2b2
3	DP3Me2f_1b1
4	DP3My1f_1a1
5	DP3Mm2f_1a1
6	LB5Lm2f_0b2
7	LB5Lr2f_0c2
8	LB5Lr1f_0b1
9	RG4Ll1f_1a1
10	DF4Le2f_2a1
11	DF4Lm2f_1a1
12	BG3Le1f_2b2
13	BG3Lm2f_2b2
14	GD3Me1f_3b3

Table : Soil characteristics of mapped soil

Mapped Soil	Soil Texture	Soil Depth	CEC (cmol $p^+ kg^{-1}$)	pH	PBS (%)	OC (surface) ($gmkg^{-1}$)	EC (dsm^{-1})
1	Coarse Loamy	Deep Throughout	8.7	4.5-5.5	32	9.4	Negligible Throughout
2	Coarse Loamy						
3	Fine Loamy		7.5	4.5-5.5	38	10.9	
4	Fine Loamy		7.5	<4.5	38	7.8	
5	Fine Loamy		7.5	4.5-5.5	38	11.7	
6	Moderately Fine Loamy		6.1	4.5-5.5	32	8.7	
7	Moderately Fine Loamy		6.1	4.5-5.5	32	6.5	
8	Moderately Fine Loamy		6.1	<4.5	32	7.2	
9	Moderately Fine Loamy		7.6	<4.5	33	8.9	
10	Moderately Fine Loamy		7.8	4.5-5.5	34	9.7	
11	Moderately Fine Loamy		7.8	4.5-5.5	34	11.6	
12	Moderately Fine Loamy		7.9	<4.5	37	9.4	
13	Moderately Fine Loamy		7.9	4.5-5.5	37	9.1	
14	Fine Loamy		8.5	<4.5	35	8.5	

Table : Site characteristics of mapped soil

Mapped Soil	Slope %	Drainage Condition	Flooding
1	0-1	Well drained	Moderately Flooded
2	1-3	Well drained	Moderately Flooded
3	1-3	Imperfect	Slightly Flooded
4	0-1	Imperfect	Slightly Flooded
5	0-1	Imperfect	Slightly Flooded
6	1-3	Well drained	Nil
7	3-8	Well drained	Nil
8	1-3	Well drained	Nil
9	0-1	Moderately Well Drained	Slightly Flooded
10	0-1	Moderately Well Drained	Moderately Flooded
11	0-1	Moderately Well Drained	Slightly Flooded
12	1-3	Imperfect	Moderately Flooded
13	1-3	Imperfect	Moderately Flooded
14	1-3	Imperfect	Severely Flooded

Table : Suitable crops for the identified soil mapping units in NICRA villages

Sl.No.	Soil Mapping Unit		Highly Suitable crops	Moderately suitable crops	Marginally suitable
1	KP5Rr2f$_2$a1	Kachikatapathar	Maize, pigeon pea, toria, sesamum, citrus, banana	potato	Rice, sugarcane
2	KP5Ry2f$_2$b2	Kachikatapathar			
3	DP3Me2f$_1$b1	Dapathar	-	Rice, maize, toria, banana	Pigeonpea, sesamum, sugarcane, potato, citrus
4	DP3My1f$_1$a1	Dapathar			
5	DP3Mm2f$_1$a1	Dapathar			
6	LB5Lm2f$_0$b2	Lombabori	pigeonpea, toria, sesamum,	Maize, potato, citrus	Sugarcane, banana
7	LB5Lr2f$_0$c2	Lombabori			
8	LB5Lr1f$_0$b1	Lombabori			
9	RG4Ll1f$_1$a1	Rongajan	-	Rice, maize, pigeon pea, toria, sesamum	Sugarcane, citrus, banana, potato

10	DF4Le2f$_2$a1	Dapholapothar	-	Rice, maize, toria, sesamum	Sugarcane, citrus, banana, potato, pigeon pea
11	DF4Lm2f$_1$a1	Dapholapothar			
12	BG3Le1f$_2$b2	Bongali pathar	-	Rice, maize	Pigeon pea, toria, sesamum, sugarcane, potato, citrus, banana
13	BG3Lm2f$_2$b2	Bongali pathar			
14	GD3Me1f$_3$b3	Gonokdoloni	-	Rice, Maize	Pigeon pea, toria, sesamum, sugarcane, potato, citrus, banana

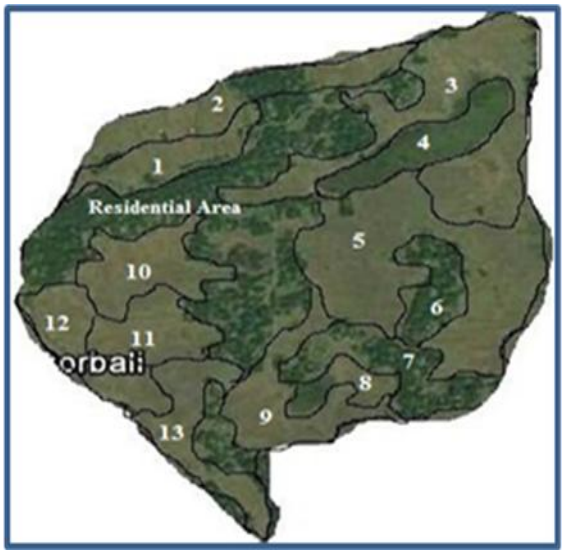


Fig: Soil Map of NICRA village, *Chamua*

Fig: Soil Map of NICRA village, *Gonokdoloni*

Soil Mapping Units of Biswanath College of Agriculture

Soil Series	Mapping Unit
AICRP(DA) Farm	**BNCA(D)Em3**
	BNCA(D)Em2
	BNCA(D)El2
Horticultural Orchard	**BNCA(H)Mm2**
	BNCA(H)Mm3
	BNCA(H)Me2
	BNCA(H)Ml2

9. NICRA ACTIVITIES:

NICRA on farm activities during 2010-11 to 2014-15

9.1. REAL TIME CONTINGENCY PLAN

1. As a Real time contingency plan implementation in a participatory mode seventeen crops like Ginger, Turmeric, Arahar, Napier, Rice(Sali), Blackgram, Greengram, Sesamum, potato, Rapeseed & mustard, Pea, Lentil, Lathyrus, Ahu rice, Maize, Summer blackgram, Colocasia were demonstrated.
2. Rain water harvesting in farm ponds during pre-monsoon months and recycling for nursery bed preparation helped in timely sowing of *Sali* rice, especially long duration cultivars **viz. Ranjit, Mahsuri, Gitesh, Bahadur, Moniram, Jalkuwari** during delayed onset of monsoon condition in the village.
3. **Growing of short duration** (SDC) like Dishang, Luit, Kolong and Lachit and medium duration (MDC) like TTB-404, Mohan, Mulagabharu *Sali* rice cultivars for dry spells management.
4. **In Village seed bank** seed production of rice cultivars like Dishang, Luit, Kolong and Lachit (SDC), TTB-404, Mohan and Mulagabharu (MDC), Ranjit (LDC), Bahadur, (LDC), Keteki (Scented rice), Jalashree, Jalkunwari (Having submergence tolerance ability) and Kokowa (deep water rice) suitable for different land and weather situations for management of drought and flash flood.
5. Growing alternate crops or crop diversification with different crops like Ginger, turmeric, sesame, tomato, potato, rapeseed etc.
6. **Growing submergence** tolerance rice cultivars Jalashree and Jalkunwari and Swarnasub for flash flood management. In the nursery bed, just the day after sowing of sprouted seed, the crop was immerged under water for 9 days. However no seedling was damaged due to this complete submergence of the varieties.
7. **Growing *Sali* rice** cultivars Gitesh and Prafulla. having staggering ability for flash flood management.
8. **Growing deep water rice** cultivars Kekowa, Maguri, Rangabao, Dhusuri, Tulshi for flood management.
9. Demonstration of growing maize Cultivar: All-rounder (Hybrid) after harvesting potato, rapeseed or paddy in the driest period of the year.

9.2. ENERGY MANAGEMENT

1. A custom hiring centre with farm implements and tools like Disc plough (two bottom), Disc harrow, Rotavator, Spring type cultivar, Ridger two button, Peg type dry land weeder, Wetland paddy weeder, Knapsack sprayers, Power/ Self propelled reaper, Hague thresher (Paddy) , Chaff cutter, Monoblock diesel engine centrifugal pump set, Low cost micro irrigation system (Excluding pump), Non recording raingauge , Self recording raingauge , Maximum and minimum thermometer , Single Stevenson screen , Top pan balance (50 kg capacity) Top pan balance (50 kg capacity),has been established in the NICRA village.

9.3. RAIN WATER MANAGEMENT (*In-situ* and *ex-situ*)

1. Ginger and turmeric were grown as In-situ conservation of moisture mulching with locally available organic material like rice husk, thatch etc for in situ moisture conservation.
2. As Ex-situ water conservation farm ponds situated in the *Boriland* (upland*)* area of the NICRA village has been renovated for rainwater harvesting. Thirteen farm ponds scattered in the NICRA village Chamua has already been renovated under NICRA project.

9.4. ALTERNATE LAND USE

1. Promoting use of improved organic manure with production of vermicompost. Production and use of vermicompost was demonstrated among the farmers of the village. Vermicompost produced by the famers was utilized in their crop field
2. Strengthening farming system with Fish +duck+ agriculture, Pig + Fish + duck + agriculture Already existing farming system has been strengthened by developing housing facilities for duckery and piggery.
3. Protected cultivation inside low cost polyhouse by growing unseasonal or cash crops inside low cost polyhouse.

NICRA on station activities

9.5. REAL TIME CONTINGENCY PLANNING

1. Cultivation of alternate crops like Pigeonpea (cultivars- ICPL -88039, ICPL-11330, ICPL -11305, TS-36, ICPH- , Maruti, Local-2).
2. Organic cultivation of spinach and turmeric as nutrient management.

9.6. RAINWATER HARVESTING AND USE

1. Efficient rain water conservation through mulching with locally available organic matter (potato, turmeric and ginger) and with black polythene (banana and Pineapple) in potato, turmeric, banana, pineapple.

2. Roof top rainwater harvesting and use for supplemental irrigation in Potato (demonstration). Potato cultivars like Kufri Jyoti and Kufri Pokhraj were grown (

9.7. ALTERNATE LAND USE SYSTEM

1. Production of vermicompost, compost, mushroom, vegetables, honeybee, azolla, spinach, turmeric, banana, pineapple etc in Dry land technology park and organic farm unit. The Dryland Technology Park has a production capacity of approximately 20 t compost/ enriched compost and 22 t vermicompost annually, and production of azolla and BGA, vegetables (Tomato, capsicum etc.). The dryland technology park is being visited by various visitors regularly including farmers, self help groups as well as students from various parts of Assam and North East India and it is functioning as a research, extension and production unit of AICRPDA, Biswanath Chariali center.

2. Development of organic block for cultivation of horticultural crops with some selected horticultural crops of North bank Plain zone of Assam under NICRA project.

3. Banana, turmeric, pineapple and spinach are the crops, which are grown in the organic farm unit on experimental basis with the objective of developing organic package of practices of the crops.

4. Study on quality of ground water in block(s) of North Bank Plain Zone of Assam.

9.8. A SUCCESS STORY:

A progressive farmer Mr. Harendra Neog was selected for the crop diversification programme under NICRA project during 2011-12. The farmer generally grows only *Sali* rice in his field. His field is situated in the bank of a small river- *Kachikata.* Soil of his field is sandy loam soil and the land situation is medium to upland. That is why, if there was no rainfall even a few days, the rice crop grown in his field suffers from water stress. Therefore the *Sali* rice grown in his field often suffers from water stress during mid season or terminal dry spells.

During 2011-12, under NICRA project, the farmer were encouraged to grow various crops which require less water in a portion of his field (0.8 ha). In the other portion of his field (0.4), he grows rice crop of his own. Under crop diversification, the farmer cultivates more than 20 crops like turmeric, ginger, pegeonpea, napier, black gram, green gram, sesamum, potato, pea, lathyrus, toria, french bean, bittergourd, Cowpea, ridgegourd, bhindi, pumpkin etc. He used rice straw, rice husk, rice stubbles, leaves of arecanut *etc* as mulch materials for growing turmeric, ginger, bitter guard and tomato. The small farm pond situated in his filed was used for giving supplemental irrigation to small area of his rice field during mid season and terminal dry spells occurring during 2011. No midterm corrections for occurrence of multiple dry spells were given to the rice crop grown by him. That is why the rice crop grown by him (farmer's practice) suffered badly from the water deficit and yield was reduced drastically. The farmer was able get only the seed yield of 9 qt/ha. In terms money the gross return was only Rs. 13,500.00 per hectare of land from his own practice. Thus the farmer could hardly earn any money from his rice crop.

On the other hand, the yield from the area where he cultivated many crops other than rice which require less water, crops were not affected by the multiple dry spells occurring during that year. It was estimated that his net income was Rs. 1,49,000.00 (One lakh forty

nine thousand) per hectare from the crop field where he followed diversified cropping system.

Therefore, in medium land situation one can expect higher income under diversified cropping system as compared to mono cropping of rice with same soil condition and rainfall amount. Thus the diversified cropping is more resilient to climate variability or climate change and should be advocated.

Many farmers of NICRA village earned substantially higher income from the cropping system adopted under NICRA project as compared to mono-cropping of rice.

9.9. OTHERS:

1. To make the fodder seedlings of different cultivars available to the farmers a 'fodder seed bank' was established at the NICRA village Chamua under NICRA in collaboration with "AICRP on Forage Crops, Jorhat Centre, AAU, Jorhat. The fodder seed bank was established in 0.26 ha of land of a farmer of NICRA village. Three species of perennial fodder varieties *viz.* - Hydrid Napier (Variety: CO -2 and CO - 4), Cognosignal and Setaria were planted in the fodder bank of NICRA village Chamua.
2. Under NICRA project linkages have been developed with State Department of Agriculture, State Department of Veterinary, State Department of Fishery, All India Coordinated research project on Tuber crops other than Potato, Jorhat centre, Department of Panchyayat and Rural Development.
3. NICRA sensitization meeting, Soil Samples collection with GPS, Participatory Rural Appraisal (PRA), Training on cultivation practices of Turmeric, Ginger, Pigeon Pea, and Napier, scientific cultivation of rice on cultivation black gram, green gram, sesame, potato, pea, scientific cultivation of Ahu rice, Maize and Colocasia, production and use of vermicomst and other organic manures, post harvest storage of fruits ,Cattle vaccination Programme were conducted.
4. Harvest festival cum farmers' fair: Consecutively for two years on 3/11/2011 and 7/1/2013 "Harvest Festival cum Farmers' fair" were organized at the NICRA village.
5. NICRA, AICRPDA, Biswnath Chariali Centre participated in the North East Regional Agri-Fair, held at AAU, Khanapara, Guwahati from 10 to 1^{2th} February, 2012. A model of NICRA village Chamua was exhibited in the NE Region Agri-Fair. Mr. Sanjay Krishna, IAS, Commissioner, Govt of Assam, Dr. K. M. Bujarbaruah, V.C. AAU, Jorhat, Dr. G. N.

Hazarika, Director Research (Agri), AAU, Jorhat, Dr. Nachang, Director, ICAR Research Complex for NEH Region, Shillong, Dr. A.K. Gogoi, ZPD, Zonal Project Directorate, Zone III, ICAR Res. Complex NEH etc. visited & observed the displayed model. The model displayed was highly appreciated by the dignitaries and other viewers.

6. Soil health cards of the farmers of the NICRA village have been prepared and distributed among the famers. GPS based Soil data collected for different land situations of the village.
7. As per the guide line, the Village Climate Risk Management Committee, Chamua was constituted headed by the president of the committee. The VLCRM, Chamua is successfully managing various activities of NICRA project right from the beginning. The committee is helping in identifying interventions that are to be adopted in the villages. Renovation or construction works related to the NICRA project like erecting small building for custom hiring centre, a training hall (NEH grant), renovation of farm ponds, erecting housing facilities of duck and pigs, erecting low cost poly houses, construction of vermicompost units etc were carried out in the village through the VLCRM.
8. NICRA up scaling programme: As part up-scaling of NICRA model of NICRA-AICRPDA Biswanath Charilai, tested climate resilient technologists are being demonstrated in TSP village in Dhemaji district, Jinjia village in Sonitpur district and Satirkur village in Nalbari district of Assam.
9. NICRA Up-scaling programme at Jinjia village: *Jinjia* village is located Bihali Sub-division of Sonitpur district of Assam. Land situation of the village is medium land. Potato is extensively cultivated in the locality where the village is situated. Unlike others places of Assam, cropping system of the locality is potato based cropping system. Farmers of the locality grow potato crop extensively after harvest short duration rice cultivars (mainly *Bihari Ahu* – a local variety). Potato productivity in that locality is very high. They put heavy doses of fertilizers (NPK) and use pesticides indiscriminately during the cultivation of Potato. There is the every possibilities deterioration soil health as well as soil, water and air pollution due indiscriminant use of chemicals to their fields. Looking at the problems of the locality following initiative has been taken under NICRA up-scaling programme in Jinjia village.
10. Agro met Advisory Bulletins issued by AAS, Sonitpur, BN College of Agriculture is regularly displayed in the NICRA village officeas a Agromet Advisory Service in NICRA village

10. TSP ACTIVITIES:

Details of TSP Village

Village: Jalakiasuti
Latitude and longitude : 27.6083 ^{o} N & 94.7550 ^{o} E
Block: Sissiborgaon
District: Dhemaji, Assam

The village was selected by KVK Scientists after preliminary survey with the help of local VLEW. The villagers were purely dependent on agriculture and allied sector. But the natural calamities (both drought and flood) are the major hurdles for agricultural development in spite of hard labour and encouraging engagement of youth class in the sector. One water course in the name of Jalakiasuti originating from hillock of Arunachal Pradesh is streaming through the village, which was thought as blessing of nature earlier but distressing now a day due to mass deforestation in the hillock. Administratively, the village falls under Jonai subdivision and Sisiborgaon block of Dhemaji district.

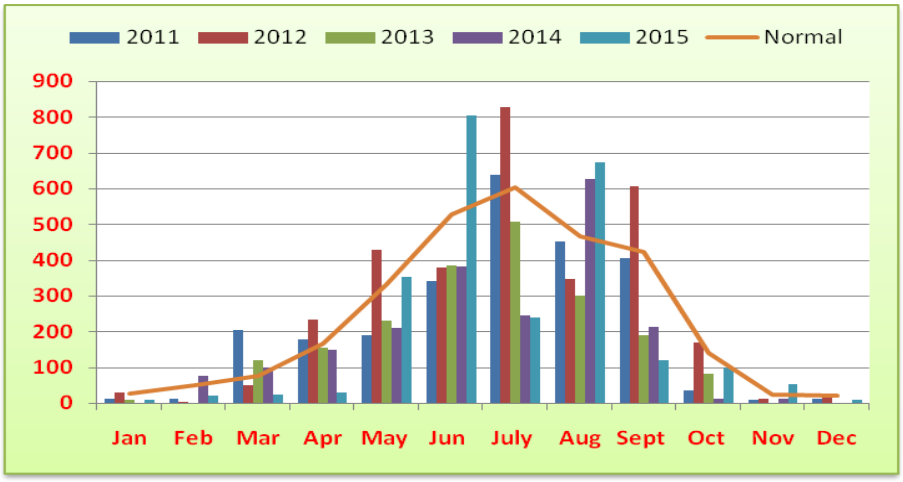
DISTRIBUTION OF HOUSEHOLDS IN THE VILLAGE:

Particular	Landless	Marginal	Small	Medium	Large	Total
Number	20	47	57	28	8	160
Average landholding size (ha)	0-0.3	0.3-1.0	1.0 – 2.0	2.0 – 4.0	>4.0	

AGRICULTURAL PROFILE:

Major Soils	**Area (ha)**	**Per cent (%) of total GA**
1. Sandy loam	**175**	**100**
2. Clay loam	**--**	**--**
Agricultural land use	**Area (ha)**	**Per cent (%)**
Total geographical area	**228**	
Total cultivated area	**175.4**	**76.9**
Cultivable wasteland	**24.0**	**10.5**
Pasture land	**1.0**	
Rainfed area	**169.2**	**96.5**
Net irrigated area	**6.0**	**0.035**

WEATHER DURING 2011-2015



INTERVENTIONS DURING 2011-15

Theme	No. of Interventions				Area (ha)/ Number	No. of farmers
	2012-13	2013-14	2014-15	2015-16		
Natural Resource Management		3	3	3	2 ha	All stakeholders
Crop Production	--	7	8	3	29.17+56.47+6	133+372+190
IPM package demonstration	--			2	0.67	10
Livestock	--	3	2	1	750+4810+100	103+160+5
Fishery	--	--	1	--	2 ha	All stakeholders
Diversification of Agriculture	--	**3**	**3**	**3**		**82**
Post Harvest Handling and Secondary Agriculture	--	**1**	**1**	**1**		**5**
Capacity Building-Training, Exposure visit, Literature Development	--	**36**				All stakeholders
Institutional arrangement-Custom hiring Centre, E-Connectivity	--	**1**		**1**	**1**	All stakeholders

NRM Intervention (2013-14)

A. Renovation of Water harvesting structure (Area: 2 ha)

- Renovation of community pond
- Fish gate construction
- Borewell installation


B. Aforestation for soil conservation

- Plantation in river bank of Jalakiasuti
- Plantation of Neem and Subabul plant in road side of approach road of the village
- Bore well Recharge (renovation & recharge)


Assets created

- Rain Water Harvesting Structure =2 ha pond
- Low cost Meshang Changhar House = 2
- Low cost Vermicompost Unit =32 nos
- Borewell recharge=3nos
- Paddy Storage structure =3 nos
- Custom Hiring Center: o1
- Agricultural Training Hall and store for Custom Hiring Center

Livelihood activities

- Distribution of improved poultry breed “Vanraja”
- Construction of Water Harvesting Structure and renovation of fish pond
- Distribution of 7 Nos. Boar
- Honey bee unit
- Turmeric cultivation
- Green fodder cultivation
- Distribution of Banana sapling
- Vaccination against FMD of cattle, pig and goat
- Introduction of improved goat breed
- Vaccination of poultry against Ranikhet
- Borewell Recharge
- Animal Health Camp
- Low Cost Vermicompost Unit
- Distribution of Khaki Campbell duck
- Distributed of Paddy storage structure – *Duli*
- Crossbred Kids of Beetal bucks

Trainings/Exposure visits

- Training on Natural resource management
- Training on Fish-livestock-horticultural farming, a IFS model
- Training on year – round management of fish pond
- Training on Backyard rearing of dual purpose poultry breed “Vanraja”
- Training on IPM in Sali and Boro Paddy
- Training on preservation of seasonal vegetables by pickling:
- Training on improved cultivation practices of blackgram and oilseed:
- Training programme cum exposure visit to FMTTI, Biswanath Chariali

A GLIMPSES OF TSP ACTIVITIES AT JALAKIASUTI

11. NICRA UPSCALING

A GLIMPSE OF ACTIVITIES OF THE NICRA UPSCALING PROGRAMME AT NALBARI, ASSAM BEING UNDERTAKEN BY AICRPDA, BISWANATH CHARIALI CENTRE IN ASSOCIATION WITH KVK, NALBARI

The success stories of NICRA being implemented in the state of Assam and adjoining parts have been the rays of hope for ushering a green revolution from the rainfed regions of eastern and north eastern India. With the realization of the potential impact of the NICRA project in uplifting the livelihood security through the all round utilization of village level natural and human resources, an initiative has been made to upscale the rainfed agricultural and other related technologies and interventions in other parts of the state. As a first step a cluster of four villages around the central place Satirkur at seven Km from the district head quarter of Nalbari, Assam.

About the area: The cluster of the villages comprises four villages viz., Barnarddi, Mohkholi, Doukuchi and Churchuri having around 200 farm families mostly dependant on agriculture as the primary source of earning. However, in the recent past it has been observed that many of the farmers have diverted from the Agriculture to other forms (casual workers/ rikshwa and cart puller/security workers etc.) of earnings. As a result there has been shrinkage of cropping intensity (shifted from double rice cropping to mono cropping), even many parts being remained vacant throughout the year. A village stream has passed through the area which brings the surface water from the upstream areas during heavy rains creating problems in transplanting of rice and even damaging transplanted rice. On the other hand when rain recedes it drains out all the water from the surrounding fields. The entire area is rainfed and no irrigation facility is available. The area can be divided into the following categories:

1	Rainfed lowland	168.0
2	Rainfed upland (Open)	15.5
3	Rainfed Upland (Bari)	20.0
4	Water bodies	21.5
	Total=	225.0 ha

Interventions made so far: Keeping in view the concepts of four themes under NICRA viz. Real time contingency, Rain water harvesting, Energy management and alternative land use and the village resources we are implementing different interventions including agri-horticultural crops, multipurpose use of defunct water bodies, increasing cropping intensity, incorporation of animal raring for profit maximization of farm families. A brief account of the activities implemented so far is given below:

1. The project has been started with a sensitization programme during November, 2012 by the team of AICRPDA scientists from BNCA and PC, KVK, Nalbari.

2. Following this a rabi crop cultivation programme has been undertaken with different rabi crops like Toria, potato, rajmah, vegetables and flower crops comprising of an area of 20 ha.
3. In order to strengthen mechanization and farm power availability, a custom hiring centre is being established with incorporation of almost all the needed farm implements.

4. With a view to propagate the concepts of farming system approach, attempt has been made in alternate land use, incorporation of animal components and demonstrating the mutual benefits obtained from the crop and animal husbandry enterprises.
5. Fishery cum duckery units have been developed in the four village units. Improved backyard poultry has been introduced to enhance the income of the farm families utilizing the household feed materials. A fishery-duckery-poultry-piggery units is being established by a group of young youths with the technical and financial assistance from the AICRPDA.

6. With a view to improve local low yielding goat breeds, improved goat breeds are introduced in the villages. Two such centers have been established in two farm families, where improved service males are kept for providing insemination service to the farm families of the locality. It is expected that a large number of cross bred kids will be available after a few months in the locality.

7. A number of training programmes have been conducted for capacity building of the farmers of the locality by the scientists of AICRPDA, KVK and state department officials.
8. Collaboration have been established with the State Department of Agriculture and Veterinary and Animal Husbandry in providing technical backup, vaccination and disease monitoring services and arrangement of subsidies to farmers in procuring farmer friendly implements.
9. Collaboration are being sought from the state employment generation mission, NABARD, District Administration etc. for bringing about all round development of the farming communities in the village clusters.

- **CONTINGENCY PADDY NURSERY**: Short duration winter paddy variety "Disang" suitable for late transplanting to cope with the post flood condition were distributed among the flood affected farmers.
- **PRODUCTION OF POTATO SEED TUBERS AS CONTINGENCY:** In view of the shortage of quality potato seed, programme on production of potato seed has been undertaken in collaboration with certified potato seed grower of Gingia to produce about 100q of certified seed of potato per hectare for ensuing potato season of 2016-17.
- About 15 nos of indigenous rice varieties have been submitted to concerned authority for registration which was collected from NICRA village.

FACULTY MEMBERS' INVOLVEMENT IN AICRPDA ACTIVITIES:

Alongwith the Scientists of AICRPDA, BNCA, other faculty members are also actively involved in different ongoing activities under AICRPDA.

12. AWARDS AND RECOGNITION:

- "Best AICRPDA Centre Award 2014" for outstanding contribution in Dryland Research during the XXIV Biennial Workshop of AICRPDA held at RVSKW, Indore on 27th December, 2014.
- Best Dryland Farmer Award, 2014 for outstanding contribution in adoption and popularization of crop diversification in rainfed uplands for higher productivity and profitability.
- The XV Working group meeting of AICRPDA, CRIDA was held at AICRPDA centre, Biswanath Chariali from 24-27th December, 2015.

- **Farmers awarded:**

Following 7 famers (including one woman farmer) from NICRA, NICRA upscalling and TSP villages (*Chamua, Ganakdoloni, Bornadi, Jinjia and Jalakia suti*) located at different districts of Assam were honored and awarded with the ***best dryland farmer award*** by CRIDA, Hyderabad during XV Working Group Meeting of AICRPDA held at BN College of Agriculture, Biswanath Chariali from 24 to 27 December, 2015 for contribution in adoption and populaization climate resilint technoloigies.

1. **Sri Chakradhar Goswami,** Chamua Village, Lakhimpur District, Assam, for his outstanding contribution in leading village level institution for *successful adoption of climate resilient agricutural technologies.*
2. **Sri Harendra Neog,** Chamua Village, Lakhimpur District, Assam, for his outstanding contribution in adoption and popularization of *crop diversification in rainfed upland and protected cultivation*
3. **Sri Jadab Dutta,** Ganakdoloni Village, Lakhimpur District, Assam, for his outstanding contribution in adoption and popularization of *flash flood resilient rice based agro technologies.*
4. **Sri Devi Prasad Sharma,** Jinjia Village, SonitpurDistrict, Assam, for his outstanding contribution to horizontal expansion of *Potato cultivation as contingent crop and adoption and popularization of agromet advisories*
5. **Sri Dinesh Chandra Baishya**, Dowkushi Village, Nalbari District, Assam, for his outstanding contribution in adoption and popularization of *poly house nursery and integrated farming system as climate resilient technology.*
6. **Sri Luhit Sonowal**, Jalakia Suti Village, Dhemaji District, Assam, for his outstanding contribution in adoption and popularization of *integrated farming system as climate resilient technology.*
7. **Srimoti Bhabani Kachari**, Jalakia Suti Village, Dhemaji District, Assam, for her outstanding contribution in adoption and popularization of *mechanization of eri spinning technology.*

➢ **NICRA village model displayed:**

NICRA village model of NICRA-AICRPDA, Biswnath Chariali centre is becoming very popular and well appreciated by all sections of people including policy makers, scientist, farmers and all. The model was always kept in front of the stall of Assam Agricultural University, when the university participated in any prgramme. The model during XV Working Group meeting of AICRPDA held at BN College of Agriculture, Biswanath Chariali from 24 to 27 December, 2015. The model was also dispalyed during 3rd Assam International Agri-Horti Show held at Guwhati from 6 to 9 January, 2016.

13. FODDER BANK, AICRPDA, BNCA

Fodder bank was established in the year 2015 at Dryland Technology Park, AICRPDA, BNCA for production and conservation of fodder. The fodder bank was established in collaboration with AICRP on forage crop and utilization and Department of Animal Husbandary, BNCA. The fodder bank is mainly establish for production and conservation of fodder along with demonstration to the farmers, SHGs, students etc.

Photographs of Fodder bank at Dryland Technology Park

14. DOABLE TECHNOLOGIES READY FOR UPSCALING: 6 NO.

1. Intercropping of greengram and/or blackgram with sesame either in alternate rows (1:1) or double rows (2:2) produced significantly higher sesame equivalent yield over sole cropping sesame.
2. The highest grain yield of 9.10 q/ha was obtained with seed priming with 1%KH_2PO_4 which is 27.84% higher over dry sowing.
3. "Effect of Foliar Application of Potassium on Drought Tolerance and Nutrient Use Efficiency in *toria*" it was concluded that application of 100% N&P as basal (40 & 35 kg/ha) + 75% K (11.25 kg/ha) as basal + 2% KCl spray before flowering + 2% KCl spray at siliqua formation is beneficial in terms of grain yield and economics over dry sowing.
4. After three years of varietal evatuation, an early maturing Pigeonpea variety, ICPL 88039 (140-150 days) is found suitable for rainfed upland situation of Assam.
5. After three years of varietal evaluation, an Early maturing (95-100 days)drought tolerant and high yielding variety **Dehangi** is selected.
6. A bulk population of niger**, NB1** was developed with higher yield which is currently under Multilocational Evaluation at different Regional Agricultural Research Stations of Assam.

15. LIST OF TECHNOLOGIES IN PIPELINE : 14 NO.

1) Developing a suitable Maize-based double cropping system under north bank plain zone of Assam.
2) Developing optimum Fertility levels on yield and economics of sesame based intercropping system
3) Suitable planting time of local small tuber potato varieties to improved varieties under rainfed condition of Assam.
4) Suitable microclimate for intercropping of ginger with pigeon pea.
5) Relay cropping of *rabi* pulses with *kharif* rice under rainfed medium low land situation of NBPZ Assam.
6) A model for crop growth parameters and yield of rice and potato in a rice-potato cropping sequence
7) Foliar application for drought tolerance and nutrient use efficiency in *toria*.
8) Integrated nutrient management in Rice based cropping system under rainfed condition.
9) Development of medium duration high yielding rice varieties under rainfed eco-system of NBPZ of Assam.
10) Pigeon pea genotypes for rainfed upland situation of Assam
11) Sesame genotypes for rainfed upland situations of Assam
12) Early mustard genotypes under rice-*rabi* crop sequence of Assam
13) New and underutilized crop species adapted for dryland agriculture
14) Rice varieties under rainfed lowland condition of NBPZ of Assam

16. LIST OF PUBLICATIONS

16. 1. Research Paper:

Sl.No.	Name	Year	Article	Paper published in Journal/ Presented
1.	Borkakati, R.P.; Chowdhury**,** R.K.and **Kurmi, K**	2005	Studies on genetic variability and correlation in some rice hybrids	*National Journal of Plant Improvement.7* (2): 119-121
2.	Dey, P.C.; Haloi, B.; Ghose, T.J.; **Barua, N.G**. and Saud, R.K	2005	Inhibition of Pre and Post Harvest Sprouting of Autumn Rice through Non-residual Chemical Aids	*National Journal of Plant Improvement.***7** (1): 47-49.
3.	**Pathak, P. K.** and S. S. Baghel	2005	Participatory seed production	production presented in the Summer School on "Partnership Research Management for Hill Agriculture" held from July 20 to August 10, 2005 at ICAR Research Complex for NEH Region, Brapani
4.	**Pathak, P. K.** and S. S. Baghel	2005	Recent trends in plant breeding for quality traits with special reference to tea	presented in the 34th Toklai Conference held on November 28-30, 2005 at Toklai
5.	Yang, Yong-xia.; **P. K. Pathak** and Zhu Jun	2005	Age-specific mapping of QTLs associated with cold tolerance for seedling weight in rice (*Oryza sativa* L.)	Journal of Zhejiang University (Agric. & Life Sci.) **31:** 131-138.
6.	**Pathak, P. K.** and A. K. Pathak	2005	Three decades of rice breeding programs in Assam Agricultural University	published in Rice India 15(9):

7.	Gogoi, N.K.; Dey, P.C.; **Kurmi, K**. and Ali, M.S	2006	Sheath blight incidence under rice-rice cropping (Autumn-Winter) system and its management.	In Souvenir & Abstracts of papers of National Seminar on *Current Trends in Crop Disease Management for Improving Productivity*, Indian Phytopathological Society, Eastern Zone, Regional Research Laboratory, Jorhat, 19-20 January 2006, Pp20.
8.	**Kurmi, K**	2006	Agro techniques in Integrated Nutrient Management	In compendium of lectures presented in ICAR sponsored Short Summer Course on *Integrated Nutrient Management in Rainfed Agro-Ecosytem* Department of Soil Science, Assam Agricultural University, Jorhat,20-29, July,2006, Pp69-72.
9.	Das KN., Basumatary ,A and Borkotoki, B	2009	**Sulphur Status in Some Rapeseed Growing Alfisols of Assam**	*International Journal of Tropical Agriculture*, 27 (3-4) : 605-614
10.	Singh NAK, Basumatary, A., **Barua, N. G**	2009	**Influence of INM on yield, nutrient uptake and economics in rice-niger cropping sequence.**	*Oryza* 46:160-162.
11.	Talukdar, M.C.,**Basumatary, A** and Dutta, S.K	2009	**Status of DTPA –extractable cationic micronutrients in soils under rice and sugarcane ecosystem of golaghat district in Assam.**	*Journal of Indian society of Soil Science* 57:313-316
12.	Talukdar, M.C.,Goswami, G., Basumatary, A	2009	**Crop suitability for char areas of**	*Agropedology* 19(1):41-46

	and Das, A.K		**Nalbari District,Assam(2009)**	
13.	Saikia, A.J., Patgiri, D.K. and Deka, P.K	2009	**Effect of liming materials on aggregation in soils of upper Brahmaputra valley zone of Assam.**	*Journal of Indian society of Soil Science* 57(2): 315-317
14.	**Deka, B**; Baruah,T.C; **Neog, P. and Baruah,H.C**	2010	**Soil Erodibility in relation to physical and 87hysic-chemical characteristics in Ghiladhira watershed of the Northern Brahmaputra Valley Zone of Assam**	Paper Presented in National Conference of Soil Conservation Society of India on Watershed Management of Sloping lands for environment and Livelihood security, held at Shillong during, Nov ,11-13, 2010
15.	**Deka, B**;Baruah,T.C;Dutta,M	2010	Mapping basic soil fertility parameters of different landscape units in Ghiladhira watershed of Assam using remote sensing and GIS Techniques.	Paper Presented in the International Geographic Union Commission Seminar on Land use, Biodiversity and Climate change held at Cotton College during, Dec,11-13, 2010
16.	Goswami, R. K., Choudhury, H., **Sarma, M. K**., **Sharma, D.** and Bhuyan, J	2010	Evaluation of greengram genotypes for morpho-physiological traits and seed yield.	Annals of Plant Physiology, 24(2): 115-120
17.	Bhuyan, J., Sarma, H. and **Sarma, M.K**	2010	Scope and opportunities for promotion of soybean in nontraditional areas of North East India.	Paper presented in the National Congress on Emerging Trends in Agricultural Research, PDFSR, Modipuram, Meerut, India
18.	Hazarika, P., **Saikia, P., Sarma, M.K.,** Choudhury, H. and Bora, S	2010	Genetic diversity of bamboo in North East India.	Paper presented in the National Congress on Emerging Trends in Agricultural Research, PDFSR,

				Modipuram, Meerut, India
19.	**Sarma, M.K.,** Mahanta, P., Bora. S. and Pranabjyoti Hazarika	2010	Bamboo as a potential bio-energy resources, Proc Nat.	Conference on Renewable Energy for Developmentof Underdeveloped areas with particular reference to North East India, March 23-25, 2010, Tezpur University
20.	**Sarma. M. K.,** Bora, S, **Saikia, Pinki,** Choudhury, H. and Mahanta, P	2011	Studies on the relative efficiency of different crop species for developing a suitable bamboo based cropping system	Paper presented in IFRO sysmposium on short rotation forestry: Synergies for wood production and environmental amelioration, Feb, 10-12, 2011, PAU, Ludhiana.
21.	**Sarma, M.K.,** Bora, S., **Saikia, Pinki,** Mahanta, P. and Choudhury, H	2011	Bamboo: A potential bio- resource for livelihood security and environmental sustainability of the North East India.	Paper presented in the National seminar on Biochemical and biotechnological research approaches for bio-resource management of North East India towards sustainable rural development, 11-12 November, 2011, BNCA, AAU, Biswanath Chariali.
22.	Goswami, R. K., Choudhury, H., **Sarma, M. K**., Borah, H. K., Das, R. and Sarma, A. K	2011	Effect of water stress on seed germination and seedling growth in *Vigna radiata* L. Wilczek	Advances in Plant Sciences, 24 (II): 535-537
23.	**M.K. Sarma,** Goswami, R. K., Choudhury, H.,	2011	Genetic diversity for seed yield and	Paper presented in the National

	Patowary, A., Mayuri Baruah and Mouchumi Duara		its attributes in greengram (*Vigna radiata* L).	seminar on Biochemical and biotechnological research approaches for bio-resource management of North East India towards sustainable rural development, 11-12 November, 2011, BNCA, AAU, Biswanath Chariali.
24.	Baruah, Sangeeta, **Sarma, M. K.,** Kandali, R. and Baruah, S.J.N	2011	Application of Nanotechnology in Agriculture.	Paper presented in the National seminar on Biochemical and biotechnological research approaches for bio-resource management of North East India towards sustainable rural development, 11-12 November, 2011, BNCA, AAU, Biswanath Chariali.
25.	**Deka, B**., Baruah, T. C., Dutta, M. and **Neog, P**	2011	Soil loss estimation on RS data and GIS techniques soil in Ghiladhari watershed of northern Brahmaputra valley of Assam.	*Journal of soil and water conservation*, 10(2): 123
26.	Goswami, R. K., Choudhury, H., **Sarma, M. K**., Kandali, R., and Goswami, J	2011	Genotypic variation for physiological traits in greengram (Vigna *radiata* L. Wilczek).	Paper presented in the National seminar on Biochemical and biotechnological research approaches for bio-resource management of North East India towards sustainable rural development, 11-12 November,

				2011, BNCA, AAU, Biswanath Chariali.
27.	**M.K. Sarma**	2011	Biotechnology in Crop Improvement: A reality in 21st Century	Biotech Today, Jul-Dec, 2011
28.	Ramchiary, N. and **Sarma, M.K**	2011	Genome mapping and its impact in Plant Breeding.	Paper presented in the National seminar on Biochemical and biotechnological research approaches for bio-resource management of North East India towards sustainable rural development, 11-12 November, 2011, BNCA, AAU, Biswanath Chariali.
29.	P. Das, L. Paswan, H. Choudhury, J. Das and **P. Saikia**	2011	Effect of Inorganic,Organic and Biofertilizer on yield attributes of tuberose(*polianthestuberose* Linn.)"	Crop Research Vol. 42(1,2&3), pp. 227-230
30.	**Mayuri Baruah,** P. K. Neog and **Rijumni Rajbongshi**	2011	Studies on Impact of climate change on Growth,Yield and Biotic stress of Tea in Sonitpur District of Assam	National Seminar-Agro meteorological Research and Sciences to combat climate change challenges,December 9-10,2011,Association of Agrometeorologists,BCKV,W.B.
31.	**Barthakur P.K.; Sarma P.K. and Sarma , D**	2011	Effect of biofertlizer and organic mulching on growth and yield of ginger(*Zingiber Officinale*)	Proceedings of the 18th IFOAM Organic World Congress, Gyeoggi Paldang/Republic of Korea 26th

				September to 5 Oct, 2011.
32.	Sarma,P.K.Kumar,S, Grewal,K.S	2011	Soil water retention and transmission characteristics for the soils of Central Brahmaputra Valley zone of Assam	Journal of Soil and Water Conservation (Vol 10) pp. 2013-220.
33.	Neog, P. and Deka, B	2011	Characterization of rainfall and potential evapotranspiration in relation to wetland management at Biswanath Chariali of Assam.	*Proc. National seminar on wetland management for rural development in North East India*: 77-81
34.	P.Das,L.Paswan,H.Choudhury, J.Das and **P.Saikia**	2012	Effect of Inorganic,Organic and Biofertilizer on flower yield and flower quality of tuberose (*polianthestuberose* Linn.)	Crop Research Vol. 43(1,2&3), pp. 116-119
35.	**M. Hazarika,** D.B.Phookan, H.Choudhury **P.Saikia**	2012	Effect of different levels of NPK on yield and quality parameters of watermelon (*Citrullus lanatus* Thunb.)	Crop Research (An International Journal) 44(3):370-374
36.	Goswami, R. K., Choudhury, H., **Sarma, M. K**., Kandali, R., Goswami, J. and **Sarma, D**	2012	Physiological efficiency in greengram (Vigna *radiata* L. Wilczek).	Advances in Plant Sciences, 25 (II): 487-491
37.	P. Das, L. Paswan, H. Choud hury, J. Das and **P. Saikia**	2012	Effect of Inorganic, Organic and Biofertilizer on flower yield and flower quality of tuberose (*polianthestuberose* Linn).	Crop Research Vol. 43(1,2&3), pp. 116-119
38.	**M. Barua and M.K. Sarma**	2013	Occurrence of Blister Beetle,	Paper presented in the National

			Mylabrisspp (Coleoptera; Meloidae) as a serious insect pest of okra and pigeon pea at Biswanath Chariali, Assam.	seminar on "Climate change and climate resilient agriculture", 18-19 March, 2013.
39.	**P.Saikia** and L.C.Dutta	2013	Evaluation of *Ailanthus* species in relation to cocoon and yarn characters oferi silkworm, *samiaricini*boisd	Indian Journal of Applied Zoological Researchers. Vol no.24(2), pp.177
40.	**Nikhita Kakati** and B. Mahanta	2013	Efficacy of *Glomus fasciculatum*, *Trichoderma harzianum*,Neem cake and Carboguran 3G in management of *Meloidogyne incognita* on Cucumber	*Ann. PI. Protec. Sci.* 21(2),pp 405-407
41.	**Nikhita Kakati** and B. Mahanta	2013	Screening of Cucumber Cultivars Against *Meloidogyne incognita*	Indian Journal of Nematology Vol.43, No.1,pp105-106
42.	Goswami, R. K., **Sarma, M.K.,** Choudhury, H., Bhuyan J, Kandali, R., **Neog, P** and Barua, N	2013	Variation in physiological traits in Ahu rice genotypes under upland situation of the North Bank Plain Zone of Assam,	Paper presented in the National seminar on "Climate change and climate resilient agriculture", 18-19 March, 2013.
43.	**M.K. Sarma,** Bhuyan J, Barua Sangeeta and Sharma, A.A	2013	Euclidian cluster analysis of genetic diversity in soybean germplasm.	Paper presented in the National seminar on "Climate change and climate resilient agriculture", 18-19 March, 2013.
44.	**M.K. Sarma, Barua, M, Kurmi, Anita, Neog P, Sarma, D. and Sarma, P.K**	2013	Evaluation of pigeonpea germplasm under rainfed upland situation of Assam	Paper presented in the National seminar on "Climate change and climate resilient agriculture", 18-19 March, 2013.
45.	Choudhury, H., Bhuyan J, Goswami, R. K.,	2013	Physiological indices to screen	Paper presented in the National

	Neog, P., Sarma, M.K., Barua, N. and Sarma, K		soybean genotypes possessing resilience to weather variability	seminar on "Climate change and climate resilient agriculture", 18-19 March, 2013.
46.	Sarmah. Kushal**, Rajbongshi. Rijumani**, **Neog. Prasanta** and Maibangsha. Marcy	2013	Rainfall probability analysis of Lakhimpur, Assam.	*J. of Agrometeorology. 15 (Special Issue-II): 247-250*
47.	**Neog, Prasanta.;** Sarmah, Kushal**.** And **Rajbongshi Rijumani**	2013	Thermal indices in Rapeseed grown in the North Bank Plain Zone of Assam.	*J. of Agrometeorology.* 15**(**2**)**:174-177
48.	**Neog, Prasanta.; Rajbongshi Rijumani** and Sarmah, Kushal	2013	Predictive model for aphid incidence in rapeseed & mustard in relation to crop phenology and weather in the North Bank Plain Zone of Assam	*J. of Agromet.* 15*(Special Issue – I):* 77-80
49.	Bhuyan J, Choudhury, H., **Neog, P., Sarma, M.K.,** Goswami, R. K.and Sarma, K	2013	Identification of soybean genotypes exhibiting resilience to weather variability	Paper presented in the National seminar on "Climate change and climate resilient agriculture", 18-19 March, 2013.
50.	**M.K. Sarma**	2014	Developing Rainfed Agriculture in Assam; Ushering the second green revolution	Souvenir, National seminar on Climate change and climate resilient Agriculture, 18-19 March, 2013, pp.44-48
51.	**Sarma D.; Saikia P.; Sarma P.K.; Hazarika M.; Bhattacharya M.; Sarma M.K.; Neog .P** and Srinivasrao Ch	2014	Effect of seed priming of toria (*Brassica napus* L. Var. Napus L.)onDrought Tolerance and its Yield Performance	*Indian Journal of Dryland Agricultural Research and development* 29(1):35-39.
52.	**Sarma P.K.; Saikia P** and Baruah T.C	2014	A study on the efficiency of low cost vermicomposting structure.	*Proceedings of the 4th ISOFAR Scientific Conference. 'Building*

				Organic Bridges', at Organic World Congress 2014, 13-15 Oct., Istanabul, Turkey (eprint ID 23720).
53.	**Sarma M.K.; Bhattacharyee M.** And Sharma A.K	2014	Crop Genetic Resources of North East India: Current Status and Future Strategies.	*Progressive Agriculture*, **15**(1):28-34
54.	Baruah S.; **Sarma M.K**.; Baishya D.; Sharma A.A.; **Borah R**. And Bhuyan J	2014	Genetic variation for seed yield and Yellow Mosaic Virus Resistance in Soybean (*Glycine max* (L.)Merrill).	International Journal of Scientific and Research Publications, Volume **4**, Issue 9, September, 2014.
55.	Kalita, M. K., **Sarma, P. K**. Das, J. Das, P. , Gautam, B.P. and Baruah, T.C	2014	Disease incidence in Bhut jalakia grown under integrated nutrient management in Assam.	Ann. Pl. Protec.Sci.2014, 22(2):422-460.
56.	**A K Roy, P K Sarma, P Neog, D Sarma,G Moral, M K Sarma**,BP Gautom,DN Hazarika,S Langthasa and RK Goswami	2014	Efficiency of harvested rain water on potato under rainfed condition	Extended summaries Pages 44-46; National Symposium on Dryland Agriculture, Gwalior Aug, 2014
57.	**Sarma M.K.;** Goswami R.K.; Sharma A.K.; **Baruah M.; Sarma D. And Neog P**	2015	Genetic Variability and Diversity In Indigenous Rice Germplasm Of Assam under aerobic condition	*Progressive Agriculture*, **15**(1):71-76
58.	Kumar J.; Phookan D.B.; Lal N.; Kumar H.; Sinha K.; **Hazarika M.;** Dubedi A.K.and Kumar R	2015	Effect of Organic Manure and Biofertilizers on yield and yield attributes characteristic of	*Trends in Biosciences* 8(3): 672-677.

			Cabbage (*Brassica oleracea L. Var. Capitata*) cv. Golden Acre	
59.	Baruah S.; **Sarma M.K.;** Baishya D.; Sharma A.A.; Bhuyan J. And **Borah R**	2015	Genetic variability, Character association and Genetic Divergence in Soybean (*Glycine max* (L.)Merrill) germplasm under rainfed situation of Assam	*Progressive Agriculture,* **15**(1):1-8
60.	**Hazarika M.; Sarma P. K.; Sarma D.; Saikia P.; Neog P.; Rajbongshi R.; Kakati N.; Bhattacharjee M**. And Srinivasarao Ch	2015	Effect of foliar application of potassium on yield, drought tolerance and rain water use efficiency of *toria* under rainfed upland situation of Assam.	*Indian Journal of Dryland Agricultural Research and Development.* 30(1):55-59
61.	**SarmaM.K.; Bhattacharyee M. and** Sharma A.K	2015	Crop Genetic Resources of North East India: Current Status and Future Strategies.	*Progressive Agriculture,* **15**(1):1-8
62.	**Neog, Prasanta;** Dihingia, P.C.; **Sarma, P.K.;** Maruthi Sankar, G.R.; **Sarmah, D.; Sarmah, M.K.; Rajbongshi, R**.; Sarmah, K.; Chary G.R.; Rao, Ch. Srinivasa and Mishra, P.K	2015	Different Levels of Energy Use and Corresponding Output Energy in Paddy Cultivation in North Bank Plain Zone of Assam, India.	Indian Journal of Dryland Agricultural Research & Development
63.	J. Kumar, D. B. Phookan, N. Lal, H. Kumar, K.Sinha, **M. Hazarika**	2015	Effect of Organic Manure and Biofertilizers on nutritional quality of Cabbage (*Brassica oleracea L. Var. Capitata*)	Journal of Eco-Friendly Agriculture 10(2) : 114-119
64.	**Neog, Prasanta.; Sarma, P.K.;** Chary**,** G Ravindra**;** Dutta, S.; **Rajbongshi, R.;** Sarmah, K.; Baruah, S.; **Sarma, D**.; **Sarma, M.K.; Borah, P.;** Rao, Ch Srinivas & Hazarika, G.N	2016	Building climate resilient agriculture through traditional floating rice in flash flood affected areas of the North bank plains zone of Assam. [Manuscript No	Indian Journal of Traditional Knowledge **Accepted for publication**

			TK-7253]	
65.	**R.Rajbongshi,P Neog,P.K. Sarma,**K.Sarma,**M.K.Sarma, D. Sarma,M. Hazarika**	2016	Thermal indices in relation to crop phenology and seed yield of pigeon pea (Cajanus cajan L. Millsp.) grown in the North Bank plain Zone of Assam.	MAUSAM, 60,2:397-404
66.	Pramod Chandra Dihingia,G. V. Prasanna and **Pallab Kumar Sarma**	2016	Development of a Hopper-type Planting Device for a Walk-Behind Hand-Tractor-Powered Vegetable Transplanter	Journal of Biosystems Engineering 41(1) -21-33,2016
67.	**M.Hazarika, P.K.Sarma, P. Borah, H.C. Baruah, B. Deka, G.Moral, D.Sarma, M.Bhattacharya, M.K.Sarma** and Ch. Srinivasrao	2016	Long Term Effect of Integrated Nutrient Management on soil properties and productivity Toria (*Brassica campestris*) in an Inceptisol under Rainfed Upland Condition of North Bank Plain Zone of Assam.	Indian J. Dryland Agric.Res. & Dev. 31(1) : 9-14
68.	**D. Sarma, P. Saikia, M. Bhattacharya, M. Hazarika**, R. K Goswami**, P. K Sarma M. K Sarma and P. Neog**	2016	Effect of intercropping greengram and blackgram with sesame in augmenting the productivity and Rain water use efficiency under rainfed upland condition	Indian J. Dryland Agric.Res. & Dev. 31(1) : 51-55
69.	**Neog. Prasanta**; Sarmah. Kushal**, Rajbongshi, Rijumani** and Kalita, M.K		Development of weather based forewarning models for Downy mildew and *Alternaria* blight diseases of Rapeseed (*Brassica campestris)* in North Bank Plain Zone of Assam	[Manuscript No J-065(5603)] **Accepted for publication in *Mausam*.**

16.2. Abstracts:

Sl.No.	Name	Year	Article	Published in
1.	R K Goswami., H Choudhury., **M K Sarma.**, R Kandali., **D Sarma** and J Bhuyan	2010	Evaluation of greengram genotypes for morpho- physiological traits and seed yield	National Conference of Plant Physiological and Molecular Approaches for Crop Improvement under changing environment. Held at BHU, Varanasi dated November 25-27, 2010 Abst.Volume page 52.
2.	**Baruah Mayuri** andAhmed,Benazir	2010	Laboratory bioassay of Beauveria bassiana(Bals)Vuill.against Tea Mosquito bug Helopeltis thelvora Waterhouse (Hemiptera; Miridae).	National Symposium on Emarging trends in Agricultural Research Organized by Hi-Tech Horticultural Society,Meerut-250110,11-12 September,2010
3.	**P.Saikia** and D.P.Khanikor	2010	Cocoon and Yarn Parameters of Eri Silkworm reared on certain host plants	Assam Science Society, 55th Annual Technical Session org by GU during 15th February, 2010, pp.16.
4.	**P.Saikia.**,P.Hazarika.,**M.K.Sarma.**,H.Choudhury and S.Bora	2010	The Phenomenon of Gregarious Flowering of Bamboo	National Symposium on Emerging Trends in Agriculture Research org by Hi-Tech Horticultural Society

				at Meerut during 11-12 September'2010,pp.125
5.	P.Das., L.Paswan., H.Choudhury., J.Das and **P.Saikia**	2010	Effect of Organic and Biofertilizer on Performance of tuberose (*polianthestuberose* Linn)"	National Symposium on Emerging Trends in Agriculture Research org by Hi-Tech Horticultural Society at Meerut during 11-12 September'2010, pp.125.
6.	P.Hazarika.,**P.Saikia.**,**M.K.Sarma.**,H.Choudhury and S.Bora	2010	Genetic Diversity of Bamboo in North East India.	National Symposium on Emerging Trends in Agriculture Research org by Hi-Tech Horticultural Society at Meerut during 11-12 September'2010.pp.168.
7.	**Rajbongshi, R.**, **Neog, P.** and Kalita, M.K.	2010	Effect of Weather Variables on the Incidence of Alternaria blight and downy mildew diseases of rapeseed and Mustard in the North Bank Plain zone of Assam.	National Seminar on Climate Change and Sustainable Development with reference to India Organized by Department of Environmental Science, Tezpur University on 1-3 April 2010.

8.	**Neog, Prasanta.**, **Rajbongshi, Riju.**, Hazarika, Bhaskar., Neog, Ratul and **Deka, Bipul**	2010	Thermal Time in Relation to Phenological Development of Rapeseed-Mustard and Development of Forewarening Model of Mustard Aphid (*Lipaphis erysimi*) based on weather variables on real time basis.	National Seminar on Climate Change and Sustainable Development with reference to India Organized by Department of Environmental Science, Tezpur University on 1-3 April 2010.
9.	**D Sarma., P Saikia.**, R K Goswami and **M Bhattacharya**	2011	Seed Priming of toria (Brassica *napus L. Var. Napus l.) for drought hardiness*	National Seminar on "Bio chemical and Biotechnological Research Approaches for Bio-resource Management of North East India Towards Sustainable Rural development" org by Deptt. Of Biochemisty and Agril Chemistry at BNCA during 11-12 November,2011,pp.35
10.	**D Sarma., P Saikia and M Bhattacharya**	2011	Comparative study of rice (Oryza sativa) based cropping systems under rainfed upland situation of Assam	National Seminar on " Agro meteorological Research and Services to Combat Climate Change Challenges" held at BCKV on 9-10 December,2011
11.	**D Sarma., P Saikia.,** R K Goswami and **M Bhattacharya**	2011	Rice (*Oryza sativa*) based cropping sequences and their rain water use	National Seminar on "Bio chemical and Biotechnological Research Approaches for Bio-

			efficiency	resource Management of North East India Towards Sustainable Rural development" org by Deptt. Of Biochemisty and Agril Chemistry at BNCA during 11-12 November, 2011, pp.36.
12.	**D Sarma., P Saikia and M Bhattacharya**	2011	Effect of seed priming on growth and yield of toria	National Seminar on " Agro meteorological Research and Services to Combat Climate Change Challenges" held at BCKV on 9-10 December,2011
13.	**M.K.Sarma.**, S.Bora., **P.Saikia.**,P.Mahanta and H.Choudhury	2011	Bamboo:A potential bio-resource of N.E.for livelihood security and environmental sustainability of N.E.India	National Seminar on "Bio chemical and Biotechnological Research Approaches for Bio-resource Management of North East India Towards Sustainable Rural development" org by Deptt. Of Biochemisty and Agril Chemistry at BNCA during 11-12 November,2011,pp.20
14.	**Neog. P**., Kalita. M.K., **Rajbongshi. R**., **Baruah. M**., Sarmah. K.**,** and Neog, R.C	2011	Effect of weather variable in the incidence of Downy mildew of Rapeseed and mustard.	National Seminar on "Biochemical and Biotechnological Research Approach for Bio-researce

				Management of North East India towards Sustainable Rural Development" at B.N. College of Agriculture, AAU Biswanath Chariali during 11-12 November, 2011. Pp 30
15.	**M.K.Sarma.**, S.Bora., **P.Saikia**, P.Mahanta and H.Choudhury	2011	Studies on the relative efficiency of different crop species for developing a suitable Bamboo based cropping system	IUFRO Symposium on short rotation forestry org by PAU, Ludhiana during 10-12, February 2011.pp.56.
16.	**Rajbongshi R.**, Kalita M.K., **Neog P., Baruah M.** and Sarmah K.	2011	Effect of Weather Variable in the Incidence of Alternaria Blight of Rapeseed and Mustard.	National Seminar on "Agrometeorological Research and Services to Combat Climate Change Challenges" at BCKV, Kalyani, West Bengal during 9-10 December 2011. Pp 94.
17.	**Neog P., Baruah, M. and Rajbongshi Rijumani**	2011	Effect of time of sowing on population incidence of Mustard Aphid, *Lipaphis Erysimi* Kalt in Rapeseed and Mustard.	National Seminar on "Agrometeorological Research and Services to Combat Climate Change Challenges" at BCKV, Kalyani, West Bengal during 9-10 December 2011. Pp 97-98.

18.	**Baruah Mayuri., Neog P.K.** and **Rajbongshi Rijumani**:	2011	Studies on Impact of Climate Change on Growth, Yield and Biotic Stress of Tea.	National Seminar on "Agrometeorological Research and Services to Combat Climate Change Challenges" at BCKV, Kalyani, West Bengal during 9-10 December 2011. Pp54
19.	**Neog P., Baruah M., Rajbongshi Rijumani.,** Pujari D. and Deka, S.N	2011	Thermal incidence in Rapeseed Grown in the North Bank Plain Zone of Assam.	The abstract book of Kalyani, West Bengal during 9-10 December 2011. Pp 13.-134.in Sonitpur district of Assam. 54.
20.	**Neog P., Rajbongshi Rijumani**., Sarmah, Kushal. and Kalita M.K.	2012	Development of forewarning models for Downy mildew and Alternaria blight diseases of Rapeseed (Brassica compestries) using weather variables.	The abstract book of UGC sponsored National seminar held at Biswanath college,Sonitpur during 10-11 August,2012 pp1.
21.	R K Goswami.,H Choudhury., **M K Sarma.**, R Kandali., J Goswami and **D Sarma**	2013	Physiological Efficiency in greengram genotypes	National Seminar on climate change and climate resilient agriculture,18-19 Mar,2013,BNCA
22.	**Neog, Prasanta., Sarma, P.K., Sarma, M.K.,** Maruthi Sankar, G.R., **Rajbongshi, Rijumani** and Sarmah, Kushal.	2013	Changes in rainfall and other weather parameters at Biswanath Chariali, Tezpur and Lakhimpur districts in Assam.	The abstract book of National Seminar on "Climate Change and Climate Resilient Agriculture:" held at B.N. College of Agriculture,

				Biswanath Chariali, Assam during 18-19 March, 2013. Pp 43.
23.	**Rajbongshi, Rijumani**., **Neog, Prasanta.,** Sarmah, Kushal and **Gogoi, Utpal**.	2013	Influence of weather parameters on seed yield of Rapeseed & Mustard in the North Bank Plain Zone of Assam.	The abstract book of National Seminar on "Climate Change and Climate Resilient Agriculture:" held at B.N. College of Agriculture, Biswanath Chariali, Assam during 18-19 March, 2013. Pp 53.
24.	Sarmah, Kushal.**; Neog. Prasanta**., **Rajbongshi, R.** And Sarma, A.	2013	Verification and usability of medium range weather forecast for North Bank Plain Zone of Assam.	The abstract book of National Symposium on "Climate Change and Indian Agriculture: Slicing down the Uncertainties" held at CRIDA, Hyderabad during 22-23 January, 2013. Pp 180
25.	**P Saikia and D Sarma**	2013	Intercropping studies in sesame with greengram and blackgram	National Seminar on climate change and climate resilient agriculture,18-19 Mar,2013,BNCA,Page127
26.	**D Sarma, P saikia**	2013	Effect of seed primimg on growth and yield of Toria (*Brassica Napus*L.) var. Napus L.	National Seminar on climate change and climate resilient agriculture,18-19 Mar,2013,BNCA,Page126

27.	**D.Sarma,P.Saikia and P.K.Sarmah**	2013	Comparative study of Rice (*OryzaSativa)* based cropping sequences	National Seminar on Climate change and Climate Resilient Agriculture org by Agromet Advisory Services at BNCA during 18-19 March, 2013, pp121.
28.	**D.Sarma and P.Saikia**	2013	Effect of seed primimg on growth and yield of Toria (*Brassica Napus*L.) var. Napus L.	National Seminar on Climate change and Climate Resilient Agriculture org by Agromet Advisory Services at BNCA during 18-19 March, 2013, pp.126.
29.	**P.K.Sarma, P.Saikia** and T.C.Baruah	2013	A study on efficiency of low cost vermicomposting structure	National Seminar on Climate change and Climate Resilient Agriculture org by Agromet Advisory Services at BNCA during 18-19 March, 2013, pp134.
30.	**P.Saikia and D.Sarma**	2013	Intercropping studies in sesame with greengram and blackgram	National Seminar on Climate change and Climate Resilient Agriculture org by Agromet Advisory Services at BNCA during 18-19 March, 2013, pp127.

31.	**Nikhita Kakati** and B. Mahanta	2013	Effect of different bioagents, Neem cake and carbouran 3G on multiplication of *Meloidogyne incognita* infecting Cucumber	National Seminar on Climate Change and Climate Resilient Agriculture, 18-19 March, 2013
32.	**Mainu hazarika, P.K Sarma & G. Moral**	2013	Effect of foliar application of potassium on drought tolerance and nutrient use efficiency in *toria*,	National Seminar on "Climate change and climate resilient agriculture", at BN College of Agriculture, Sonitpur, Assam, 18-19 March 2013.
33.	**P.K Sarma, Mainu Hazarika & G. Moral**	2013	Permanent 105roducti trial for *rice toria* system under rainfed situation in North Bank Plain Zone of Assam	National Seminar on "Climate change and climate resilient agriculture", at BN College of Agriculture, Sonitpur, Assam, 18-19 March 2013.
34.	**Mainu Hazarika**, **P.K.Sarma,** D.N.Hazarika, T.C.Baruah, M.K.Kalita and K.C.Deka	2013	Integrated nutrient management in Banana cv. Honda	National Seminar on "Climate change and climate resilient agriculture", at BN College of Agriculture, Sonitpur, Assam, 18-19 March 2013.
35.	**M K Sarma, M Barua, Anita Kurmi, P Neog,D Sarma and PK sarma**	2013	Evaluation of Pigeonpea genotype under rainfed upland situation of assam	National Seminar on climate change and climate resilient agriculture,18-19 Mar,2013,BNCA,Page131
36.	**Mainu Hazarika** & D.B. Phookan	2013	Effect of different levels of NPK on growth, yield and quality of	National Seminar on "Climate change and climate resilient agriculture", at BN College of

			watermelon var. Sugar Baby	Agriculture, Sonitpur, Assam, 18-19 March 2013
37.	**D Sarma, P saikia and P K sarma**	2013	Comparative study of rice- based cropping sequences	National Seminar on climate change and climate resilient agriculture,18-19 Mar,2013,BNCA,Page121
38.	Sarmah, Kushal.; **Rajbongshi. Rijumani. Neog. Prasanta.** And Maibangsha. Marcy.	2013	Rainfall probability analysis of Lakhimpur, Assam.	National Symposium on "Climate Change and Indian Agriculture: Slicing down the Uncertainties" at CRIDA, Hyderabad during 22-23 January, 2013. Pp 26
39.	**Neog, Prasanta., Rajbongshi, Rijumani.** And Sarmah, Kushal.	2013	Predictive model for aphid incidence in rapeseed & mustard in relation to crop phenology and weather in the North Bank Plain Zone of Assam	National Symposium on "Climate Change and Indian Agriculture: Slicing down the Uncertainties" held at CRIDA, Hyderabad during 22-23 January, 2013. Pp 239
40.	**Neog, P.,** Sarmah, Kushal, Bhuyan, J., Choudhury, H., Goswami, R.K., **Rajbongshi, R. And Gogoi, U.:**	2013	Growth and Yield Response of Soybean in Relation to thermal time requirement in North Bank Plain Zone of Assam.	National Seminar on "Climate Change and Climate Resilient Agriculture:" held at B.N. College of Agriculture, Biswanath Chariali, Assam during 18-19 March, 2013. Pp 43-44.

41.	Sarmah, Kushal., **Neog, P., Rajbongshi, R.**, Maibangsa, M., Sarma, A., Deka, N. And **Gogoi, U.**	2013	Verification of Rainfall Forecast for Lakhimpur of North Bank Plain Zone of Assam.	National Seminar on "Climate Change and Climate Resilient Agriculture:" held at B.N. College of Agriculture, Biswanath Chariali, Assam during 18-19 March, 2013. Pp 57-58.
42.	**Neog P.; Sarma, P.K.; Sarma, D.; Sarma, M.K.; Rajbongshi, R.;** Sarmah K.; **Borah, P**. and Chaudhury, H.	2014	Growth, Yield and Disease Dynamics of Ginger as Influenced by Varying Microenvironments	*International Symposium on New-Dimensions in Agrometeorology for Sustainable Agriculture (NASA-2014)*, 16-18 October 2014 at GBPUAT, Pantnagar. pp 110-111.
43.	**Rajbongshi R.; Neog P.; Sarma P.K.;** Sarma K.; **Sarma M.K.; Sarma D. And Hazarika M.**	2014	Thermal Indicies in Relation to Crop Phenology and Seed Yield of Pigeonpea grown in the North Bank Plain Zone of Assam	International Symposium on "New Dimensions in Agrometeorology for Sustainable Agriculture" is being organized jointly by G.B. Pant University of Agriculture and Technology, Pantnagar and Association of Agrometeorologists, Anand during 16-18 October, 2014,pp379.

44.	**Roy A.K.; Sarma P.K.,;Neog P.; Sarma D.; Moral G.; Sarma M.K.;** Gautam B.P.; Hazarika D. N.; Langthasa S. And Goswami R.K.	2014	Efficiency of harvested rainwater on potato under rainfed condition	National Symposium on Dryland Farming and Food Security in India, Gwalior, Madhya Pradesh, India, 30-31 August, 2014 Organized by Rajmata Vijayaraje Scindhia Krishi Viswa Vidyalaya, Gwalior, and sponsored by Indian Agricultural Universities Association, New Delhi.
45.	**Roy A.K.; Sarma P.K.; Neog P.; Sarma D.; Sarma M. K.; Moral G and Bora P**	2015	Studies on effectiveness of different lining materials on rainwater storage in farm pond.	Conference Book & Souvenir of International Conference on Technological Interventions in Agricultural Sciences for Enhanced Productivity, Nutritional Quality and Value Addition (TIAS-2014) at Central Institute of Horticulture, Medziphema, Dimapur, Nagaland-797106 India on February, 17-19, 2015pp 09
46.	**Sarma P.K.; Hazarika M.;Borah P.;** Baruah S.; **Sarma D.; Sarma M.K.; Bhattacherjee M.**	2015	Long -term manorial trial for Rice-Greengram-Toria system under	International Conference on "Technological Interventions

			rainfed situation of North Bank Plain Zone of Assam,	in Agricultural Sciences for Enhanced Productivity, Nutritional Quality and Value Addition", at Central Institute of Horticulture, Department of Agriculture and Co-operation, Dimapur, Nagaland, 17-19 February, 2015,pp 07
47.	**Sarma P.K.; Hazarika M.; Borah P.; Sarma D.; Sarma M.K. and Neog P.**	2015	Effect of foliar application of different plant nutrients on drought tolerance and yield of Toria var. TS-36	International Conference on "Technological Interventions in Agricultural Sciences for Enhanced Productivity, Nutritional Quality and Value Addition", at Central Institute of Horticulture, Department of Agriculture and Co-operation, Dimapur, Nagaland, 17-19 February, 2015,pp 41

48.	**Neog P.; Rajbongshi R.; Sarma, P.K.; Sarma M.K.** and Sarmah K.	2015	Comparision of the yield of potato under different microenvironment in the North Bank Plain Zone of Assam	Conference book and Souvenir of International Conference on Tecnological Interventions in Agricultural Sciences for Enhanced Productivity, Nutritional Quality and Value Addition(TIAS-2014).17-19, 2015. At Central Institute of Horticulture, Department of Agriculture and Co-Operation, Ministry of agriculture, Govt. Of India, Medziphema, Dhimapur, Nagaland-797106, india.pp. Theme-1.8-9.
49.	**R. Borah, M. K. Sarma, A.K.Roy**, S. Baruah, A.A.Sarma, **D.Sarma and P.K.Sarma**	2015	Studies on genetic parameters of variation and character association in sesame (Sesamum indicum L).	Conference Book & Souvenir of International Conference on Technological Interventions in Agricultural Sciences for Enhanced Productivity, Nutritional Quality and Value Addition (TIAS-2014) at Central Institute of Horticulture, Medziphema, Dimapur, Nagaland-797106 India on February, 17-19, 2015

50.	**Borah R.; Sarma M.K**.; Baruah S.; Sarma A.A.; **Sarma D.and Sarma P.K.**	2015	Improvement of niger (Guizotia abyssinica L.) population through recurrent selection.	International Conference on Technological Interventions in Agricultural Sciences for Enhanced Productivity, Nutritional Quality and Value addition (TIAS-2014), February-17-19, 2015.
51.	**Sarma M.K**.; Sarma A.A.; **Borah R.; Sarma A.K** and Baruah S	2015	Breeding major food crops of North East India: Current status and Future Strategies	International Conference on Technological Interventions in Agricultural Sciences for Enhanced Productivity, Nutritional Quality and Value addition (TIAS-2014), February-17-19, 2015.
52.	**Saikia P and Sarma M.K**	2015	Study on Crop diversification through intercropping of Bamboo and other component crops	International conference on technologies intervention in Agriculture science for enhancing productivity, nutritional quality and value addition. Org by central Institute of Horticulture, Nagaland during 17-19 Feb, 2015.

53.	**Borah R.; Sarma M. K.; Roy A.K.;** Baruah S.; Sarma A.A.,;**Sarma D. And Sarma P.K.**	2015	Studies on genetic parameters of variation and character association in sesame (Sesamum indicum L)	International Conference on Technological Interventions in Agricultural Sciences for Enhance Productivity, Nutritional Quality and Value Addition (TIAS-2014) at Central Institute of Horticulture, Medziphema, Dimapur, Nagaland-797106 India on February, 17-19, 2015.
54.	**P.Saikia**,**M.K.Sarma** and A.A.Sharma	2015	Study on crop diversification through intercropping of bamboo and other component crops	International conference on Technologies Interventions in Agricultural Sciences for enhanced productivity, nutritional quality and value addition org by Central Institute of Horticulture at Dimapur, Nagaland during 17-19 February, 2015

16.3 Popular articles:

Sl No.	Name of the article	Authors	Magazine / Newspaper/ Souvenir
1.	Shasshyar utpadan susam sarar abayashakata	**Basumatary, A**	Payobhara (Yojana-Assamese).Nov,2009.
2.	Ahu Dhanor Khetit Saar Panir Jaton	**Dr. Bipul Deka**	Ajir Dainik Batori -10.05.2010
3.	Asomar Matir Bhin- bhin Prakar	**Dr. Bipul Deka**	Ajir Dainik Batori-03.07.2010
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16.4.1. Practical manual:

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1.	Practical Manual on Environmental Science (Course No. BAC 322)	Prepared by: Dr. R. Kandali, Dr. R. K. Goswami, Dr. P. K. Sarmah, BN College of Agriculture, B. Chariali & Dr. T. C. Barua, Professor & Head, Dept. of BAC, College of Agriculture, Jorhat, Department of Biochemistry & Agril Chemistry & Agril Chemistry, BN College College of Agriculture, Assam Agricultural University – 2014
2.	Practical Manual of Introduction to Soil Science (Course No. Soil 113)	Prepared by: Dr. P. K. Sarma,Mrs.P.Borah,Miss

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3.	A Handbook cum Practical Manual on Elementary Genetics [ForB.Sc.(Agriculture) and other students of Genetics of the Indian Universities]	Prepared by: Dr. M. K. Sarma, Dr.J.Bhuyan and Dr.B.N.Medhi, Department of Plant Breeding and Genetics,BN College of Agriculture, Assam Agricultural University – 2016

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2.	Soils of NICRA Villages: Survey and Land use planning [AAU/DR/15(BL)/08/2015-16]	Prepared by: S. Dutta, P.K. Sarma, P.Neog ,R.M. Karmakar, S.Baruah, P.Borah and Published by- All India Coordinated Research Project for Dryland Agriculture ,Biswanath Chariali(MC),Sonitpur Assam-784176,in Collaboration with Department of Soil Science,Assam Agricultural University,Jorhat-13

3.	Soils of Biswanath College of Agriculture farm: Survey and Land use planning [AAU/DR/15(BU)/99/2015-16]	Prepared by:S. Dutta, P.K. Sarma, T.C. Baruah, P.Neog ,R.M. Karmakar,P.Borah,Sbaruah and Published by- All India Coordinated Research Project for Dryland Agriculture ,Biswanath Chariali(MC),Sonitpur Assam-784176,in Collaboration with Department of Soil Science,Assam Agricultural University,Jorhat-13
4.	Resilient Agriculture for Flash Flood Affected Areas of North Bank Plains Zone of Assam [AAU/DR/15(BU)87/2015-16]	Prepared by: P.Neog, P.K. Sarma, S. Dutta, U.Gogoi, R.Rajbongshi, K. Sarma, S.Baruah, P.Borah ,D.Sarma, M.K.Sarma,G.Ravindra Chary,Ch.Srinivasa Rao and G.N. Hazarika and Published by- The Chief Scientist, All India Coordinated Research Project for Dryland Agriculture ,Biswanath Chariali Center, B.N. College of Agriculture, Assam Agricultural University, Biswanath Chariali - 784176

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2.	NICRA Upscaling Programme,AICRPDA,NICRA,Nalbari,2014-15	Implimented by: KVK,Nalbari in collaboration with BN College of Agriculture AAU
3.	Bulletins of weather abased agro-advisories are regularly issued twice in a week and published news paper, web sites etc, 1 July, 2010 to 30 June, 2013,330 nos.	P.Neog
4.	Management of tea under extreme weather events, 2013	P.Neog
5.	Training leaflet on Vermicomposting (In Assamese) (LF/AAU/NT/01/2014/006)	Harindra Gogoi,Yater Das,Rijusmita Sarma Deka
6.	Training leaflet on 126ontrol of Ufra disease of paddy (In Assamese) (LF/AAU/NT/01/2014/005)	Gunjan Gogoi,Sapan kr. Sarma,Rijusmita Sarma Deka
7.	Training leaflet on rearing of *Bonraja* (In Assamese) (LF/AAU/NT/01/2014/004)	Ashim kr. Saikia,Rijusmita Sarma Deka
8.	Cultivation practices of Bamboo	S. Bora, **M K Sarmah,** P. Mahanta and H.Choudhury
9.	Rearing of Improved Duck Breed- Khaki- Campbell [AAU/KVK/DMJ/OP/12/15/029(A)]	Dr. Ashim Kr. Saikia and Gunjan Gogoi
10.	Cultivation practices of Annual fodder crops [AAU/KVK/DMJ/OP/12/15/029(B)]	Dr. Ashim Kr. Saikia, Swapan Kr. Sarma and Gunjan Gogoi
11.	Integrated Pest Management [AAU/KVK/DMJ/OP/12/15/029I]	Gunjan Gogoi, Swapan Kr. Sarma and Bibha Ozah
12.	Diseases of Betelvine cultivation in *Khuti* system and its management	Gunjan Gogoi, Swapan Kr. Sarma and Binita Konwar

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13.	Biofertilizers and their methods of application [AAU/KVK/DMJ/OP/12/15/029(E)]	Bibha Ozah, Swapan Kr. Sarma and Gunjan Gogoi
14.	Some important crops of Dhemaji District and their fertilizer management [AAU/KVK/DMJ/OP/12/15/029(F)]	Bibha Ozah, Monuranjan Gogoi, Binita Konwar and Gunjan Gogoi
15.	Nursery management practices for Vegetables [AAU/KVK/DMJ/OP/12/15/029(G)]	Binita Konwar, Swapan Kr. Sarma, Monuranjan Gogoi and Gunjan Gogoi
16.	Scientific cultivation of Banana [AAU/KVK/DMJ/OP/12/15/029(H)]	Binita Konwar, Swapan Kr. Sarma and Gunjan Gogoi
17.	Anemia and its Prevention [AAU/KVK/DMJ/OP/12/15/029(I)]	Monuranjan Gogoi, Dr. Ashim Kr. Saikia, Bibha Ozah and Gunjan Gogoi
18.	Balance diet in human nutrition [AAU/KVK/DMJ/OP/12/15/029(J)]	Monuranjan Gogoi, Bibha Ozah, Dr. Ashim Kr. Saikia and Gunjan Gogoi
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25.	Unnat paddhatire salidhanar kheti	**D.Sarma**
26.	"Center at a glance": AICRPDA, Jorhat Center	Published by Chief Scientist,AICRPDA,BNCA,2012-13
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29.		
30.	Agromet Advisory bulletins (biweekly 104 numbers published in three websites, 10 numbers of bulletins published in News paper	**P.Neog**
31.	TSP NICRA news letter of KVK, Dhemaji under AAU ,Issue-I,Vol.I	Rijusmita Sarma Deka (Chief Editor); Dr.Ashim Kr.Saikia and Dr. Digambar Sharma(Co-Editor); Mr.Horindra Gogoi,Ms.Yater Das and Mr.Swapan Kr. Sharma(Member)
32.	TSP NICRA news letter of KVK, Dhemaji under AAU,with financial assistance from CRIDA,ICAR,Hyderabad,Vol.II	Programme Coordinator,KVK,Dhemaji (Chief Editor); Dr.P.K.Sarma,Chief Scientist,AICRPDA,BNCA,Dr.R.K.Saud,ADEE(P&I),AAU, Mr.M.Gogoi andMs.B.Konwar (Co-Editor); Dr.Ashim Kr.Saikia,Mrs.B.Ozah and Mr.S.K.Sarma (Member)
33.	Indigenous Technical Knowledge AAU/DR/14(BU)/73/2014-15-1	Edited by A.K.Roy and P.K.Sarma, Published by AICRPDA Biswanath Chariali Centre, B N College of Agriculture, AAU B. Chariali, Sonitpur, Assam

34.	Souvenir of All India Coordinated Research Project for Dryland Agriculture ,CRIDA,Hyderabad,XV Working Group Meeting(24th-27th December,2015.Biswanath Chariali Center,AAU	Editedby:M.K.Sarma,P.K.Sarma,D.Sarma,P.Neog,P.Borah, P.Chhetri,R.Borah and R.Rajbongshi and Published by- All India Coordinated Research Project for Dryland Agriculture ,Biswanath Chariali Center,Sonitpur ,Assam-784176

6.4.4 Training Mannual:

Sl No.	Name	Authors
1.	Contingency Crop Planning and Livestock.Rearing (Training Manual)	Published by- Krishi Vigyan Kendra,Dhemaji,in collaboration with All India Coordinated Research Project for Dryland Agriculture-BNCA,Biswanath Chariali, Assam Agricultural University,2014
2.	Integrated Farming System	Editedby:**D.Sarma,P.K.Sarma,M.K.Sarma,P.Neog,G.Moral,M.Boruah,P.Saikia, M.Hazarika, R.Rajbongshi, N.Kakoti, M.Bhattacharjee, P.Chhetri,U.Gogoi,A.K.Roy and P.Boruah** and Published by- All India Coordinated Research Project for Dryland Agriculture ,Biswanath Chariali(MC),Sonitpur Assam-784176 during 2011-2012.pp 1-5.
3.	A training manual on database Management	**M.K.Sarma**
4.	Assessment of Soil quality in soils of Assam	**Borah,D.K.,Basumatary,A,Barua,N.G., Nath ,D,J**

16.4.5 Technical Bulletin:

Sl No.	Name	Authors
1.	A Technical bulletin on Mushroom cultivation, Biotech Hub, BNCA, AAU.	**M.K. Sarma *et.al*.2014.**
2.	Technical Bulletin on Integrated pest management of citrus(In Assamese)	Gunjan Gogoi,Rijusmita Sarma Deka
3.	Kam Khorosot Kesu Xar Utpadon (In Assamese) (Bulletin No.T.B. 1/AICRPDA/BNCA/2014-15)	**P. K. Sarma,P. Saikia,Padum Chhetri,**T. C. Baruah
4.	Low cost vermicompost production (In English) AAU/DR/14(BU)/74/2014-15	**P.K.Sarma,P. Saikia**,T. C.Barua,**Padum Chhetri**
5.	"Development, standardization and dissiminition of technologies for increasing production and productivity of Bamboo based cropping system", Bamboo Project, BNCA, AAU. 2013.	**Sarma, M.K.2013**

16.4.6 Book Chapters:

Sl No.	Name of the Book Chapter	Name of the Book	Published by & Year of publication	Author
1.	Improved Agronomic Practices for Rained Crops in North Bank Plain Zone of Assam	Improved Agronomic Practices for Rainfed Crops in India. (pp.46-58)	AICRPDA, ICAR-Central Research Institute for Dryland Agriculture, Hyderabad. Year-2016	**D.Sarma,P.K.Sarma, M.K.Sarma,** **P.Neog,P.Saikia,M.Hazarika**

2.	Developments in Biotechnology: looking ahead the challenges and opportunities for 21st century,	In. Accelerating Science (Ed.) by D. Das and Surajit Choudhury,	Published by Publication Department,Sikshak Karmachari Sabha, Jamuguri HS, Jamuguri pp.313-321, 2014.	**M.K. Sarma** and Sangeeta Baruah.
3.	Climate change and sustainability of Biodiversity.	In. Climate Change effect on crop productivity (Ed.), RS Senger and Kalpana Senger,	Published by CRC Press, Taylor and Francis Group, UK, pp. 385-396,2014	**M.K. Sarma** and Sangeeta Baruah
4.	Botoror vinnota onujaiei Asomor Dhankheti	Botor, Jalabayu Aru Jalabayu Paribartan":An Assamese book on weather, climate and climate change; edited by Dr. Prasanta Neog and Mr. Utpal Gogoi, assisted by Kushal Sarmah and Rijumani Rajbongshi, BN College of Agriculture	Published by the Agromet Advisory Services, Sonitpur, Biswanath College of Agriculture (AAU), Chariali – 784176, Assam during March, 2013 (pp 97-101)	**M.K. Sarma** and R.Das
5.	Bola ami Nikra Gaonoloi jau	Botor, Jalabayu Aru Jalabayu Paribartan":An	published by the Agromet Advisory Services, Sonitpur, Biswanath College of Agriculture (AAU), Chariali –	**P. Neog**

		Assamese book on weather, climate and climate change; edited by Dr. Prasanta Neog and Mr. Utpal Gogoi, assisted by Kushal Sarmah and Rijumani Rajbongshi, BN College of Agriculture	784176, Assam during March, 2013 (pp 102-128)	
6.	Basic concept of Soil Science	In. Accelerating Science (Ed.) by D. Das and Surajit Choudhury,	Published by Publication Department, Sikshak Karmachari Sabha, Jamuguri HS, Jamuguri, 2014.	**P.K.Sarma, B. Deka and H.C.Boruah**
7.	Indigenous Technical Knowledge in Organic Agriculture	Indigenous Technical Knowledge	Published by All India Coordinated Research Project for Dryland Agriculture, Biswanath Chariali Center,2014-15	**Amiyo Kumar Roy**
8.	Jolobayu poribartan aru year karoksamuh	Botor, Jalabayu Aru Jalabayu Paribartan":An Assamese book on weather, climate and climate change; edited	Published by the Agromet Advisory Services, Sonitpur, Biswanath College of Agriculture (AAU), Chariali – 784176, Assam during March, 2013 (pp 34-40)	**Deka Bipul, Gogoi Utpal and Rajbongshi Rijumani**

		by Dr. Prasanta Neog and Mr. Utpal Gogoi, assisted by Kushal Sarmah and Rijumani Rajbongshi, BN College of Agriculture		
9.	Jonobiswasot botoror purbanuman.	"Botor, Jalabayu Aru Jalabayu Paribartan":An Assamese book on weather, climate and climate change; edited by Dr. Prasanta Neog and Mr. Utpal Gogoi, assisted by Kushal Sarmah and Rijumani Rajbongshi, BN College of Agriculture	Published by the Agromet Advisory Services, Sonitpur, Biswanath College of Agriculture (AAU), Chariali – 784176, Assam during March, 2013 (pp 75–79)	**Rajbongshi Rijumani** and Sarmah Kushal
10.	Botor aru Jolobaiu : Upadan totha Boisisto	"Botor, Jalabayu Aru Jalabayu Paribartan":An Assamese book on weather, climate and climate change; edited by Dr. Prasanta Neog and Mr. Utpal Gogoi,	Published by the Agromet Advisory Services, Sonitpur, Biswanath College of Agriculture (AAU), Chariali – 784176, Assam during March, 2013 (pp 1-9)	**P. Neog** and Kusal Sarmah

		assisted by Kushal Sarmah and Rijumani Rajbongshi, BN College of Agriculture		
11.	Asomor Borosun	"Botor, Jalabayu Aru Jalabayu Paribartan":An Assamese book on weather, climate and climate change; edited by Dr. Prasanta Neog and Mr. Utpal Gogoi, assisted by Kushal Sarmah and Rijumani Rajbongshi, BN College of Agriculture	Published by the Agromet Advisory Services, Sonitpur, Biswanath College of Agriculture (AAU), Chariali – 784176, Assam during March, 2013 (pp 10-16)	**P. Neog**
12.	Khorang aru Asomot shristi hua ovutopurbo khorang shodrish poristiti	"Botor, Jalabayu Aru Jalabayu Paribartan":An Assamese book on weather, climate and climate change; edited by Dr. Prasanta Neog and Mr. Utpal Gogoi, assisted by Kushal Sarmah and Rijumani	Published by the Agromet Advisory Services, Sonitpur, Biswanath College of Agriculture (AAU), Chariali – 784176, Assam during March, 2013 (pp 17-25)	**P. Neog** and Nikhilesh Boruah

		Rajbongshi, BN College of Agriculture		
13.	Asomor Banpani	"Botor, Jalabayu Aru Jalabayu Paribartan":An Assamese book on weather, climate and climate change; edited by Dr. Prasanta Neog and Mr. Utpal Gogoi, assisted by Kushal Sarmah and Rijumani Rajbongshi, BN College of Agriculture	published by the Agromet Advisory Services, Sonitpur, Biswanath College of Agriculture (AAU), Chariali – 784176, Assam during March, 2013 (pp 26-33)	**Utpal Gogoi and P. Neog**
14.	Seuj griho gas-Nitrous Oxide	Botor, Jalabayu Aru Jalabayu Paribartan":An Assamese book on weather, climate and climate change; edited by Dr. Prasanta Neog and Mr. Utpal Gogoi, assisted by Kushal Sarmah and Rijumani Rajbongshi, BN College of	Published by the Agromet Advisory Services, Sonitpur, Biswanath College of Agriculture (AAU), Chariali – 784176, Assam during March, 2013 (pp 41-49)	**P. Neog**

		Agriculture		
15.	botoror purbanuman aru gramin krishi mousom sewa	Botor, Jalabayu Aru Jalabayu Paribartan":An Assamese book on weather, climate and climate change; edited by Dr. Prasanta Neog and Mr. Utpal Gogoi, assisted by Kushal Sarmah and Rijumani Rajbongshi, BN College of Agriculture	Published by the Agromet Advisory Services, Sonitpur, Biswanath College of Agriculture (AAU), Chariali – 784176, Assam during March, 2013 (pp 57-65)	**P. Neog**
16.	Seuj griho gas-Ozon	Botor, Jalabayu Aru Jalabayu Paribartan":An Assamese book on weather, climate and climate change; edited by Dr. Prasanta Neog and Mr. Utpal Gogoi, assisted by Kushal Sarmah and Rijumani Rajbongshi, BN College of Agriculture	Published by the Agromet Advisory Services, Sonitpur, Biswanath College of Agriculture (AAU), Chariali – 784176, Assam during March, 2013 (pp 50-56)	**P. Neog**

17.	Udvidor bydhi aru kit potongor songkromon	Botor, Jalabayu Aru Jalabayu Paribartan":An Assamese book on weather, climate and climate change; edited by Dr. Prasanta Neog and Mr. Utpal Gogoi, assisted by Kushal Sarmah and Rijumani Rajbongshi, BN College of Agriculture	Published by the Agromet Advisory Services, Sonitpur, Biswanath College of Agriculture (AAU), Chariali – 784176, Assam during March, 2013 (pp 66-74)	Kushal Sarmah and **Rijumani Rajbongshi**
18.	Jolobaiu poriborton sohishnu krishi	Botor, Jalabayu Aru Jalabayu Paribartan":An Assamese book on weather, climate and climate change; edited by Dr. Prasanta Neog and Mr. Utpal Gogoi, assisted by Kushal Sarmah and Rijumani Rajbongshi, BN College of Agriculture	Published by the Agromet Advisory Services, Sonitpur, Biswanath College of Agriculture (AAU), Chariali – 784176, Assam during March, 2013 (pp 88-96)	**P. Neog, Utpal Gogoi and P.K.Sarma**

19.	Sharing experiences of NICRA project implementation in Assam	Natural Resource Management for Enhancement and Adaptation and Mitigation potential under Changing climate	Director, ICAR Research Complex for NE Region,Umium, Meghalaya 793 103.ISBN:978-81-928041-0-1(2014)	**Neog P.** and **Sarma P**.**K**.
20.	Ways and means of scientific intervention to tackle climate change in rainfed areas	"Natural Resource Management for Enhancement of Adaptation and Mitigation Potential under Changing Climate",	Director, ICAR Research Complex for NEH Region, Umiam, Meghalaya 793 103. **ISBN: 978-81-928041-0-1**, (2014).	**Sarma P**.**K**. and Baruah S.
21.	Developments in Biotechnology: Looking Ahead the Challenges and Opportunities for 21st Century	In. Accelerating Science (Ed.) by D. Das and Surajit Choudhury,	Published by Publication Department,Sikshak Karmachari Sabha, Jamuguri HS, Jamuguri.	**M**.**K**. **Sarma**

22.	**Chapter 10.** Eastern Himalayan Region (Assam) **1**. Foliar application of potassium for higher 139roductivity of Toria in North Bank Plain Zone of Assam.(pp149) **2**.Inter cropping of Greengram and Blackgram with Sesame for North Bank Plain Zone of Assam.(pp150) **3.**Crop diversification for higher productivity in North Bank Plain Zone of Assam.(pp151)	Rainfed farming A compendium of Doable technologies	All India Coordinated Research Project for Dryland Agriculture, Central Research Institute for Dryland Agriculture, Hyderabad.(2014)	**P.K.Sarma, D.Sarma and M.K. Sarma**

16.4.7 Books:

Sl.No.	Name of the Book	Coordinated or edited by	Published by and year of publication
1.	Botor, Jalabayu aru jalbayur paribartan	Dr. Prasanta Neog & Utpal Gogoi	Agromet Advisory Services, Sonitpur, March, 2013
2.	Introduction to Soil Science	**Dr. Pallab Kumar Sarma, Dr.Bipul Deka and Dr. Hem Chandra. Boruah**	published by B.N.College of Agriculture, Biswanath Chariali.(Under ICAR development Grant) ,2010
3.	Progress report (2010-12), NICRA	Coordinated or edited by Dr. Prasanta Neog	Published by Chief Scientist, AICRPDA, BNCA, 2013
4.	Progress report (2012 to 2014, NICRA, BNCA)	Coordinated or edited by Dr. Prasanta Neog	Published by Chief Scientist, AICRPDA, BNCA

16.4.8 Docu-feature film/ Documentary:

SL.NO	Title of the documentary/docu-feature film	Year of production
1	Documentary on NICRA village	2011-12
2	Docu-feature film “Let us go to the NICRA village”	2012-13

17. LIST OF SCIENTISTS WHO CONTRIBUTED TO THE RESEARCH WORK

CHIEF SCIENTIST	**PLANT BREEDING**
Dr. R. M Karmakar Dr. H. C. Baruah Dr. P. K. Sarma	Dr. P. K. Pathak Dr. M. K. Sarma
AGRONOMY	**AGRICULTURAL ENGINEERING**
Dr. K. Kurmi Dr. D. Sarma	Dr. P. K. Bora
SOIL PHYSICS	**AGROMETEROLOGY**
Dr. N. G. Barua Dr. B. Deka Dr. G. Moral Mrs. P. Borah	Dr. P. Neog

18. LIST OF TECHNICAL STAFF WHO CONTRIBUTED TO THE RESEARCH WORK

Mrs. Mayuri Baruah	Senior Research Fellow
Miss Naznin Begum	Senior Research Fellow
Miss Haridra Sarma	Senior Research Fellow
Miss Moutoushi Bhattacherjee	Senior Research Fellow
Miss Manju Bhattacharjee	Senior Research Fellow
Miss Ratna Kalita	Junior Research Fellow
Mr. Achyut Ch. Patowary	Junior Research Fellow
Mrs Pinki Saikia	Senior Research Fellow
Miss Mainu Hazarika	Senior Research Fellow
Mrs Moushumi Duruah	Senior Research Fellow
Miss Riju Mani Rajbonshi	Senior Research Fellow
Mr. Utpal Gogoi	Junior Research Fellow
Mr. Padum Chetri	Senior Research Fellow

Miss Anita Kurmi	Junior Research Fellow
Mr Saurav Baruah	Senior Research Fellow
Miss Nilakshi Dutta	Senior Research Fellow
Miss Nikhita Kakati	Senior Research Fellow
Mr. Rupam Borah	Senior Research Fellow
Mr Nupur Kalita	Senior Research Fellow


VERMI COMPOSTING UNIT
DRYLAND TECHNOLOGY PARK
AICRPDA
BNCA


Relay Cropping of Pea With Sali Rice under Upland Condition.
AICRP for Dryland Agriculture
BN College of Agriculture, AAU
Biswanath Chariali- 784176
Year- 2015-16


ALL INDIA CO-ORDINATED RESEARCH PROJECT FOR DRYLAND AGRICULTURE


Fodder Bank, AICRPDA, BNCA
In Collaboration With AICRP on
Forage Crops and Utilization
and Dept. of Animal Husbandry BNCA
Year- 2015-16


R1
D3 V1
R1
D3 V2


Arecanut Based Multiple Cropping System
Crop: Arecanut, Assam Lemon and Betel Vine
AICRP for Dryland Agriculture
BN College of Agriculture, AAU
Biswanath Chariali- 784176
Year- 2015-16


R1 C1