Annual Report

2073/74 (2016/17)

Government of Nepal

Nepal Agricultural Research Council

Regional Agricultural Research Station

Tarahara, Sunsari, Nepal

2017

Regional Agricultural Research Station (RARS)

Nepal Agricultural Research Council (NARC)

Tarahara, Sunsari, Nepal

Telephone : 00977-25-476461/476462

Fax : 00977-25-476462

Email : rarst.narc@gmail.com

URL : http://www.narc.gov.np

Citation:

RARST. 2017. Annual Report 2073/74(2016/17). Regional Agricultural Research Station, NARC, Tarahara, Sunsari, Nepal.

Cover Page Photo:

Office building, Regional Agricultural Research Station, Nepal Agricultural Research Council (NARC), Tarahara, Sunsari, Nepal.

FOREWORD

This Annual Report presents the outcome of station research works, outreach research works, production programs and other support activities of Regional Agricultural Research Station, Tarahara carried out during Fiscal Year 2016/17 (2073/74).The major effort of this station, as in other past years, was on the development of technologiesfor increasing the production and productivity of crops, horticulture, piggery, poultry and fishery. Our ultimate goal is livelihood improvement offarmers by enhancing their farm income and improving food security situation in eastern terai region (ETR). Mechanization was set at high priority to develop cost effective, sustainable and environment friendly technologies to make agriculture a profitable and attractive profession. In addition, production and distribution of source seed, horticultural saplings, fish fingerlings, pig and poultry breeds were given top priority. To serve the purpose of transferring technologies and assessing agricultural issues, technical working group meetings were organized by RARS Tarahara, Regional Agriculture Directorate, Biratnagar and Regional Livestock Services Directorate, Biratnagar. Practical trainings to extension personnel and farmers were organized for technology dissemination. NARC Day celebration, National Rice Day celebrationand Progress Review Meetings were some examples of such programs which were not mentioned in approved program budget.

I would like to express my sincere gratitude to the Executive Director and Directors of NARC for their directives, guidelines and support to carry out the program efficiently. My special thanks are due to the Scientists, Technical Officers and all the staff of the research station for their special contribution in carrying out different activities. I would like to thank Mr. Manish Kumar Thakurfor helping me bring out this report in this form.

I am very much hopeful this Annual Report will be useful for the policy makers, extension personnel, farmers and the persons engaged in agriculture research and development works. Comments and suggestions from the readers are highly appreciated.

Ram Deo Pandit

Regional Director

ABBREVIATIONS

ARS	Agriculture Research Station
ASFRP	Animal Science and Forage Research Programme
AYT	Advanced Yield Trial
CVT	Coordinated Varietal Trial
DADO	District Agriculture Development Office
DD	Disciplinary Division
DLSO	District Livestock Service Office
DOA	Department of Agriculture
DSR	Direct Seeded Rice
EDR	Eastern Development Region
ETR	Eastern Tarai Region
HRD	Horticulture Research Division, Khumaltar
HRP	Horticultural Research Program, RARS, Tarahara
IRRI	International Rice Research Institute, Philippines
NARC	Nepal Agricultural Research Council
NCRP	National Commodity Research Program
PRD	Potato Research Division, Khumaltar
RAD	Regional Agriculture Directorate, Biratnagar
RARST	Regional Agricultural Research Station, Tarahara
RLSD	Regional Livestock Service Directorate, Biratnagar
RVT	Regional Varietal Trial
ZTSD	Zero TillSeed Drill
ZT	Zero Tillage

TABLE OF CONTENTS

प्रमुख सार - संक्षेप

गत आ.व. २०७३/७४ मा क्षेत्रीय कृषि अनुसन्धान केन्द्र, तरहरा अन्तर्गत विभिन्न अनुसन्धान तथा उत्पादन कार्यहरु संचालन गरिएका थिए | कृषिका मुख्य सेक्टर हरु जस्तै बाली, बागबानी, पशु, तथा मत्स्यका बढी उत्पादन दिने जात/नश्ल तथा प्रबिधिहरु पहिचान गरिएका थिए |

थोरै पानीमा उच्चा ठाउमा हुने क्षरुवा बिधि द्वारा धानको जातीय परिक्षणमा ३२ ओटा जातहरु परिक्षण गरिएका थिए | IR92521-114-2-2-2 (५८३३ किलो), IR93821-41-1-2-1 (५७२९ किलो), IR92521-173-1-3-2 (५५२१ किलो) र IR92521-173-1-1-1 (५३१२ किलो) जातहरु अन्य जातहरु भन्दा बढी उत्पादन दिने उत्तम जातहरुको रुपमा देखिएको छ । त्यसै गरि धानमा समन्यवात्मक जातीय परिक्षणमा ३६ ओटा जातहरु परिक्षणका लागि छनौट गरिएका थिए | जसमध्ये IR95836-14-3-1-2 (७८१२ कि/हे) र IR95814-29-1-1-3 (७७३४ कि/हे) रहेको साथै क्रमसः १२६ दिनमा तथा १२३ दिनमा पाक्ने पाईयो ।

सुख्खा सहन सक्ने धानको जातीय परिक्षणको लागि १२ वटा जातहरु छनौट गरिएको थियो । जसमध्ये सुक्खा अवस्थामा तुलनात्मक रुपमा बढी उत्पादन दिने जातहरु क्रमशः राधा ४ (२.९१७ टन/हे), IR87707-445-B-B-B (२.६४ टन/हे), IR87705-14-11-B (२.५७३ टन/हे) र IR87705-44-4-B (२.५७ टन/हे) हुन् तसर्थ इ जातहरुलाई सिरहा र सप्तरीको सुक्खाहुने क्षेत्रमा खेति गर्न सिफारिश गरिन्छ । त्यसै गरी सिंचित अवस्थामा पनि बढी उत्पादन दिने जातहरु क्रमशः राधा ४ (५.३४७ टन/हे), IR87706-215-B-B-B (३.९६ टन/हे) र IR87728-102-B-B (३.८९० टन/हे) पाइएको छ ।

धानमा लिफ ब्लास्ट र नेक ब्लास्ट सम्बन्धि परिक्षणमा Trip @ 2 gm/lt. ले प्रभाबकारी रुपमा नेक ब्लास्ट कम गरेको पाइयो | धानको फल्स स्मटको परिक्षणमा फुल फुल्नु भन्दा अगी र पछी पिनाकल अथवा धानुकप छरेर रोग ब्यबस्थापन गर्न सकियो | बिउ उपचार सम्बन्धी परिक्षणमा trichoderma को उपचारले Bacterial Blight रोग न्युनतम गराउनुको साथै बढी उत्पादन दिएको पाइयो ।

गहुँको समन्यवात्मक क्षेत्रीय जातीय परिक्षणमा मा २४ जात हरुको परिक्षण गरिएको थियो जसमध्ये BL3264 (३.०३ टन/हे), BL3535 (३.२ टन/हे), BL3623 (३.०३ टन/हे), NL1135 (३ टन/हे) र BL3978 (३.०३ टन/हे) ले तुलनात्मक रुपमा बढी उत्पादन दीयो ।

गहुँको रोग अनुगमनमा लिफ रस्ट र फोलियर ब्लाइट पुर्वान्चलमा मुख्य रोगको रुपमा पाइयो | NL 297 मा लिफ रस्ट सबभन्दा बढी पाईयो | तिलोत्तमा, एन.एल. 971 र आदित्य जातमा लिफ रस्ट पाईएन | ढुशीनासक सम्बन्धि अध्ययनमा पिनाकल (2 ml/lt) को प्रयोगले लिफ रस्ट नलागेको र अधिक उत्पादन (३३०० के.जी./हे.) भएको पाईयो | लिफ रस्टको कारणले ११.९१% सम्म उत्पादनमा ह्रास आएको पाईयो | हाईब्रीड गोलभेंडाको समन्यवात्मक जातीय परिक्षणमा १३X ७ (१५.९ कि/प्लट) ले अधिकतम उत्पादन दियो | त्यसै गरि गोलभेंडाको खुल्ला परागसेंचित समन्यवात्मक जातीय परिक्षणमा V5 जातले अत्यधिक उत्पादन (३४.२ कि/प्लट) तथा बृधि बिकास भएको पाइयो । आलुको समन्यवात्मक जातीय परिक्षणमा CIP 395017.229 जातले अधिकतम उत्पादन दियो | साथै आलुको पछौटे डढुवा नियन्त्रणको लागि सेक्टिन २ ग्राम / लि. पानीको दरले छार्किदा नियन्त्रण भएको पाइयो |

आपमा १७ जातहरु अनुसन्धानको लागि संरक्षण गरिएका छन् | एकीकृत खाध्यतत्व ब्यबस्थापन द्वारा एक बर्ष बिराएर फलदिने समस्या समाधानको लागि कम्पोस्ट ५० कि.+ ओइल केक १० कि. + N: P: K @ ०.३६ कि:०.०९१ कि:०.३३५ कि. + अग्रोमिन २ मि.लि./लि.पानी प्रयोग गर्दा क्रमिक रुपमा बर्सेनि उत्पादन तथा फल संख्या बढ्ने पाइएको छ । लिच्चिमा Titan (२ ml./l) को प्रयोगले रस्ट (सिन्दुरे) रोग प्रभाबकारी रुपमा नियन्त्रण भएको पाइयो | कोलामा पिन्नेकल १मि.लि. / लि. पानीको दरले प्रयोग गर्दा सिगतोका थोप्ले रोग नियन्त्रण भएको पायो | बागबानीमा लिच्ची, सुपारी, नरिबल, अम्बा, सपोटा, मेवा, कटहर, एभोकाड़ो, अमिला जातका फलफुल र ड्रागन फ्रुट संरक्षण गरिएका छन् |

17 Alpha Methyltestosterone hormone (८० मि. ग्रा.) प्रति के.जी दानामा मिसाएर खुवाएर परिक्षण गर्दा ९० प्रतिशत भाले टिलापिया देखियो । पंगास माछाको

उत्पादकत्व ५४.५ मे.टन/हे रहेको प्रारम्भिक नतिजाबाट देखिएको छ | माछामा पन्गासको प्रजनन सम्बन्धि अध्ययनले जुन र जुलाइमा प्रजनन गरायो भने बढी सफल हुने देखाएको छ | अगस्टमा प्रजनन गरायो भने स्पनिंग, प्रजनन र भुरा उत्पादनमा कमि आएको देखियो | पन्गास माछाको मृत्युदर घटाउन उचित घनत्व र जैविक पदार्थको आबश्यकता रहेको पाइयो |

बंगुरको दाना सम्बन्धि अध्ययनमा ४०० ग्राम- २ केजी/ दिन को प्रयोगले बंगुरको तौल ११८.२७ के.जी. सम्म पाइयो | साथै बंगुरको कृत्रिम गर्भाधान परिक्षणमा Frozen semen को प्रयोगबाट हालसम्म जम्मा २६ ओटा माउ बंगुर बाट जम्मा १४० ओटा पाठापाठी जन्मिएको (४६.४३ प्रतिशत सफल) छ । हाल सम्म विभिन्न किसानको १८२ ओटा बंगुरमा Fresh Semen बाट कृतिम गर्भाधान गरिएको (८४ प्रतिशत सफल), केन्द्रमा ५७ ओटा माउंबाट ३७० ओटा पाठापाठी जन्मिएको छ |

कृतिम कुखुरामा भाले र पोथी गिरिराजको तौल स्थानीय ब्यबस्थापनमा क्रमसः ३ के.जी. र २.६ के.जी. पाइयो | कृषकले स्थानीय पोथी कुखुरामा गिरिराजा कुखुराको अन्डा राखेर चल्ला निकाल्ने थालेको पाइयो | कृषकस्तरमा गिरिराजा कुखुरा र अनुसन्धान केन्द्रमा टर्कीको उत्पादन प्रविधिको मुल्याकंन गरियो |

श्रोत बिउमा सबै भन्दा बढी धानको बिउ (६२.५ मे.ट.), त्यस पछी गहुँको बिउ (२५.३२ मे.ट.), मकै बिउ (१.८१ मे.ट.), घाँसको बिउ (०.२६ मे.ट.), आलुको बिउ (४.९ मे.ट.) र तरकारी बिउ (१६८.१ के.जी.) उत्पादन भएको थियो | माछामा ५४५०००० ह्याचलिंग, २१११३०० फ्राई, र २०१७१० फिन्गर्लिंग बिक्रि भएको थियो | बंगुर र कुखुरामा ४४१ पाठापाठी, १८१७४ चल्ला र २९४४६ अन्डा बिक्रि भएको थियो |

यस अनुसन्धान केन्द्रमा भ्रमण गर्न आएका कृषक, उधमी र प्राबिधिकहरुलाई च्याउ उत्पादन, रोग किरा ब्यबस्थापन, माटोको नमुना संकलन र खाधतत्व परिक्षण, कुखुरा/ टर्की / बट्टाई उत्पादन, माछा पालन आदि बिषयमा सल्लाह परामर्श दिइएको थियो |

EXECUTIVE SUMMARY

Various activities of research and production were carried out under Regional Agricultural Research Station, Tarahara during 2073/74. Many high yielding varieties/breeds and promising technologies in major sectors viz. crops, horticulture, livestock and fisheries were identified.

In rice, 32 genotypes were tested for Water saving trial of rice on upland aerobic condition. In terms of yield potential, genotypes IR92521-114-2-2-2 (5833 kg), IR93821-41-1-2-1 (5729 kg), IR92521-173-1-3-2 (5521 kg) and IR92521-173-1-1-1 (5312 kg) observed to be superior then standard check Vandana. Similarly 36 genotypes of rice was was used for water saving trial on AYT medium under transplanted condition. The result revealed that genotypes IR95836-14-3-1-2 (7812 kg/ha) and IR95814-29-1-1-3(7734 kg/ha) yielded highest as compared to others and matured on 126 and 123 day respectively.

Twelve genotypes of rice was used for evaluation of rice genotypes for Reproductive Stage Drought Stress. In drought stress condition highest yield was produced by Radha 4 (2.917 t/ha), IR87707-445-B-B-B (2.64 t/ha), IR87705-14-11-B (2.573 t/ha) and IR87705-44-4-B (2.57 t/ha) respectively and recommended for drought prone area if Siraha and Saptari district. Similalry, Radha 4 (5.437 t/ha), IR87706-215-B-B-B (3.96 t/ha) and IR87728-102-B-B (3.89 t /ha) yielded maximum under irrigated condition.

In the pesticide evaluation on incidence of leaf and neck blast in rice, application of Trip@2g/l significantly reduced the incidence of neck blast disease. In the pesticide evaluation against false smut in rice, the results showed that false smut could be managed by spraying pinnacle or Dhanucop before and after flowering. In a study of seed treatment effect with Trichoderma isolates, significantly lower BLB score but higher yield was recorded on seed treatment with IRRI-3 and IRRI-4.

In wheat, 24 genotypes were tested in Regional Advanced Varietal trial where the highest grain yield was observed with genotype BL3264 (3.03 t/ha), BL3535 (3.2 t/ha), NL1135 (3 t/ha) and BL3978 (3.03 t/ha). Monitoring of wheat diseases revealed that leaf rust and foliar blight were the major diseases of wheat in the eastern region. Highest incidence of leaf rust was recorded in NL 297. Varieties viz.

Tilottama, NL 971 and Aditya were found free from the leaf rust disease. In a study on the use of fungicide, no leaf rust and the highest grain yield (3.3 t/ha) were recorded with application of pinnacle at the rate of 2 ml/l. In an assessment of yield loss due to leaf rust disease in wheat, 11.91% yield reduction was recorded in leaf rust infected plots as compared to the disease free plots.

In Mango, 17 cultivars have been conserved as mother stocks for research support. The integrated nutrient management study reveals that the application of manure or compost 50 kg + oil cake 10 kg + N:P:K @) 0.36 kg:).091 kg: 0.335 kg + Agromin 2 ml/lt water per tree resulted increased fruit number, fruit yield and quality of fruit consequently every year. In Litchi, red rust disease was significantly suppressed by applying Titan @ 2 ml/l. SIgatoka leaf spot of Banana was effectively controlled by the application of Pinnacle® @ 1 ml/l . Different cultivars of litchi, arecanut, coconut, guava, sapota, papaya, jackfruit, avocado, citrus species, and dragon fruit have been maintained and conserved.

17 Alpha Methyltestosterone hormone apllied @ 80 mg/kg per kg of fish feed increased male tilapia population up to 90%. Preliminary trial on Pangas proponded that the productivity of it observed to be 54.5 mt/ha. For pre-hatching reproductive performance of pangas broods, the results indicated that the high rate of spawning success with better fecundity and fertilization rate could be achieved if breeding episodes carried out during June to July. Although Pangas responded to induced breeding in August, the late breeding resulted in poor spawning success, low fertility and hatching rate. The optimum density and biomass would be required for pangas species to maintain continuous biomass gain without significant increase in fish mortality.

In a study of pig feeding system at outreach site, the treatment of mass 400 gm up to 2kg/day resulted highest weight gain in pig (118.27 kg). Artificial insemination (AI) in pig by frozen semen pig produced 140 piglets from 26 sows obtaining success rate of 46.43%. Similarly, AI was practiced by using fresh semen in farmers field revealed 84% success rate. 370 piglets was born from 57 sows at the center. In poultry, average matured weight of male and female Giriraja was recorded as 3 kg and 2.6 kg, respectively at outreach sites. Farmers started to produce Giriraja chicks by using local broody hen for hatching fertile egg of giriraja chicken. Germplasm improvement and conservation of different poultry breeds have been done. Verification of Giriraja chicken at on-farm condition and performance evaluation of Turkey at on-station was done.

Highest amount of source seed was produced for rice (62.5 ton) followed by wheat (25.32 ton) and maize (1,81 ton), forage seed (0.26 ton), seed potato (4.9 ton) and vegetable seed (168.1 kg) and distributed. A total of 5450000 hatchlings, 2111300 fry and 211710 numbers of fingerlings were sold. Similarly, in pig and poultry, 441 piglets, 18174 chicks and 29446 eggs were distributed.

Counseling service about mushroom production, disease and pest management, soil sample collection and nutrient analysis, pig production, poultry production, fish culture etc was provided to farmers, entreprenuers and technicians visiting the station from different districts of Nepal.

1.**WORKING CONTEXT**

Regional Agricultural Research Station (RARS) is located in ward No. 2 of Itahari Municipality in Sunsari District of Province 1. It is five kilometers north of Itahari Chowk lying in the eastern side of Dharan-Biratnagar high way.

RARS, Tarahara has six command districts of Eastern Terai Region (ETR) of Nepal. It is a tropical zone with warm climatic conditions. Majority of the area is under irrigated condition but badly affected by present climate change and has partial irrigation. RARS, Tarahara is located at 26º42'16.85" North latitude and 87º16'38.43" East longitude. It is located at an elevation of 136 meters above sea level.

The climate of the farm is sub-tropical. The soil texture of whole farm land is dominated by clay loam with sandy loam to loam varying with the distribution of land within the farm. The pH of the soil ranged 6.5-7.0 which indicates slight acidic to neutral status of the soil.

The total area of RARS Tarahara farm is around 104 ha. The land allocation, however, is according to unit settlement, but one unit may utilize the land in another unit depending upon situation and need of research and production activities (Figure 1). The land occupied and mentioned in miscellaneous is average of all. The National Buffalo Research Program was established in 2070 BS. The area required for the buffalo research program was allocated from RARS.

Certain lands are sometimes become unfit for winter crop due to exertion of excess moisture in the field. Under such situation lands are left fallow or utilized for winter rice studies. This research station is favorable mainly for crops and warm water fishes due to nearly available of water table from the surface. Farm tries its best to utilize whole land round the year but sometimes lack of irrigation facilities hinders to run smoothly. Lands are utilized with plantation of dhaicha during fallow period for green manure. Dhaicha is generally planted after wheat harvesting and before rice transplanting. It is plowed down to mix with the soil.

Figure 1: Farm area of Regional Agriculture Research Station, Tarahara.

It has four major research programs run by four research units under on-station condition, while under on-farm condition it conducts its technology verification program through Outreach Research Program (ORP) in all four sectors. At the station the research units for different commodities are Crop Research Program (CRP), Animal Science and Forage Research Program (ASFRP), Horticulture Research Program (HRP) and Fishery Research Program (FRP).

Majority of the area is covered with crops in the ETR. There is a good access to road and market centers and most of the districts are self sufficient in food. The community in the area is mixed type. The Brahmin, Chhetri, Maithili, Janjatis and Dalits are the major communities living in this area. Outreach research programs were focused in mixed community so that technology could be disseminated easily.
Every yearduring rainy season, farm area suffers from natural flooding that hampers the farm area. The outlet and drainage are blocked during rainy season and floods cause heavy loss mostly in fish ponds and its surrounding area. Despite many efforts with cooperation of local people, the occasional flooding problem is yet to solve.

The command districts of RARS Tarahara are Jhapa, Morang, Sunsari, Saptari, Siraha and Udayapur. The predominant agriculture commodities are cereal, warm water fish, mango and piglet. The cereal crops are widely grown in this region and

rice has higher productivity especially in Jhapa and Morang. Laboratory is the key functional support subunit for research that backs up technology generation as well as technology verification. Laboratories functional in the station are as follows.

a) Soil Laboratory:

It provides the facilities for soil pH testing, organic matter and soil nutrient analysis. Lack of skilled lab technician, poor infrastructure and obsolete lab equipment are the constraints in laboratory work.

b) Plant Protection laboratory

This lab is renovated and facilitated with modern equipments. It provides the facility like identification of plant diseases,study of different diseases and insects. Renovation of this lab has overcome the previous problem of inadequate space and frequent contamination that used to hamper the research works.

c) Agronomy laboratory

This lab does not have a separate building with adequate space. This lab provides the support for varietal improvement work as well as agronomic trials. Field materials are harvested and measured forthousand grain weight, yield weight, moisture content etc.

2. INTRODUCTION

2.1 Introduction

This station was established in 1960 AD by the name of “Birat Krishi Farm” to start agriculture research and demonstration of different cereal crops. The main objective of this farm was to increase production of cereal crops through demonstration of improved crop cultivation practices in this region. Later, poultry and fishery programs were added in 1962. Similarly, the research and development activities in livestock commodities like pig, buffalo and forage crops were initiated in 1965. In the same way, research and development activities on fruit and vegetable cultivation were started in 1968. Outreach research program was initiated in 1992-1993. The organizational structure of this station is presented in Figure 2.

2.2 Goal

a. Generate and verify sustainable agricultural production technologies to increase the productivity of Eastern Terai Region (ETR).

b. Improve the livelihood of farmers through increased farm income with better technology.

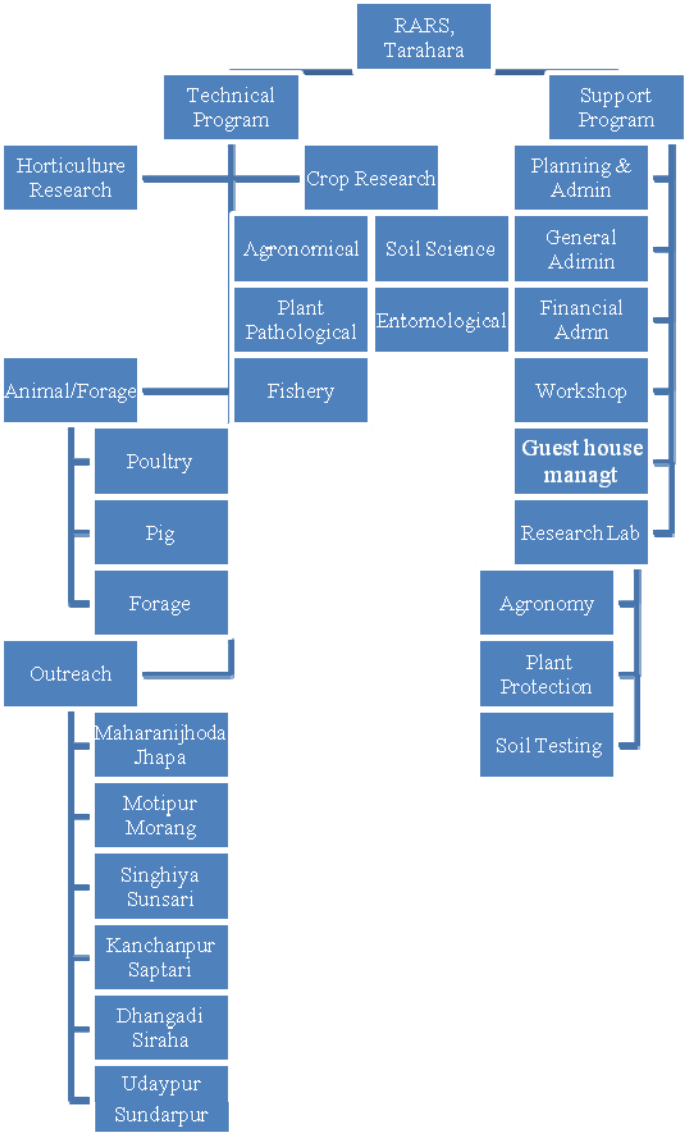


Figure 2: Organizational structure of Regional Agriculture Research Station, Tarahara

2.3 Objectives

a. Carry out agricultural research works based on farmers' need and priorities for Eastern Terai Region (ETR).
b. Conduct multi-location testing in collaboration with commodity research programs, I/NGOs and other national and international agencies.
c. Conduct on-farm research through Outreach Research Program (ORP) and verify the generated promising technologies on cereals, pulses, oil crops, animals, birds, forage crops, fish, fruits and vegetables in the command area under prevailing agro-eco-zones and to work as interface between research and extension for dissemination of technologies.
d. Develop economically viable and sustainable packages of technologies for increasing the productivity.
e. Maintain the selected genotypes/breeds of plants and animals/birds and produces seeds and saplings of improved varieties, breeds of improved species.
f. Organize training, monitoring tours, technical meetings and seminar to address clients' needs and also provide resource person for training.
g. Organize coordination and planning meeting; review workshops for linkage with GOs, I/NGOs and stakeholders.

2.4 Strategies

2.4.1 Crop

Cereals (rice, wheat and maize) are major commodities of this region. This region contains about one third area of total rice cultivation in the country. Farmers in this region are now motivated to grow fine and aromatic rice. Wheat and maize are also grown in large area in this region. Winter legumes (lentil, chickpea) are also gaining popularity in the areas. At present, climate change has posed both drought as well as flash floods in the region affecting rice-wheat systems adversely. Considering these facts, strategies of the crop research are formulated as follows.

- ✯ Development and promotion of stress tolerant rice varieties
- ✯ Selection and development of fine and aromatic rice varieties
- ✯ Identification of early maturing wheat varieties to escape hot westerly wind during grain filling stage and identification of varieties tolerant to heat and hot wind during grain filling stage
- ✯ Selection and development of suitable wheat (sterility free) and maize varieties for ETR
- ✯ Integrated nutrient management and crop intensification/ diversification using different legumes/cash crops to enhance productivity and sustainability of cropping system

- ✯ Development of integrated pest management (IPM) packages for the control of pest and diseases
- ✯ Integration of crop/livestock/horticultural/commodity for improvement of soils and better economic return
- ✯ Production and maintenance of quality and reliable seed for its availability to the farmers of ETR
- ✯ This station could be developed as a center of excellence for agricultural research, training and laboratory services

2.4.2 Livestock

Livestock is a major component of Nepalese farming. Pig and goat farming for meat production are also popular in the region. Poultry farming is also increasing in farmer's level. Certain ethnic groups like Rai, Limbu, Magar and Gurung preferred to rear pig for meat. Along with these increments, the awareness of farmers towards feeding nutritive green fodder to their animal is also increasing. Considering these facts, strategies of the crop research are formulated as follows.

- ✯ Focus on economic rearing of pig and poultry
- ✯ Maintenance of Poultry birds
- ✯ Maintenance and genetic improvement of pig breeds
- ✯ Conservation and utilization of local breeds of pig and birds of poultry
- ✯ Development and dissemination of year round green forage production system to farmers
- ✯ Production of piglets for distribution to the stakeholders
- ✯ Production and distribution of poultry birds (Giriraja) to stakeholders
- ✯ Production and distribution of forage and grass seeds

This station acts as a leading institution for poultry and piggery research.

2.4.3 Horticulture

This area is one of the important areas for tropical fruits. Similarly mango and litchi are major tropical fruits in this region. Similarly, coconut and areca nut are widely grown in eastern Terai (Jhapa and Morang). Large numbers of vegetable species are grown in summer and winter season. Farmers in this area encounter with several problems on these horticultural crops. Considering these facts, strategies of the horticultural crop research are formulated as follows:

- ✯ Focus research on coconut and areca nut (production and post harvest processing)
- ✯ Conservation and evaluation of tropical fruits for sustainable research and development

- ✯ Technology development on post harvest/fruit processing (jam, jelly, drying technology)
- ✯ Technology development on normal season and off-season vegetable production and post harvest storage
- ✯ Research and development of hybrid vegetables seed production
- ✯ Production and distribution of foundation seeds of vegetables and fruit saplings

2.4.4 Fishery

Fisheries research unit of this station is only one station in Nepal for warm water fisheries research. In this context, there are a lot of opportunities for technology development in warm water fish. Considering these facts, strategies of the crop research are taken as follows

✯This station leads in research and development of warm water fish

- ✯ Research emphasis on Tilapia, Pangas and Prawn (warm water fish)
- ✯ Maintenance of pure breed and quality fingerlings production
- ✯ Priority for the improvementof local fish species
- ✯ Production and distribution of quality fingerlings and fry of Tilapia, Pangas and other warm water fish species.

2.4.5 Outreach Research

Outreach research with feedback system is very important for station research. Station research is often guided by outreach research. Therefore, outreach research unit has been strengthened. To make a strong unit at this station, a multidisciplinary group is involved. On-station generated technologies are evaluated and verified at outreach sites and economically viable technologies are recommended and transferred. A strong linkage between extension (GO) and NGO/INGO has been developed for technology verification and dissemination.

- ✯ A monitoring group representing the members from governmental, nongovernmental organizations and private sectors will be formed to evaluate the performance of research programs carried out at outreach research sites in grass root level.
- ✯ A core group of scientists consisting of different disciplines and commodities are working for outreach research programs in various aspects (varietal development, agronomical, breed improvement, management, IPM, IDM, socio economic, farming system). This group always tries to seek furthermore opportunities of working jointly with partner organizations in various fields of agriculture.
- ✯ In above context multi-commodity and multidisciplinary research has been given priority.

2.4.6 Thrust Area for Research:

The major activities of this station are research works on crops through Crop Research Program (CRP), Livestock (Pig, Poultry and Forage) through Animal Science and Forage Research Program (ASFRP), Fruits and Vegetables through Horticulture Research Program (HRP) and Fishery through Fishery Research Program (FRP). Verification of on-station generated promising technologies is carried out through Outreach Research Program (ORP).

A. Crop Research Program (CRP)

Major research works on rice, wheat and maize are being carried out. Varietal improvement work like breeding, cropping system, disease and insect management and long-term fertility etc. are the focal aspects of research works. However, certain short term experiments are also designed and implemented based on farmers' needs and perception. Plant protection and soil laboratories are also functioning to support different crop related activities. Rice genotypes that can yield successfully under minimum water availability are also being identified under the research works of water saving technologies. Selection of genotypes in earlier breeding cycle with shuttle breeding, physiological aspect of breeding was started from 2070 BS cropping season. Similarly, the promising genotypes of winter (Boro) rice and spring rice (Chaite) are also under study and certain genotypes are identified for further testing. Similarly, the genotypes of rice, wheat and maize that can tolerate water stress are also being tested through participatory approach.

B. Animal Science and Forage Research Program (ASFRP)

The main research activities under ASFRP are being carried out in pig, poultry, and forage crops. The research works in pig and poultry are concentrated on selection and identification of species for high meat and egg production. Improvement of local races/species through introducing improved breed/species of pig/poultry has also been initiated. It includes production and distribution of piglets and chicks to the farmers. Research on summer and winter forage crops are also going on.

C. Horticulture Research Program (HRP)

This program includes study on tropical fruits, summer and winter vegetables, spices and research on tea has also been initiated. Control measures on mango stem borer, fruit drop and fruit rot in coconut and areca nut were studied and results were reviewed and applied to farmer's field.

Short term and long term research works are designed accordingly based on farmers' problem. Study on potato, brinjal (Egg plant), tomato, mango, acid lime,

guava and jackfruit are also going on with specific objectives of production potentiality, disease resistance and compatible grafting purposes.

D. Fisheries Research Program (FRP)

This station has emphasized research on warm water fish species. Research work on breeding, growth performance, prawn culture and farming technologies of tilapia and pangasius are the major focus of fishery research.

Study on different carp fishes and polyculture (farming of different fish species in a pond), fish production through different source of nutrition, enhancing flesh production of tilapia through sex reverse technologies are studied at station.

E. Outreach Research Program (ORP)

On-station generated promising technologies are further verified in farmers' field with their active participation which is called outreach research. This station has identified outreach research sites in six districts based on agro-ecological zones of ETR (Annex 1.1). They are given in the following Table 1.

Table 1: Outreach Research Sites under RARS, Tarahara

S.N.	District	VDC/s	Remarks
1	Jhapa	Maharanijhoda	Mixed-wetland- Irrigated Rainfed
2	Morang	Motipur	Mid-wetland-Rainfed
3	Sunsari	Singhiya	Mid-wetland-Irrigated
4	Saptari	Kanchanpur	Lower-wetland-Irrigate
5	Siraha	Dhangadi	Low-wetland-Rainfed
6	Udayapur	Sundarpur	Up-land-Irrigated

Most of the activities in outreach research program are related to rice and wheat crops. However, technology verification on horticultural crops (fruits and vegetables), livestock (pig and poultry) and fishery is also done side by side. Farmers' reactions are noted and project is designed or modified accordingly. Researchable problems are identified through village level planning and review workshop in each site in joint participation of farmers, researchers, extension staff and other stakeholders. Recommendations made during RATWG and NATWG are also considered for program planning. Activities on pig, poultry, forage, vegetables and potato are also designed and implemented based on farmers' needs and perception. Rice-Fish farming has encouraged farmers to produce fish in rice field and farmers get benefit from fish as well as paddy production simultaneously. Similarly, Pig-Fish integration has benefited farmers by obtaining production of

double commodities of pig and fish. Pig is farmed on the dike of pond in a shed and its excreta become the ration for fishes.

Increased costs of cultivation and labor scarcity havebecome the burden for farmers during peak agricultural activities. It has led researchers to develop and disseminate Resource Conservation Technology (RCT). This station has initiated to disseminate RCT in rice and wheat cultivation and farmers are well benefited by using seed cum fertilizer zero till seed drill machine. The major benefits from this machine is that it reduces the cost of field preparation, help timely seeding of wheat, apply both seed and fertilizers efficiently, conserve soil moisture due to direct seeding, saves time and quantity of irrigation water and ultimately results comparatively more production with reducing cultivation costs. Since this technology requires the availability of machines, farmers if provided with subsidy in buying it will benefit large, medium and small farmers as well who can at least hire this machine in wheat season.

3. RESEARCH HIGHLIGHTS

3.1 Rice

3.1.1 Surveyon Rice Alternate Wetting and Drying Technology:

Twenty farmers were selected from each of four districts in eastern terai region of Nepal. The districts having potentiality of growing aerobic rice, following alternate wetting and drying technology were prioritized for household survey using questionnaire with the given template from IRRI. Four major sites; Mrigauliya of Morang, Bhokraha of Sunsari Kadmaha of Saptari, and Lahan of Siraha were surveyed. Each cluster was characterized based on irrigation system, existing cropping pattern, method of irrigation and socioeconomic situation. In terms of socioeconomic condition, selected farmers were subsistence to commercial types of producers with mix community and gender. In general, survey included socio economic background of the household, identification of area and information from farmers. The information includes existing cultivated rice varieties, acceptable traits of the varieties, negative traits of rice varieties, availability of water for the last five years, total land area under transplanted condition and existing production. The potentiality of rice variety after completion of this project was assessed from the questionnaire like benefit of aerobic cultivation practices, alternate wetting and drying cultivation practices, problem associated with aerobic cultivation practices and future prediction of varietal yield in such condition.

The results of the household survey differed from place to place. In Siraha and Saptari districts, dominating community engaged in farming is Tharu (Chaudhary). The respondents from Sunsari and Morang districts were of mix communities.

About 80 percent surveyed areas have rainfed ecosystem. Kanchhi Masuli, Indian Sona Masuli and Hardinath-1 are popularly cultivated varieties in Siraha and Saptari districts whereas Ranjeet, Kanchhi Masuli and Hardinath-1 are cultivated in Sunsari and Morang districts. Sunsari and Morang were characterized as semi irrigated to rainfed whereas Siraha and Saptari were categorized under complete rainfed ecosystem for rice cultivation. Kanchhi Masuli is the most popular variety grown for many years because it has good eating quality, cooking quality, drought tolerance traits and other abiotic stress. It is also popular for popped and beaten rice and thus, it fetches higher market price. Similarly, it fits well for the rice- wheat cropping pattern of Nepal. Its straw quality and medium plant height are acceptable characters. Thus, the variety has enough potentiality to be improved in future by introduction of blast resistance traits. Indian Ranjeet is second popular variety for

the rainfed to irrigated ecosystem but it has poor straw quality. Among the newly developed varieties, Hardinath-1 and Tarahara-1 were found more popular. Besides that, Sukha Dhan-3 and Sukha Dhan-5 were also preferred varieties but they were recently pushed for cultivation. There is need to promote these varieties.

Declining trend of water availability for the last 5 years was information received from all surveyed sites. As a result, rice area production was reported as decreasing continuously. Went down of water table and lack of climate resilient short duration varieties for water short areas were reasons for decreasing area and production of rice in eastern terai region. Farmers demand the rice variety which could have potential to produce better yield under the water short condition. In addition, they are also getting convinced now to grow rice under the direct seeded condition. These information clearly indicate that they will adopt aerobic rice and alternate wetting and drying technology and ultimately would be benefited in terms to productivity.

3.1.2 Water saving trial of rice on upland aerobic condition.

For this experiment32 genotypes of rice was selected. Each treatment considered as an individual treatment and replicated thrice. Research design used was randomized complete block design.The plot size of each treatment was 5 m x 1.4 m. The fertilizer doses applied was 100:30:30 NPK kg/ha. The seeding date was 1st March, 2016.

In terms of yield potential, genotypesIR92521-114-2-2-2, IR93821-41-1-2-1, IR92521-173-1-3-2 and IR92521-173-1-1-1 observed to be superior then standard check Vandana as stated in table 2. Therefore, these genotypes can be recommended for cultivation by direct seeding on upland aerobic condition and can be proposed for releasein future.

Table 2: Water saving trial of rice on upland aerobic condition

Genotypes	Yield (kg/ha)	Heading days	Maturity days	Panicle length (cm)	Tillers per m^2	Plant height (cm)
IR92521-114-2-2-2	5833	73	102	24	233	113
IR92521-173-1-3-2	5729	71	100	25	169	128
IR93821-41-1-2-1	5521	71	104	24	187	99
IR92521-173-1-1-1	5312	71	100	23	229	113
IR83399-B-B-52-1	5104	72	97	24	158	114
IR91326-20-1-1-1	5000	70	99	22	179	115

IR93835-167-2-2-2	4896	70	99	22	230	118
IR93835-78-3-1-1	4896	72	101	24	206	115
IR93828-195-2-1-1	4896	70	99	24	193	111
IR92521-143-7-2-1	4896	72	101	23	204	102
IR91326-20-2-1-2	4792	69	98	22	205	101
IR91326-7-13-1-1	4688	75	101	23	185	109
IR93835-74-2-1-1	4583	70	99	22	225	104
IR92521-172-5-1-1	4583	74	103	23	213	106
IR92521-120-1-3-2	4479	72	101	23	216	102
IR91326-20-2-1-4	4479	74	103	23	214	101
IR93835-73-2-3-1	4375	71	100	22	219	108
IR91328-43-6-2-1	4375	73	102	23	182	104
IR91326-20-1-1-2	4375	73	102	22	199	105
IR92521-146-3-3-2	4375	73	102	22	158	103
IR92521-147-3-1-2	4375	71	103	23	170	106
IR93823-36-1-1-1	4167	75	104	22	180	100
IR93835-70-2-2-1	4167	76	105	22	164	101
IR92521-143-4-3-2	4062	75	104	23	466	104
IR92521-143-2-2-1	4062	78	109	25	203	110
IR93835-133-3-1-1	3750	74	103	21	167	100
IR91326-19-2-1-2	3750	77	106	22	153	101
NSIC2011RC192	4688	77	106	21	220	103
UPLRi7	4792	82	111	23	188	102
Vandana (Check)	5312	78	107	22	198	108
IRRI132	6250	84	113	22	222	104
Tarahara-1	4708	80	108	24	182	109
CV%	20	2.9	2.4	4.8	18.6	4.7
P-Value	0.32	<.001	<0.001	<0.001	0.139	<.001

3.1.3 Water saving trial on AYT medium under transplanted condition

36 genotypesincluding IR74371-70-1-1 was selected for the Advanced Yield Trial (AYT) medium under alternate wetting and drying irrigation system. These genotypes was selected based on the phenological traits during 2016 wet season at RARS Tarahara. These genotypes have better yield potential and are excellent under semi irrigated condition.The design used was alpha lattice with two replications. The plot size of 4m x 0.8m with spacing of 20cm x 20cm was used. The genotypes were seeded on July 16, 2016 and transplanted on August 15, 2016. Fertilizer dose of 100:30:30 NPK kg/ha was used. All the genotypes differed

significantly with respect to yield (kg/ha) and observed to be superiorto standard check Sukha Dhan-3 (IR74371-70-1-1).

Table3: Water saving trial on AYT medium under transplanted condition

Genotypes	Yield(kg/ha)	Heading Days	Maturity Days	Panicle length (cm)	Tillers per m^2	Plant height (cm)
IR95836-14-3-1-2	7812	98	126	23	348	99
IR95814-29-1-1-3	7734	96	123	23	337	98
IR95780-43-1-1-1	7375	92	122	25	302	102
IR95817-23-2-1-2	7188	98	126	25	331	98
IR95785-5-2-2-1	7031	93	123	25	316	101
IR93810-17-1-2-3	6719	95	123	24	335	100
IR95785-15-2-1-2	6719	94	123	23	301	102
IR93856-10-2-3-3	6541	93	122	24	327	100
IR93856-10-2-3-2	6016	91	121	24	288	99
IR95840-35-1-2-3	5938	98	126	25	333	100
IR95785-31-2-1-2	5781	98	126	23	323	99
IR95840-35-1-2-2	5781	106	133	24	306	100
IR92545-4-2-1-2	5625	93	121	24	300	100
IR95814-27-1-2-3	5625	106	133	25	275	98
IR88964-11-2-2-4	5469	91	120	24	311	97
IR93809-2-1-3-2	5391	92	121	25	261	92
IR94224-17-1-3-3	5312	90	119	26	304	101
IR93807-8-1-1-1	5312	98	126	24	286	91
IR95793-5-2-2-3	5234	93	123	25	315	100
IR95801-6-3-1-1	5000	113	140	24	336	97
IR92526-1-1-1-2	4688	102	129	23	277	88
IR96279-33-3-1-2	4612	109	136	25	265	97
IR95785-5-2-2-2	4412	103	131	24	282	98
IR74371-70-1-1	4219	93	122	27	278	100
IR95781-15-1-1-4	4109	107	134	24	297	90
IR95804-5-1-1-2	4062	107	137	25	311	100
IR95786-9-2-1-2	3906	103	132	23	335	93
IR96319-6-3-1-2	3828	108	134	23	296	91
IRRI119	6094	116	143	25	349	102
MTU1010	6250	93	122	23	296	101
IRRI123	6406	93	123	24	290	101

IR64	5469	92	122	24	332	97
IR74371-70-1-1	3478	94	123	26	235	96
IRRI119	4531	118	146	24	254	105
IRRI123	5781	99	126	26	273	94
IR74371-70-1-1	4375	94	123	24	277	94
CV%	18.5	5.9	4.1	4.5	10.8	5.1
P-Value	<0.004	<0.001	<0.001	0.124	0.141	0.238

3.1.4 Water saving trial on AYT late under transplanted condition.

For this experiment,55 genotypes was selected oncludingIRRI123, Samba Mansuli and Swarna as a check. These genotypes have better yield potential under semi irrigated condition.These genotypes were selected based on the phonological traits during 2016 wet season at RARS Tarahara. Seeding was done on July 16, 2016 and transplanted on Aug 15, 2016. The seedling was transplanted at a spacing 20cm x 20cm in a plot sized 4m x 0.8m. The result revealed that all thegenotypes differed significantly with respect to yield. IR95815-4-1-1-3,IR93856-104-1-1-4,IR92522-70-3-1-2 and IR93858-38-1-1-2 had produced higher yield than resistance check IRRI123.

Table 4: Water saving trial on AYT late under transplanted condition

Genotypes	Yield(kg/ha)	Heading days	Maturity days	Panicle length	Tillers per m2	Plant height
IR95815-4-1-1-3	7031	102	129	24	293	93
IR93856-104-1-1-4	6719	97	126	24	284	103
IR92522-70-3-1-2	6719	98	127	25	324	90
IR93858-38-1-1-2	6250	99	127	25	295	102
IR95804-2-1-1-2	6250	98	126	24	269	94
IR95840-5-1-1-3	6250	100	129	24	280	91
IR93849-22-3-1-1	6234	94	123	24	287	91
IR93856-23-1-1-1	6172	105	133	24	263	92
IR93827-29-1-1-3	6094	97	125	24	332	101
IR92545-51-1-1-3	6094	92	121	24	264	92
IR93810-11-1-1-3	6016	94	122	23	269	97
IR95840-33-3-2-2	6016	96	124	26	312	105
IR93806-19-4-3-1	5937	91	120	23	289	87
IR92545-24-1-1-2	5937	97	125	24	281	84
IR95784-21-1-1-2	5937	109	142	25	280	91
IR95795-53-1-1-2	5937	92	135	24	263	101

IR95814-10-2-2-2	5937	101	129	23	254	86
IR95817-5-1-1-2	5937	99	127	24	304	90
IR95817-5-1-1-1	5875	98	126	23	241	90
IR95840-33-3-2-1	5875	102	130	25	278	95
IR93827-29-1-1-4	5859	99	127	24	328	104
IR92522-91-3-1-4	5859	96	124	22	279	92
IR91298-27-1-1-2	5859	102	129	25	271	94
IR93822-9-2-3-1	5781	100	126	22	324	84
IR93810-2-1-1-1	5781	102	130	23	265	94
IR95809-25-1-1-1	5781	101	129	26	261	88
IR95817-14-1-1-2	5625	96	124	23	323	100
IR93857-49-2-1-3	5547	97	125	25	230	94
IR95839-24-1-1-2	5531	101	129	24	289	93
IR93827-29-1-1-2	5469	93	122	23	296	93
IR93809-9-1-1-3	5469	100	128	26	241	93
IR95836-31-2-1-3	5469	104	132	25	301	95
IR92545-45-4-1-1	5312	96	124	23	277	89
IR89889-34-2-1-1	5156	101	129	25	273	88
IR95829-1-1-1-3	5078	98	126	23	286	89
IR93807-44-2-1-1	5000	102	129	23	293	88
IR93806-32-2-2-1	5000	97	126	23	288	88
IR92540-8-3-3-1	5000	101	129	24	261	87
IR83377-B-B-47-3	5000	98	126	23	230	84
IR93809-110-1-3-2	4856	102	130	25	264	93
IR93810-11-1-1-1	4844	96	124	23	280	90
IR93810-17-1-4-1	4844	100	128	23	260	100
IR93858-48-1-2-1	4766	91	120	23	299	90
IR89889-18-1-2-1	4766	101	129	22	246	86
IR93827-29-2-1-3	4609	101	129	23	297	97
IR93809-9-2-1-4	4609	99	126	24	262	86
IR92545-42-2-2-1	4531	94	123	25	303	87
IR93810-2-1-1-2	4297	97	126	23	294	95
IR89889-13-3-2-2	4297	108	136	24	247	82
IR92546-8-3-1-4	4141	101	129	23	247	83
IR93810-16-3-2-4	4062	96	124	24	271	95
IR93810-9-1-1-1	3594	95	124	21	298	88
IRRI123	6094	96	125	26	329	95
Samba Mansuli	2944	118	146	21	308	63

Swarna	2734	119	147	20	295	69
CV	13.8	3.6	3.3	5.6	12.3	4.5
LSD	<0.001	<0.001	<0.001	0.014	0.431	<0.001

3.1.5 Breeder seed Production of rice genotypes

Breeder seed of IR79907-B-389-8-1, IR80991-B-330-U-1, Tarahara-1 and Sukha Dhan-3 is being produced at RARS Tarahara. The genotypes IR79907-B-389-8-1 and IR80991-B-330-U-1 were selected as best genotypes from earlier phase of ADB project. They were screened for yield potential, excellent phenotype including nematode resistance, weed competitiveness and nutrient use efficiency.

3.1.6 Selection on F2 segregating generation

For this experiment 20 genotypes was selected in the F.Y. 2016. Among them IR108063, IR108065, IR108071, IR108085, IR108199, IR108202 and IR108204 were selected for more vigor, high tillers, cleanness, uniform panicles exertion, and uniform maturity at three growth stages. Their seed was multiplied as head to row method for next generation.

Fig. 3: Seed bed Preparation of selected entries from AYT medium and AYT Late for AWD trial in 2015 and seed production of IR79907-B-389-8-1 and IR80991-B-330-U-1 (Far left)

Fig 4: Rice genotypes were placed under dry direct seeded condition in spring 2015 at RARS Tarahara, Nepal

3.1.7 Advanced yield trials of rice in upland rainfed condition.

The advanced Yield Trial was was carried out under upland condition during rainy season in the year 2016. The trial was laid out in Alpha lattice design that included 28 entries in three replications. The net harvest area was 4m x 0.8mand fertilizer dose applied was 80:50:30 NPK kg/ha. Half dose of nitrogen and full dose of phosphorus and potassium was applied as a basal dose. The remaining half dose of nitrogen was applied during tillering stage.

Table 5: Advanced yield trials of rice in upland rainfed condition

Entry Number	Yield (ton/ha)	Maturity Days(DAS)	Heading Days(DAS)	Plant Height(cm)	Panicle Length(cm)
IR86857-61-2-1-2	0.833	106	77.33	88	22.33
IR85735-42-1-4-4	1.48	104	78.67	91	22.67
IR853399-B-B-52-1	1.26	105	76.67	80	23
IR82635-B-B-47-1	1.08	106	77.67	91.67	22.33
IR82098-B-B-23-B	1.83	111	82	90.33	24.33
IR82635-B-B-47-2	1.40	108	79	80.67	22
IR86857-48-4-1-3	**2.03**	106	77	92	20.67
IR74371-54-1-1(C.K)	1.96	106	80	92	34.33
IR85749-8-3-1-4	1.76	110	84	89.33	22.33
IR85749-11-3-5-4	1.10	105	79.67	80.33	22.33
IR86815-23-4-1-2	**2.1**	106	77.33	83.67	24

TARAHARA-1(C.K)	1.8	107	81.67	94.67	22.33
IR87287-2-2-1-2	**2.3**	108	79	84.33	22
UPLR-17(C.K)	**2.1**	107	81	77	21.33
IR83928-B-B-81-2	1.6	105	79.33	87.33	24.33
IR85733-19-4-1-1	**2.3**	104	78	78.67	22.33
IRRI-132(C.K)	1.7	105	79	85.67	22.33
IR8689-34-1-1-4	1.7	107	81.33	86.33	25.67
IR86840-42-1-2-1	**2.4**	110	84	87	24
IR86857-101-2-1-3	2.2	114	88	90	23
IR83929-B-B-132-3	**2.02**	108	82	90	21.67
IR86841-47-2-1-3	**2.26**	110	84.33	84.33	24
IR85749-21-2-5-4	**2.43**	114	88.33	84.67	22.33
IR86802-19-1-1-2	1.6	105	79.67	88.33	22.33
Grand mean	1.82	108.58	81.61	85.51	22.89
CV%	27.8	4	4.9	9.1	6.9
LSD	0.82	7.15	6.58	12.72	2.60
P-Value	0.001	0.009	<0.001	0.072	0.114

Results and Conclusion:

The result revealed significant difference among genotypes with respect to grain yield, days to heading and days to maturity (Table5). The genotypes IR85733-19-4-1-1, IR86857-48-4-1-3 and IR74371-54-1-1 were higher yielder that yielded2.3, 2.03 and 1.96 ton/ha respectivelyand are early in maturity.

3.1.8 Evaluation of rice genotypes for Reproductive Stage Drought Stress.

The twelve genotypes were used in each (drought and irrigatedenvironmental) conditionsand replicated twice. The trialwas carried out in split plot design.Drought stress trial was carried out in upland condition by making trench around the plot to drain out the rain water. The water management (drought and irrigated environment) was used as main plots and varietiesas sub plots. The fertilizer dose applied was NPK @ 80:40:30 kg/ha in each condition. The traits of both environmentwasrecorded and compared.

The stress susceptibility index is the indirect selection criteria. The genotypes with higher SSI were selected as the susceptible genotypes whereas genotypes with least SSI were selected as the drought tolerant. The variety having SSI index nearly equals to zero might be the most stable one in all environmental conditions.The genotypes differed for grain yield and plant height (Table 6).

Table 6: Evaluation of rice genotypes for Reproductive Stage Drought Stress

Genotypes	Average Yield(ton/ha)			Average Plant Height(cm)		
	Drought	Irrigated	Combined mean	Drought	Irrigated	Combined mean
IR87707-446-B-B-B	1.670	3.337	2.5	79.53	90.13	84.83
IR87707-445-B-B-B	2.640	3.753	3.19	75.87	89.27	82.57
IR87707-118-B-B-B	1.667	3.750	2.70	73.13	86.87	80
IR87729-69-B-B-B	2.013	3.473	2.74	80.47	88.33	84.40
IR87706-215-B-B-B	1.737	3.960	2.84	76.20	91.33	83.77
IR87707-182-B-B-B	2.430	3.403	2.9	81.20	91.20	86.17
IR87705-44-4-B	2.570	2.710	2.6	82.07	89.33	85.70
IR87705-14-11-B	2.573	3.193	2.88	76.67	90.53	83.60
IR87705-83-12-B	2.467	2.917	2.69	82.60	89.33	85.97
IR87728-102-B-B	2.500	3.890	3.19	77.93	83.13	80.53
RADHA-4	2.917	5.347	4.132	86.07	91.47	88.77
HARDINATH-1	2.083	1.807	1.94	88.93	101.3	95.10
Grand Mean	2.272	3.462	2.86	80.05	90.18	85.12
P-value			0.006			0.010
LSD value			0.87			6.98
CV%			26.4			7.1

Results and Discusssion:

The check varieties used for this trial were RADHA-4 and HARDINATH-1. The yield of Radha-4 under irrigated condition was the highest amongall varieties tested but rapid yield loss was observed in drought condition. The huge reductions of yield in drought condition as compared to irrigated condition indicated that Radha-4 was suitable for the irrigated condition only.

Yield of Hardinath-1 was superior in drought (stress condition) than in irrigated (non stress) condition. This indicated that the variety possesses stress tolerance. Besides Hardinath-1, IR87705-44-4-B, IR87705-14-11-B, IR87705-83-12-B and IR87728-102-B-B produced stable and higher yield under stress condition. These varieties could be used in drought prone areas of Siraha, Saptari and occasional drought prone areas like Jhapa and Morang districts of Nepal.

The higher yield was found for Radha-4, IR87728-102-B-B, IR87728-102-B-B, IR87708-215-B-B-B, IR87707-118-B-B-B and IR87707-445-B-B-B under irrigated condition. Under drought condition, higher yields were found for IR87707-445-B-

B-B, IR87707-182-B-B-B and IR87705-44-4-B. The genotypes with stable yield performance in both conditions were IR87705-44-4-B and IR87705-14-11-B.

Conclusion:

From the above result it can be concluded that huge reductions of yield in drought condition as compared to irrigated condition indicated that Radha-4 was suitable for irrigated condition whereas Hardinath-1, IR87705-44-4-B, IR87705-14-11-B, IR87705-83-12-B and IR87728-102-B-B produced stable and higher yield under stress condition can be used in drought prone areas of Siraha, Saptari and occasional drought prone areas like Jhapa and Morang districts of Nepal.

3.1.9 Evaluation of rice genotypes for Reproductive Stage Drought Stress

The experiment was conducted inside the pond of Regional Agricultural Research Station inthe year 2016.The experiment consisted of 10 popular rice variety of Nepal and India. Each variety is considered as an individual treatment and replicated thrice.The net harvest plot size was of 4m x0.8m. The fertilizer dose of 80:50:30 NPK kg/ha was applied. Half dose of nitrogen and full dose of phosphorus and potassium was applied as basal dose and remaining half dose of nitrogen was topdressedat tillering stage.

The Indian variety Ranjeet performed better in submerged condition. The popular variety Radha-12 and Sabitri also resultedthe satisfactory yield in submergence condition. The check variety IR-42 couldn't recover in all replications. Some tillers of Kanchhi Masuli also recovered. The variety Swarna sub-1, Samba Masuri sub-1 and IR64 sub-1 were chosen as new variety having good grain quality, cooking quality and medium maturity with acceptable grain yield in complete submergence for 12 days with one meter depth inside the pond. The observation taken in this year is yet to be analysed for final conclusion.

3.1.10 Survey and general information of stress prone areas of eastern terai region

The survey was carried out in Mrigauliya of Morang, Bhokraha of Sunsari Kadmaha of Saptari, and Lahan of Siraha selecting twenty farmers from each district. The districts having potentiality of growing aerobic rice, and following alternate wetting and drying technology were prioritized for household survey using questionnaire with the given template from IRRI. Each cluster was characterized based on irrigation system, existing cropping pattern, method of irrigation and socioeconomic situation. The information includes socio-economic status of individual household, existing cultivated rice varieties, acceptable traits of varieties,

negative traits of varieties, availability of water for the last five years, total area under transplanted condition and existing production. The potentiality of rice variety after completion of this project was assessed from the questionnaire like benefit of aerobic cultivation practices, alternate wetting and drying cultivation practices, problem associated with aerobic cultivation practices and future prediction of varietal yield in such condition.

The results of the household survey differed from place to place. In Siraha and Saptari districts, dominating community engaged in farming is Tharu (Chaudhary). The respondents from Sunsari and Morang districts were of mix communities.

About 80 percent surveyed areas had rainfed ecosystem. Kanchhi Masuli, Indian Sona Masuli and Hardinath-1 are popularly cultivated varieties in Siraha and Saptari districts whereas Ranjeet, Kanchhi Masuli and Hardinath-1 are cultivated in Sunsari and Morang districts. Sunsari and Morang were characterized as semi irrigated to rainfed whereas Siraha and Saptari were categorized under complete rainfed ecosystem. Kanchhi Masuli is the most popular variety grown for many years because it has good eating quality, cooking quality, drought tolerance traits and other abiotic stress. It is also popular for popped and beaten rice and thus, it fetches higher market price. Similarly, it fits well for the rice- wheat cropping pattern of Nepal. Its straw quality and medium plant height are acceptable characters. Thus, the variety has enough potentiality to be improved in future by introduction of blast resistance traits. Indian Ranjeet is second popular variety for the rainfed to irrigated ecosystem but it has poor straw quality. Among the newly developed varieties, Hardinath-1 and Tarahara-1 were found more popular. Besides that, Sukha Dhan-3 and Sukha Dhan-5 were also preferred varieties but they were recently pushed for cultivation. There is need to promote these varieties.

Declining trend of water availability for the last 5 years was information received from all surveyed sites. As a result, rice area production was reported as decreasing continuously. Went down of water table and lack of climate resilient short duration varieties for water short areas were reasons for decreasing area and production of rice in eastern terai region. Farmers demand the rice variety which could have potential to produce better yield under the water short condition. In addition, they are also getting convinced now to grow rice under the direct seeded condition. These information clearly indicate that the farmers will adopt aerobic rice, alternate wetting and drying technology benefitting in terms of productivity.

3.1.11 Varietal evaluation of rice under upland aerobic condition

36 genotypes were selected for this experiment. The major trait to be observed was grain yield (kg/ha) produced under aerobic dry direct seeded condition at RARS Tarahara. Each genotype was cosnidered as an individual treatment and replicated thrice under randomized complete block design haning plot size of 5m x 1.4 m. The fertilizer dose applied was 100:30:30 NPK kg/ha. The seeding was done on 1st March, 2016.

The result stated that genotypesIR92521-114-2-2-2, IR93821-41-1-2-1, IR92521-173-1-3-2 and IR92521-173-1-1-1 are superior with respect to yield than standard check Vandana (table 7). Thus, these genotypes can be recommended forgeneral cultivation and release in future.

Table 7: Varietal evaluation of rice under upland aerobic condition

Genotypes	Yield (kg/ha)	Heading days	Maturity days	Panicle length (cm)	Tillers per m^2	Plant height (cm)
IR92521-114-2-2-2	5833	73	102	24	233	113
IR92521-173-1-3-2	5729	71	100	25	169	128
IR93821-41-1-2-1	5521	71	104	24	187	99
IR92521-173-1-1-1	5312	71	100	23	229	113
IR83399-B-B-52-1	5104	72	97	24	158	114
IR91326-20-1-1-1	5000	70	99	22	179	115
IR93835-167-2-2-2	4896	70	99	22	230	118
IR93835-78-3-1-1	4896	72	101	24	206	115
IR93828-195-2-1-1	4896	70	99	24	193	111
IR92521-143-7-2-1	4896	72	101	23	204	102
IR91326-20-2-1-2	4792	69	98	22	205	101
IR91326-7-13-1-1	4688	75	101	23	185	109
IR93835-74-2-1-1	4583	70	99	22	225	104
IR92521-172-5-1-1	4583	74	103	23	213	106
IR92521-120-1-3-2	4479	72	101	23	216	102
IR91326-20-2-1-4	4479	74	103	23	214	101
IR93835-73-2-3-1	4375	71	100	22	219	108
IR91328-43-6-2-1	4375	73	102	23	182	104
IR91326-20-1-1-2	4375	73	102	22	199	105
IR92521-146-3-3-2	4375	73	102	22	158	103
IR92521-147-3-1-2	4375	71	103	23	170	106

IR93823-36-1-1-1	4167	75	104	22	180	100
IR93835-70-2-2-1	4167	76	105	22	164	101
IR92521-143-4-3-2	4062	75	104	23	466	104
IR92521-143-2-2-1	4062	78	109	25	203	110
IR93835-133-3-1-1	3750	74	103	21	167	100
IR91326-19-2-1-2	3750	77	106	22	153	101
NSIC2011RC192	4688	77	106	21	220	103
UPLRi7	4792	82	111	23	188	102
Vandana (Check)	5312	78	107	22	198	108
IRRI132	6250	84	113	22	222	104
Tarahara-1	4708	80	108	24	182	109
CV%	20	2.9	2.4	4.8	18.6	4.7
P-Value	0.32	<.001	<0.001	<0.001	0.139	<.001

3.1.12 Advanced Yield Trial (AYT) medium under transplanted condition

These are the genotypes selected for the Advanced Yield Trial (AYT) medium under alternate wetting and drying irrigation system. These genotypes were selected based on the phenological traits during 2016 wet season at RARS Tarahara. These genotypes have better yield potential and are excellent under semi irrigated condition.The design used was alpha lattice with two replications. The plot size of 4m*0.8m with spacing of 20cm*20cm was used. The genotypes were seeded on July 16, 2016 and transplanted on August 15, 2016. Fertilizer dose of 100:30:30 NPK kg/ha was used. The genotypes differed significantly for yield (kg/ha). These genotypes were superior to standard check Sukha Dhan-3 (IR74371-70-1-1).

Table 8: AYT medium under transplanted condition

Genotypes	Yield (kg/ha)	Heading days	Maturity days	Panicle length (cm)	Tillers per m2	Plant height (cm)
IR95836-14-3-1-2	7812	98	126	23	348	99
IR95814-29-1-1-3	7734	96	123	23	337	98
IR95780-43-1-1-1	7375	92	122	25	302	102
IR95817-23-2-1-2	7188	98	126	25	331	98
IR95785-5-2-2-1	7031	93	123	25	316	101
IR93810-17-1-2-3	6719	95	123	24	335	100
IR95785-15-2-1-2	6719	94	123	23	301	102
IR93856-10-2-3-3	6541	93	122	24	327	100
IR93856-10-2-3-2	6016	91	121	24	288	99

IR95840-35-1-2-3	5938	98	126	25	333	100
IR95785-31-2-1-2	5781	98	126	23	323	99
IR95840-35-1-2-2	5781	106	133	24	306	100
IR92545-4-2-1-2	5625	93	121	24	300	100
IR95814-27-1-2-3	5625	106	133	25	275	98
IR88964-11-2-2-4	5469	91	120	24	311	97
IR93809-2-1-3-2	5391	92	121	25	261	92
IR94224-17-1-3-3	5312	90	119	26	304	101
IR93807-8-1-1-1	5312	98	126	24	286	91
IR95793-5-2-2-3	5234	93	123	25	315	100
IR95801-6-3-1-1	5000	113	140	24	336	97
IR92526-1-1-1-2	4688	102	129	23	277	88
IR96279-33-3-1-2	4612	109	136	25	265	97
IR95785-5-2-2-2	4412	103	131	24	282	98
IR74371-70-1-1	4219	93	122	27	278	100
IR95781-15-1-1-4	4109	107	134	24	297	90
IR95804-5-1-1-2	4062	107	137	25	311	100
IR95786-9-2-1-2	3906	103	132	23	335	93
IR96319-6-3-1-2	3828	108	134	23	296	91
IRRI119	6094	116	143	25	349	102
MTU1010	6250	93	122	23	296	101
IRRI123	6406	93	123	24	290	101
IR64	5469	92	122	24	332	97
IR74371-70-1-1	3478	94	123	26	235	96
IRRI119	4531	118	146	24	254	105
IRRI123	5781	99	126	26	273	94
IR74371-70-1-1	4375	94	123	24	277	94
CV%	18.5	5.9	4.1	4.5	10.8	5.1
P-Value	<0.004	<0.001	<0.001	0.124	0.141	0.238

3.1.13 Advanced Yield Trial (AYT) late under transplanted condition

Advanced Yield Trial (AYT) wasconducted by selecting 55 genotypes as an individual treatment. These genotypes were selected based on the phonological traits during 2016 at RARS Tarahara. These genotypes have better yield potential and were excellent under semi irrigated condition. The plot size was 4m x 0.8m at a spacing 20cm x 20cm Seeding was done on July 16, 2016 and transplanted on Aug 15, 2016. The genotypes differed significantly for grain yield. Besides, these genotypes have excellent characteristics with higher yield. In terms of yield,

IR95815-4-1-1-3,IR93856-104-1-1-4,IR92522-70-3-1-2 and IR93858-38-1-1-2 had produced more yield than resistance check IRRI123. However, Samba Mahasuri and Swarna produced 2944 and 2734 kg per ha, respectively and they were used as susceptible check under late transplanted condition.

Table 9: AYT late under transplanted condition

Genotypes	Yield (kg/ha)	Heading days	Maturity days	Panicle length	Tillers per m2	Plant height
IR95815-4-1-1-3	7031	102	129	24	293	93
IR93856-104-1-1-4	6719	97	126	24	284	103
IR92522-70-3-1-2	6719	98	127	25	324	90
IR93858-38-1-1-2	6250	99	127	25	295	102
IR95804-2-1-1-2	6250	98	126	24	269	94
IR95840-5-1-1-3	6250	100	129	24	280	91
IR93849-22-3-1-1	6234	94	123	24	287	91
IR93856-23-1-1-1	6172	105	133	24	263	92
IR93827-29-1-1-3	6094	97	125	24	332	101
IR92545-51-1-1-3	6094	92	121	24	264	92
IR93810-11-1-1-3	6016	94	122	23	269	97
IR95840-33-3-2-2	6016	96	124	26	312	105
IR93806-19-4-3-1	5937	91	120	23	289	87
IR92545-24-1-1-2	5937	97	125	24	281	84
IR95784-21-1-1-2	5937	109	142	25	280	91
IR95795-53-1-1-2	5937	92	135	24	263	101
IR95814-10-2-2-2	5937	101	129	23	254	86
IR95817-5-1-1-2	5937	99	127	24	304	90
IR95817-5-1-1-1	5875	98	126	23	241	90
IR95840-33-3-2-1	5875	102	130	25	278	95
IR93827-29-1-1-4	5859	99	127	24	328	104
IR92522-91-3-1-4	5859	96	124	22	279	92
IR91298-27-1-1-2	5859	102	129	25	271	94
IR93822-9-2-3-1	5781	100	126	22	324	84
IR93810-2-1-1-1	5781	102	130	23	265	94
IR95809-25-1-1-1	5781	101	129	26	261	88
IR95817-14-1-1-2	5625	96	124	23	323	100
IR93857-49-2-1-3	5547	97	125	25	230	94
IR95839-24-1-1-2	5531	101	129	24	289	93
IR93827-29-1-1-2	5469	93	122	23	296	93
IR93809-9-1-1-3	5469	100	128	26	241	93

IR95836-31-2-1-3	5469	104	132	25	301	95
IR92545-45-4-1-1	5312	96	124	23	277	89
IR89889-34-2-1-1	5156	101	129	25	273	88
IR95829-1-1-1-3	5078	98	126	23	286	89
IR93807-44-2-1-1	5000	102	129	23	293	88
IR93806-32-2-2-1	5000	97	126	23	288	88
IR92540-8-3-3-1	5000	101	129	24	261	87
IR83377-B-B-47-3	5000	98	126	23	230	84
IR93809-110-1-3-2	4856	102	130	25	264	93
IR93810-11-1-1-1	4844	96	124	23	280	90
IR93810-17-1-4-1	4844	100	128	23	260	100
IR93858-48-1-2-1	4766	91	120	23	299	90
IR89889-18-1-2-1	4766	101	129	22	246	86
IR93827-29-2-1-3	4609	101	129	23	297	97
IR93809-9-2-1-4	4609	99	126	24	262	86
IR92545-42-2-2-1	4531	94	123	25	303	87
IR93810-2-1-1-2	4297	97	126	23	294	95
IR89889-13-3-2-2	4297	108	136	24	247	82
IR92546-8-3-1-4	4141	101	129	23	247	83
IR93810-16-3-2-4	4062	96	124	24	271	95
IR93810-9-1-1-1	3594	95	124	21	298	88
IRRI123	6094	96	125	26	329	95
Samba Mahasuri	2944	118	146	21	308	63
Swarna	2734	119	147	20	295	69
CV	13.8	3.6	3.3	5.6	12.3	4.5
LSD	<0.001	<0.001	<0.001	0.014	0.431	<0.001

3.1.14 Monitoring of rice diseases in ETR

Rice field was monitored in spring (*Chaite*), boro/winter (*Hiunde*) and main/raiy (*Barkhe*) season during seedling, tillering, flowering and ripening stage during 2016/17. Incidence of various diseases was recorded in the field. The diseased specimens were collected for laboratory investigation. Occurrence of any disease was recorded in various locations. Study revealed that seedling blight caused by *Sclerotium rolfsii* is the major disease of winter/boro and spring season rice which was observed in Jhapa, Morang and Udaypur. Unlike winter/boro and spring season, blast, bacterial blight and sheath blight were the major diseases in main season rice. Blast was observed in seedling, tillering to flowering stage in some blast susceptible varieties like Masuli, Kanchhi Masuli etc. Moreover, higher incidence of neck blast was observed in those varieties. Brown spot was also observed as major disease from nursery to ripening in the drought prone areas.

Bacterial leaf blight was observed in Jhapa, Morang, Sunsari, Udaypur and Saptari. Similarly, sheath blight was observed in Jhapa, Morang, Sunsari and Saptari. Similarly, false smut and sheath rot was also observed in Jhapa and other districts.

3.1.15 Evaluation of rice genotypes against blast under field condition

Blast, caused by *Magnaporthe oryzae*, is one of the most important diseases of rice in Nepal. It has been causing significant yield loss in all rice growing areas. The disease can be best managed through host plant resistance. This field screening experiment was conducted to identify the sources of resistance in rice to the disease. A total of 709 entries from OBN (73) Quality (16), RAVTN (22), RAVTRL (24), Hybrid (126), IRRI (63) and NRBN (385) were screened for resistance to the disease during the 2016 wet season at Regional Agricultural Research Station, Tarahara. Two rows of seeds of each rice genotypes were seeded continuously at 10 cm row to row distance under upland condition. Fertilization of 150:50:0 kg NPK/ha was done as basal. Natural dispersal of the pathogen in the test lines was allowed from border lines /inoculums rows planted around the nursery with mixture of susceptible varieties (i.e. Mansuli and Sankharika). Conducive environment for blast development was created by planting four rows of *Sesbania eculeata* around the experimental plot 35 days prior to seeding of test genotypes. Scoring was done on the 22nd day after seeding and continued for three scorings at 3 days interval using 0-9 scale developed by IRRI. The score of 0-2 was considered as resistant reaction where as 3-4, 5-6 and 7-9 were considered as moderately resistant, susceptible and highly susceptible, respectively.

Area under disease progress curve (AUDPC) varied significantly among the tested rice genotypes. The number of resistant (0-2), moderately resistant (3-4), moderately susceptible (5-6) and highly susceptible (7-9) genotypes was 596, 55, 43 and 10, respectively (Table 17). Among them, IR75299-94-1-2-2, IR70215-70-CPA-4, IR87377-B-B-93-3, IR79246-105-2-2-4, NR2167-41-11-3-1, NR2158-13-1-12-4, NR2167-46-1-1-1-1, NR2157-166-2-1-1-1, IR94391-131-358-19-B, IR96321-1099-227-B-3-1-3, CT19151-7-5-1-25R-1p, NR2167-48-5-1-2-1-1, NR4157-166-1-3-5-1, BRRI Dhan-38, NR2157-66-2-3-1-1-1, Sabitri, Ciherang Sub-1, IR74371-70-1-1, IR70210-39-CPA-7-1-1-4-2, IR82635-B-B-47-1, IR86815-23-4-1-2, IR82635-B-B-47-2, IR74371-54-1-1, NR2167-63-1-1-5-1, WAS191-10-3-FKRI, NR2165-131-3-1-1-1, NR2160-68-1-1-1-1-1, IR78937-B-B-B-B-1, Sundar, Mahima, F8 Basmati-103, IR77537-24-1-3, IR87749-10-1-1-4, NR21883-2-4-1, NHZ12-Y4-Y1-DT1, CT19021-3-5-2VI-1, IR78006-55-2-3-3, IR09F102, IR09F104, IR09F105, IR09F106, IR09F112, IR09F132, IR09F143, IR09F174, IR09F177, IR09F195, IR09F226, IR09F256, IR09F283, IR09F287, IR-42, IRRI-119, IR10F198, IR10F339, IR09F173, IR10F558, IR10F629, IR09F Sub-1, etc were free from blast.

But others were moderately resistant, moderately susceptible and susceptible to the disease. Disease severity increased in the second and third scoring in all entries

except the resistant ones. Forty six entries did not germinate during 2016. Sankharika and Kanchhi-masuli were susceptible to blast and were completely knocked down by the disease during the final scoring. Similarly, susceptible check (i.e Masuli and Sankharika) were completely knocked down by the disease. These blast resistant lines can be used in breeding program for development of blast resistant commercial varieties and/ or can be directly promoted in the blast prone areas of the country.

Table 10: Frequency distribution of reaction of rice genotypes against blast disease tested in blast nursery during 2016

SN	Reaction	Resistant	Moderately Resistant	Moderately Susceptible	Susceptible	No Germination	Total
1	OBN	21	23	19	10	0	73
2	Quality	9	4	0	1	2	16
3	RAVTN	17	3	0	1	1	22
4	RAVTRL	11	5	2	2	4	24
5	NRBN	278	30	16	25	36	385
6	Hybrid	80	22	17	5	2	126
7	IRRI	13	10	8	31	1	63
Total		429	97	62	75	46	709

3.1.16 Pesticide evaluation on incidence of leaf and neck blast in rice

The experiment was conducted at Regional Agricultural Research Station, Tarahara during the 2016 wet season. Various pesticides i.e. Trip (1 g/l, 1.5 g/l and 2 g/l), and Kasu-B (1 ml/l, 1.5 ml/l and 2 ml/l) were evaluated along with a control in a randomized complete block design with 3 replications. Rice seeds cv. Mansuli was grown in seed bed and transplanted into experimental plots at 22 days after seeding. Plot size was 6 m^2. Natural dispersal of the blast disease in the test plots was allowed from border lines / inoculums rows planted around the nursery with mixture of susceptible varieties (i.e. Masuli and Sankharika). Conducive environment for blast development was created throughout the cropping period. The nursery was sown in the dry seedbed conditions. Fertilization of 50:30:30 kg NPK/ha was done as basal and 50 Kg N was top dressed in 2 splits. Scoring was done using Standard Evaluation System (0-9 scale) for rice (IRRI 1996). Finally, incidence of neck blast and grain yield was recorded.

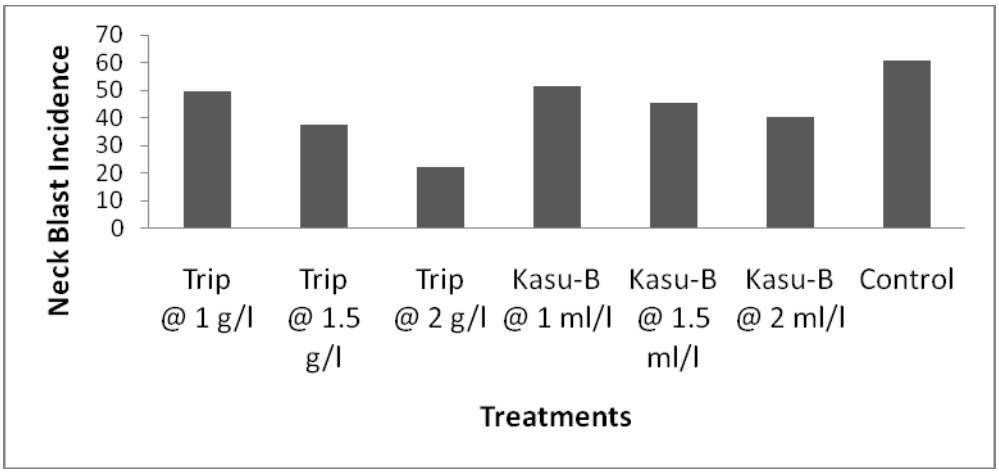


Figure 5: Efficacy of pesticide spray on incidence of neck blast in rice

Among the treatments, application of Trip @ 2g/l water could significantly reduce the incidence of neck blast disease (Figure 19). Similarly, lower incidence of the disease was recorded in Trip @ 2g/l and Kasu-B @ 2 ml/l as compared to the control.

3.1.17 Evaluation of rice genotypes for resistance to bacterial leaf blight

Bacterial leaf blight (BLB) of rice, caused by *Xanthomonas oryzae* pv. *oryzae*, is one of the most important diseases of rice in the eastern terai of Nepal. A field screening experiment was conducted to identify the sources of resistance in rice to the disease during 2016 wet season at Regional Agricultural Research Station, Tarahara. A total of 739 (73-OBN, 16-Quality, 24-RAVTRL, 22-RAVTN, 126-Hybrid, 385-NRBBN, 49-IRRI and 44 NILS) rice genotypes were evaluated for resistance to bacterial blight disease. Each entry was planted in 2 rows of 2 m length in a rod row design. Susceptible variety of rice (purple) was planted at an interval of every 10 entries. The pathogen was inoculated in all entries 56 days after transplanting using Kauffman's clipping method. The disease was scored on 14 days after inoculation and continued for three scorings at 7 days interval using 0-9 scale developed by IRRI. Severity of the disease varied significantly among the tested rice genotypes. Disease severity varied 33 to 100%. None of the genotypes were free from the disease. Out of 739 genotypes, 6 genotypes were resistant, 141 genotypes were moderately resistant, 226 were moderately susceptible, and 341 were susceptible to BLB disease.HHZ25-DT9-Y1-Y1, IR 96321-558-64-B-4-1-1, NR 10491, NR2160-68-1-1-1-1-1, IR12A182, IR12A211, IR12N267, Suravi, Swarna Sub-1, IR80411-B-28-4, IR82835-B-B-47-1, IR82635-B-B-47-2, IR75299-94-1-2-2, IR78006-55-2-3-3, Samba Masuli Sub-1, Radha-12, Tarahara-1, Sabitri, Sukha-5, IR09F102, IR09F188, IR09F195, IR09F197, IR09F226, IR09F229, IR09F236, IR09F238, IR09F251, IR09F253, IR09F283, IR09F293, IRRI-119, IR10F198, etc were moderately resistant to the disease.

Table 11: Frequency distribution of rice genotypes in different nurseries for reaction to bacterial leaf blight disease at RARS, Tarahara

SN	Nursery	Resistant	Moderately Resistant	Moderately Susceptible	Susceptible	No Germination	Total
1	OBN	0	0	21	51	1	73
2	Quality	0	0	4	11	1	16
3	RAVTN	0	3	11	8	0	22
4	RAVTRL	1	1	9	13	0	24
5	NRBBN	0	101	142	126	16	385
6	Hybrid	1	8	23	93	1	126
7	IRRI	0	11	12	20	6	49
8	NILS	4	17	4	19	0	44
Total		6	141	226	341	25	739

IR93807-44-2-1-1, IR93857-59-2-1-3, IR93806-19-4-3-1, IR93809-110-1-3-2, IR 88836-39-1-2-1, IR 87761-28-1-1-3, IR 87759-7-1-2-3, IR 91326-7-13-1-1, IR91326-20-1-1-2, IR92521-173-1-3-2, IR91328-43-6-2-1, IR 92521-172-5-1-1, IR 93835-74-2-1-1, IR 93835-133-3-1-1, IR 93823-36-1-1-1, IR87761-51-1-1-4, RP34467-3-1-1-2-1, IR86815-23-4-1-2, IR74371-54-1-1, WAS191-10-3-FKRI, NR2160-31-1-2-2-2-1, IR70215-70-CPA-4-1-1-3, Karjat -3, MTU-115, NR2157-32-2-2-2-1, NR2167-46-1-1-1-1, Brridhan – 38 were highly susceptible to the disease. Disease severity increased in second and third scoring in all entries. The moderately resistant lines can be used in breeding program for development of bacterial leaf blight resistant commercial varieties and the resistant varieties can be grown in the BLB prone areas of the country.

3.1.18 Pesticide evaluation against false smut in rice

Experiment was carried out in a randomized complete block design (RCBD) with 4 replications where treatments were pesticide application. Bavistin® (carbendazim 50%),Dithane M-45® (mancozeb 75%), Dhanucop® (Copper oxychloride 50% WP), Trip® (Tricyclazole 75%), Saff® (Carbendazim 12% + Mancozeb 63% WP) and Pinnacle® (Propiconazole 25% EC) were evaluated along with a control (water spray). Bavistin®, Dithane M-45®, Dhanucop®, Trip®and Saff®were applied at the rate of 2g/l water where as Pinnacle® (Propiconazole 25% EC) was applied at the rate of 1 ml/l water. Rice cv. Samba mahsuri Sub-1 was used for the experiment. Fertilization of 50:30:30 kg NPK/ha was done as basal and 50 Kg N was be top dressed in 2 splits. Spraying with chemicals were done before flowering and repeated once after 15 days. Incidence of false smut and grain yield were recorded.

Table 12: Effect of pesticides on incidence of false smut incidence and grain yield of rice

SN	Pesticides	False smut incidence (%)	Grain yield (t/ha)
1	Bavistin®	18.4	3.5
2	Dithane M-45®	18.1	3.4
3	Dhanucop®	7.9	3.8
4	Trip®	10.1	3.6
5	Pinnacle®	9.0	3.7
6	Saff®	14.8	3.6
7	Control	12.9	3.6

Results showed that false smut could be managed by spraying Dhanucop®(Copper oxychloride 50% WP) or Pinnacle® (Propiconazole) before flowering and after flowering (Table 12). However, there was no significant effect on grain yield.

3.1.19 Efficacy of trichoderma and gel treatment on drought tolerance, disease resistance and grain yield of rice

A field experiment was conducted at Regional Agricultural Research Station, tarahara, Sunsari, Nepal, during 2016 wet season to study the efficacy of Trichoderma and gel treatment on drought tolerance, disease resistance and grain yield. The experiment was conducted in 2 factorial randomized complete block design (RCBD) with 3 replications. One factor comprised of various treatments (i.e no treatment; seed treated with Trichoderma; gel in furrow; seed treatment with Trichoderma and gel in furrow; and seed treatment with gel) and the other factor comprised of rice varieties (ie. Sukhadhan-4 and Chaite-2). Seed treatment was done one day before seeding but furrow application was done during seed sowing. Trichoderma was used at the rate of 12 g/kg seeds and CUMI Jal (Gel Crystal) @ 1.5 Kg/Acre. All plots were direct seeded with fertilizer dose of 60:20:20 kg NPK /ha.

Table 13: Effect of seed treatment with gel and trichoderma on disease severity and grain yield of rice

SN	Varities/Treatments	First Brown Spot	First BLB Score	Second Brown Spot	Second BLB Score	Dry Shoot wt	Dry root wt (g/tiller)	Yield (t/ha)

		Score		Score		(g/tiller)		
Factor 1: Varieties								
1	Sukhadhan 4	2.7	1.4	5.1	5.4	143.6	6.4	3.5
2	Chaite 2	3.1	2.6	5.4	6.1	126.4	6.5	3.2
	LSD (α 0.05)	NS	**	NS	NS	*	NS	*
Factor 2: Treatments								
1	No treatment	3.2	2.3	6.0	6.0	115.6	5.9	3.1
2	Seed treatment with *Trichoderma*	2.8	2.0	5.0	6.0	145.6	6.6	3.4
3	Gel in Furrow	3.0	2.3	5.3	6.0	125.1	6.1	3.2
4	Seed treatment with *Trichoderma* and Gel in furrow	2.5	1.7	4.8	5.3	153.7	6.9	3.5
5	Seed treatment with Gel	2.8	1.7	5.2	5.3	135.0	6.8	3.3
	LSD (α 0.05)	NS	NS	*	NS	*	NS	NS
	CV (%)	20.47	47.14	11.73	16.58	12.94	17.71	0.0925

Table 14: Interaction effect of seed treatment with gel and Trichodermaon disease severity and grain yield of rice

SN	Varieties	Treatmetns	First Brown Spot Score	First BLB Score	Second Brown Spot Score	Second BLB Score	Dry Shoot wt (g/tiller)	Dry root wt (g/tiller)	Yield (t/ha)
1	Sukhadhan 4	No treatment	3.0	1.7	5.7	5.7	126.0	6.0	3.3
2	Sukhadhan 4	Seed treatment with *Trichoderma*	2.7	1.7	5.0	5.7	152.4	6.2	3.6
3	Sukhadhan 4	Gel in Furrow	2.7	1.7	5.0	5.7	140.9	6.2	3.4
4	Sukhadhan 4	Seed treatment with *Trichoderma* and Gel in furrow	2.3	1.0	5.0	5.0	154.0	6.8	3.7
5	Sukhadhan 4	Seed treatment with Gel	2.7	1.0	5.0	5.0	144.9	6.6	3.4
6	Chaite 2	No treatment	3.3	3.0	6.3	6.3	105.2	5.8	2.8
7	Chaite 2	Seed treatment with *Trichoderma*	3.0	2.3	5.0	6.3	138.7	6.9	3.3
8	Chaite 2	Gel in Furrow	3.3	3.0	5.7	6.3	109.3	6.0	3.0
9	Chaite 2	Seed treatment with *Trichoderma* and Gel in furrow	2.7	2.3	4.7	5.7	153.4	7.1	3.4
10	Chaite 2	Seed treatment with Gel	3.0	2.3	5.3	5.7	125.1	7.0	3.2
LSD (α 0.05)			NS	NS	NS	NS	NS	NS	NS
CV (%)			20.47	47.14	11.73	16.58	12.94	17.71	0.0925

Results revealed that BLB and brown spot was lower but plant weight and grain yield was higher in *Trichoderma* and gel treated plots. Similarly, dry root weight and dry shoot weight was significantly higher in treated plots (Table 14). Among two varieties, BLB and Brown spot was significantly lower in Sukhadhan 4 than Chaite 2. Similarly, dry shoot weight and grain yield was higher in Sukhadhan-4 than the Chaite2. Interaction of treatments and rice varieties were not significantly different (Table 14). Thus, higher grain yield along with lower BLB and brown spot can be produced by treatment with *Trichoderma* and gel crystal.

3.1.20 Participatory varietal selection in rice - Normal (irrigated)

An on-farm experiment was conducted to evaluate rice genotypes for normal irrigated condition at outreach research sites of RARS, Tarahara. IR 78875-207-B-B-B, IR 87615-9-3-1-3, IR 81826-B-B-57, Ciherang Sub-1, IR 05N 445 and Sabitri were evaluated and 4 locations during 2016. The experiment was fertilized with 100:30:30 kg NPK/ha. Fertilization of 50:30:30 kg NPK/ha was done as basal and 50 Kg N was top dressed in 2 splits. Plot size was 100 m^2. Field was observed during, tillering, flowering and maturity stage. Blast, and BLB was scored using Standard Evaluation System (0-9 scale) for rice (IRRI 1988). In blast, the score of 0-2 was considered as resistant reaction where as 3-4, 5-6 and 7-9 were considered as moderately resistant, susceptible and highly susceptible, respectively. Other agronomic practices were followed as per recommendation. The trial blocks were irrigated as and when needed. Data was analyzed using MSTAT-C and Microsoft Excel.

Among the genotypes tested under normal irrigated condition, highest grain yield was recorded in IR 81826-B-B-57 (5.85 t/ha) which was followed by Ciherang Sub-1 (5.36 t/ha), IR 87615-9-3-1-3 (5.14 t/ha), IR 05N 445 (5.04 t/ha), Sabitri (4.63 t/ha) and IR 78875-207-B-B-B (4.60 t/ha). Among them, IR 78875-207-B-B-B, IR 87615-9-3-1-3, IR 81826-B-B-57 and Sabitri were moderately resistant to the bacterial blight disease in the field condition. Similarly, Ciherang Sub-1 and IR 05N 445 were highly susceptible to bacterial blight disease.

Table 15: Response to bacterial blight and grain yield of rice genotypes under normal condition during 2016

SN	Genotypes	BLB	Grain Yield (t/ha)
1	IR 78875-207-B-B-B	MR	4.60 b
2	IR 87615-9-3-1-3	MR	5.14 ab
3	IR 81826-B-B-57	MR	5.85 a
4	Ciherang Sub-1	HS	5.36 ab
5	Sabitri	MR	4.63 b
6	IR 05N 445	HS	5.04 b
	LSD		0.72
	CV		10.72

3.1.21 Participatory varietal selection in rice – Fine and Aromatic (irrigated)

An on-farm experiment was conducted to evaluate 5 fine and aromatic rice genotypes at outreach research sites of Regional Agricultural Research Station, Tarahara. Sundar, Garima, Basamati-101, IR 77512-128-2-1-2and Lalka Basmati were evaluated at 4 locations during 2016. The experiment was fertilized with 100:30:30 kg NPK/ha. Fertilization of 50:30:30 kg NPK/ha was done as basal and 50 Kg N was top dressed in 2 splits. Plot size was 100 m^2. Field was observed during, seedlings, tillering, flowering and maturity stage. Blast and BLB was scored using Standard Evaluation System (0-9 scale) for rice (IRRI 1988). In blast, the score of 0-2 was considered as resistant reaction where as 3-4, 5-6 and 7-9 were considered as moderately resistant, susceptible and highly susceptible, respectively. Other agronomic practices were followed as per recommendation. The trial blocks were irrigated as and when needed. Data was analyzed using MSTAT-C and Microsoft Excel.

Among genotypes tested for fine and aromatic rice, highest grain yield was recorded in Garima (6.25 t/ha) which was followed by Sundar (6.08 t/ha) (Table 15). Similarly, grain yield of IR 77512-128-2-1-2, Basmati 101 and Lalka basamti were 5.02, 4.300 t/ha and 43.70 t/ha, respectively. IR 77512-128-2-1-2 was moderately resistant to bacterial blight disease. Similarly, Garima, Basmati 101, and lalka basmati were moderately susceptible but Sundar was susceptible to the disease (Table 16). Lalka basmati was susceptible to blast but others were moderately resistant to the disease. All gentypes were moderately resistant to sheath blight. Farmers also preferred Garima because of its fine grains, good taste/flavor, higher productivity and earlier maturity.

Table 16: Plant height, grain yield and disease response of rice genoipes under fine aromatic rice

SN	Genotypes	Plant Height (cm)	Grain Yield (t/ha)	Blast	BLB	Sheath blight
1	Sundar	96.6	6.08 a	MR	S	MR
2	Garima	94.6	6.25 a	MR	MS	MR
3	Basmati 101	118.2	4.00 c	MR	MS	MR
4	IR 77512-128-2-1-2	96.6	5.02 b	MR	MR	MR
5	Lalka basmati	148.6	3.70 c	S	MS	MR
	LSD		0.89			
	CV		11.57			

3.1.22 Use of salt sorted seeds of rice

This activity was conducted at Motipur where farmers were oriented about salt sorting of rice seeds. After that 20 kg seed of Tarahara 1 was sorted in salt solution and 20 kg was not sorted (control). After that, the seeds were divided into two equal parts. Later, one half of the sorted and one half of the non sorted seeds were separately cultivated by one farmer and the remaining one half of the sorted and one half of the non sorted seeds was cultivated by another farmer. Finally, 10 samples (@1m^2) from each plot was harvested, threshed, dried and weighed. The results revealed higher yield in salt sorted plots (301 g/m^2) than non-sorted plots (270 g/m^2). Thus, salt sorting of rice seeds could be a promising technology to improve crop health and grain yield.

3.1.23 Participatory seed production

SSNP supported program in seed sector was implemented in farmers groups under six command districts of RARS Tarahara. The program was very successful and has positive impact in quality seed production and supply of cereals and legumes. However, the support from World Bank for this program was over. Therefore, the program was continued at 4 groups (i.e. Sahalesh Fulbari, Mahila Jagritee, Sayapatri and Dihibar baba) to maintain and sustain quality seed production and supply system so that farmers and other stakeholders could get the seed at local level. During 2016/17, these groups produced 1.5 t Foundation seed and 9.2 t certified (first) seed of Wheat. Similarly, 18.5 t foundation seed of rice was produced by the groups. New groups in Motipur and Singhiya produced 10.4 t certified seed of rice.

3.2 Crop: Wheat

3.2.1 Regional Advanced Varietal Trial

Twenty five genotypes collected for this experiment from National Wheat Research Program (NWRP), Bhairahawa. The trial was established in Regional Agriculture Research Station Tarahara in the year 2016. The topography of this experimental site was 130 masl having sandy loam soil. Each genotype was

considered as an individual treatment and replicated twice in alpha lattice design. The analysis of variance revealed the significant variation were present in the genotypes for yield, heading days, maturity days, plant height, spikes per meter square and grain per spikes. The genotypes BL3978 (64), NL1140 (69), BL3623 (69), NL1026 (69), BL 3594(69) and BL3264 (69) required minimum number of heading days, even less than check NL297(67). The genotypes NL1140 and NL1026 were early in maturity, better grains per spikes and good yield. The most stable yield producing genotypes were BL3264, BL3535, BL3623, NL1135 and BL3978. In that respect, the earlier maturing genotypes were BL3594, NL1026, NL297, BL3978 and NL1140 with 97,97,96,92 and 97 maturity days after sowing respectively. The variety BL3978 had maturity duration of 92 days from the date of seeding which was less than check variety NL297. The genotypes NL1093 (39) and NL1094 (38) have highest numbers of grain per spikes which will be used as the parents for hybridization program. The new varieties like BL3978, BL3594 and NL1140 were realized as suitable varieties to this eastern terai region ofNepal.

Table 17: Regional Advanced Varietal Trial

Genotypes	Yield (ton/ha)	Grains/ Spike	Plant Height (cm)	Heading days	Maturity days	Panicle Length length(cm)	Spikes/m2
BL3978	3	28	91	64	92	10.5	269
NL297	2.3	28	83	67	96	10.95	209
NL1140	2.3	32	89	69	102	9.3	272
BL3623	3.03	31	81	69	98	10.65	241
NL1026	2.8	29	91	69	97	9.9	193
BL3594	2.93	26	122	69	97	9.45	256
BL3264	3.03	35	89	70	98	9.9	234
RR21	2.37	33	97	70	98	10.85	250
BL4343	2.6	32	92	70	103	7.4	164
BL3542	2.9	37	97	71	99	11.15	252
BL3528	2.8	34	92	71	99	10.85	208
BL3535	3.2	32	84	71	99	10.05	269
BL2931	2.4	30	99	71	99	10.25	194
BL4018	2.7	28	91	71	99	11.55	190
BL3471	2.5	31	87	72	100	10.5	217
NL1094	2.8	38	84	73	102	9.6	240
GAUTAM	2.66	34	93	73	100	12	212
NL1093	1.86	39	90	74	98	10.6	205
BL3401	2.57	36	87	74	102	10.85	231
BL3539	2.6	31	93	74	102	10.85	224

NL1143	2	22	91	74	101	10	222
BL4012	2.7	32	81	75	102	10.8	251
NL1135	3	24	82	75	97	8.9	202
BL3404	2.38	22	75	75	103	9.5	220
CV%	23.5	22.1	5.8	3.3	2.1	7.2	15.3
P value	0.23	0.04	0.001	0.001	0.001	0.001	0.015
G mean	2.65	31.33	90.01	71.6	99.61	10.41	230.3

3.2.2 Monitoring of Wheat Diseases

Wheat fields were monitored in the eastern plains of Nepal during 2016 and 17 at tillering, heading, grain filling and ripening stage of the crop. Incidence of different diseases was recorded in the field. The diseased specimens were also collected for laboratory investigation. Occurrence of disease was recorded with respect to location, season, genotype, incidence and severity. Study revealed that leaf rust and foliar blight were the major diseases of wheat in the eastern region. However, powdery mildew and smut were also severe in many areas. Highest incidence of leaf rust was recorded in late sown NL 297. Since the disease occurred on the late season, most of the crop escaped the heavy infestation of the disease. Leaf rust severity was upto 40% in most of the locations. Gautam was moderately resistant but Vijaya was moderately susceptible to the diseases. Tilotama, NL971 and Aditya were free from the leaf rust disease. Details of wheat rust and other diseases were recorded at 31 locations and entered into rust tool box. Wheat blast was not observed in any areas.

3.2.3 Performance of wheat genotypes at outreach research sites in the eastern Terai region

The Coordinated Farmers' Field Trial (CFFT) was conducted at 8 outreach reserch locations of Jhapa, Morang, Sunsari, Siraha, Saptari and Udapur Districts during 2015/16 and 2016/17. Plot size was 100 m^2. BL 4406, BL 4407, NL 1164, BL 4463, BL 4341 and Vijay were evaluated under natural epiphytotic conditions at farmers' field during 2015/16. Similarly, BL 4406, BL 4407, NL 1164, BL 4463, NL 1193 and Vijay were evaluated during 2016/17. Fertilizers were applied at the rate of 100:30:30 N:P_2O_5:K_2O kg ha^{-1}. All P_2O_5 and K_2O and half Nitrogen were applied during final land preparation. The remaining half N was top dressed into two splits at tillering and panicle initiation stage of wheat crop. All the other cultural practices were followed as per the requirement.

Foliar blight disease was scored using the scale developed by Saari and Prescott (1975). The double digit scale was used to measured foliar blight where the first digit equated to the height of infection and second digit with the infection severity. The scale gradations were 1 to 9. Similarly, leaf rust was scored using modified

Cobb scale and the scores were then converted to average coefficient of infection (ACI) as described by the U.S. Department of Agriculture for the International Rust Nurseries (Stubbs et al 1986). Similarly, growth stages of wheat were recorded using the scale developed by Zadoks et al (1974). Finally, grain yield was recorded. Data were analyzed by using Microsoft Excel and MSTAT-C (MSTAT, Michigan State Univ., USA). Mean comparisons were done using Duncan's multiple range test. Descriptive analysis was also performed.

NL 1164 was free from leaf rust during both the years. NL 1193, BL 4463, BL 4407 and Vijay were moderately susceptible to leaf rust and their ACI was 1.4, 3.6, 5.4 and 6.1, respectively (Table 18). Similarly, BL 4406 was moderately susceptible to leaf rust but ACI was higher than 8. Severity of foliar blight was lowest in NL 1164 (33.3%) which was followed by BL 4463 (35.2%), in BL 4407 (37.0%), BL 4406 (41.4%), Vijay (44.7%) and NL 1193 (51.0%) (Table 18). Grain yield was significantly different during 2016/17. Grain yield of BL 4406 (3.8 t/ha), BL 4407 (3.6 t/ha) and NL 1164 (3.5 t/ha) was significantly higher than Vijay (3.0 t/ha) and NL 1193 (2.9 t/ha) (Table 18).

Table 18. Grain yield and severity of leaf rust and foliar blight in wheat genotypes under CFFT in the Eastern plains of Nepal

SN	Genotypes	Leaf Rust Score		Severity of Foliar blight (%)	Grain Yield (t/ha)
		ACI	Reaction		
1	BL 4406	12.7	MS	41.4	3.8 a
2	BL 4407	5.4	MS	37.0	3.6 a
3	NL 1164	0.2	R	33.3	3.5 ab
4	BL 4463	3.6	MS	35.2	3.4 abc
5	Vijay	6.1	MS	44.7	3.0 bc
6	NL 1193	1.4	MS	51	2.9 c
					0.45

Note: Mean of 8 replications. Same letters followed in the columns are not significantly different (P= 0.05) by DMRT. DD = Double Digit system, R= Resistant, MR= Moderately Resistant, MS= Moderately Susceptible, S= Susceptible, ACI= Average Coefficient of Infection.

3.2.4 Regional Farmers Field Trial (RFFT)

The Regional Farmers Field Trial (RFFT) was conducted at 5 locations of Jhapa, Morang and Sunsari during 2015/16 and 2016/17. Plot size was 100 m^2. BL 3555, BL 3978, BL 3264, BL 4341, BL 4347 and Aditya were evaluated under natural epiphytotic conditions at farmers field. Fertilizers were applied at the rate of 100:30:30 N:P_2O_5:K_2O kg ha^{-1}. All P_2O_5 and K_2O and half Nitrogen were applied during final land preparation. The remaining half N was top dressed into two splits at tillering and panicle initiation stage of wheat crop. All the other cultural practices were followed as per the requirement.

Foliar blight disease was scored using the scale developed by Saari and Prescott (1975). The double digit scale was used to measured foliar blight where the first digit equated to the height of infection and second digit with the infection severity. The scale gradations were 1 to 9. Similarly, leaf rust was scored using modified Cobb scale and the scores were then converted to average coefficient of infection (ACI) as described by the U.S. Department of Agriculture for the International Rust Nurseries (Stubbs et al 1986). Similarly, growth stages of wheat were recorded using the scale developed by Zadoks et al (1974). Finally, grain yield was recorded. Data were analyzed by using Microsoft Excel and MSTAT-C (MSTAT, Michigan State Univ., USA). Mean comparisons were done using Duncan's multiple range test. Descriptive analysis was also performed.

Aditya showed trace resistance to leaf rust. BL 4341, BL 3978, BL 3264 and BL 4347 were moderately susceptible to leaf rust (Table 43) but their ACI was low (<8). However, BL 4347 and BL 3555 were moderately susceptible and susceptible to leaf rust, respectively, having higher ACI (>8). All the genotypes except Aditya showed susceptible reaction to foliar blight. Severity of foliar blight in BL 4341, BL 3555, BL 3978, BL 3264, BL 4347 and Aditya was 45.9%, 39.5%, 46.1%, 40.3%, 40.3% and 29.6%, respectively (Table 19).

Tested genotypes did not differ significantly in grain yield (Table 43). However, highest grain yield was recorded in BL 4341 (2.83 t/ha), which was followed by BL 3555 (2.78 t ha^{-1}), BL 3264 (2.73 t ha^{-1}), BL 3978 (2.70 t ha^{-1}) and BL 4347 (2.63 t ha^{-1}). The lowest yield was observed in Aditya (2.33 t ha^{-1}).

Table 19: Grain yield and severity of leaf rust and foliar blight in wheat genotypes in RFFT in the Eastern plains of Nepal

SN	Genotypes	Leaf rust		Severity of Foliar	Yield
		Reaction	ACI	blight (%)	(t/ha)
1	BL 4341	MS	4	45.9	2.83
2	BL 3555	S	17	39.5	2.78
3	BL 3978	MS	6.1	46.1	2.70
4	BL 3264	MS	1.2	40.3	2.73
5	BL 4347	MS	10.1	40.3	2.63
6	Aditya	R	0.2	29.6	2.33

Note: R= Resistant, MR= Moderately Resistant, MS= Moderately Susceptible, S= Susceptible, ACI= Average Coefficient of Infection.

3.2.5 Adoption and Economics of Improved Wheat Varieties in Eastern Nepal

Wheat is one of the major cereal crops after rice and maize. It has been growing since time immemorial in Nepal. It is grown in Terai, river basins, mid-hills, and high-hills of Nepal during winter season that lasts from October to April.. Among the cereal grain crops, wheat ranks third in hills and mountains and ranks second in in Terai region t in terms of production and human consumption. The present average wheat yield in terai is 2768 kg/ha compared to 2208 kg/ha in hill and 1892 kg/ha in mountain with national average 2496 kg/ha (MoAD, 2014). With proper management, wheat production can be easily obtained from 3.5 t/ha to 5 t/ha in terai region with the present wheat production technology. There are several factors responsible for low wheat productivity in Nepal like poor irrigation facilities, less availability of fertilizer, pesticides and insecticides (SARPOD,2014 ; Devkota,2013). Wheat yields suffer from some factors such as lack of reliable irrigation, inclement weather, incidence of diseases and lack of improved technology (FAO, 2007; NWRP 2011). Some of the popular wheat varieties of wheat in Nepal are getting susceptible to different diseases for instance,. NL 297 has become susceptible to new biotypes of leaf rust (NWRP, 2011).

Until 2016, NARC had released and recommended 39 wheat varieties for different agro-ecological domains. After 2000 A.D., modern varieties such as Gautam, NL 971, Aditya, Gaura, Dhaulagiri, Danphe having high yield potential and disease resistance characteristics were released by NARC (NARC, 2016). Despite having various improved wheat varieties developed and recommended by NARC, farmers were adopting old and disease susceptible varieties. Adoption of a new technology at farmers' level is determined by various factors like socio-economic characteristics of the farmers, agro-ecological condition, source of seed, role of government etc. This study analyzed adoption pattern and economics of wheat production in eastern terai region of Nepal.

Morang and Saptari district were purposively selected based on the wheat growing potentiality. Four VDCs (Banigama and Motipur of Morang, Kanchanpur and Bhardaha of Saptari) were selected for this study. Twenty households from each VDCs were selected randomly. A total of 80 households (40 from Morang and 40 from Saptari) were selected. Collected data were analyzed with descriptive and quantitative methods. All variable inputs like human labor, tractor and animal expenses, seed, inorganic fertilizers, irrigation and FYM were considered and valued at current market price to calculate cost of production.

Total variable cost = C labor + C tractor and animal + C seed + C fertilizer + C FYM + C irri

Where, C labor = Cost on human labor used (NRs./ha), C tractor and animal + tillage cost on tractor and animal used (NRs./ha), C seed = Cost on seed (NRs./ha), C fertilizer = Cost on chemical fertilizers (Nrs./ha), C FYM + Cost on organic fertilizers, C irri = Cost on irrigation (NRs./ha).

Gross return was calculated by multiplying the total volume of outputs from wheat by price of wheat grain at marketing period. Gross margin calculation was done by difference between gross return and variable costs.

Gross Margin (NRs./ha)= Gross return (NRs./ha) – Total variable cost (NRs./ha).

Benefit cost ratio is used to determine the economic performance of wheat farming. It is a relative measure, which is used to compare benefit per unit of cost.

B : C ratio = Gross return (NRs./ha)/ Total variable cost (NRs./ha)

Multiple regression model was used to study the extent of adoption of improved wheat varieties.

The model is defined as;

$Y_i = X_i ß + u$

Where, Y_i is the vector of dependent variable which is expressed as the percentage of wheat area to total area of household; ß is the vector of unknown parameter; and X_i is the vector of independent variables. The independent variables are; X_1 = Education, X_2 =Gender, X_3= Household size, X_4 = Total land,X_5 = Use of own seed or not, X_6= Membership,X_7= Training received or not

Household characteristics of wheat farmers

The average education grade of respondent was 5.29 and average household size comprised of 6.49 members. Average size of land holdings of two districts is 1.53 ha in which wheat occupied 0.67 ha with productivity of 2.29 t/ha. The seed replacement period of Saptari district (2.6 years) was higher as compared to that of Morang district (3.82 years). The average yield of wheat in both of these sample districts was lower than the national average yield of 2.59 t/ha in 2015 (MoAD 2016). Farm and household characteristics of the sample farmers are shown in table 20.

Table 20: Farm and household characteristics of sample farmers (n=80)

S.N.	Variables	Morang	Saptari	Average
1	Average education grade	4.73	5.85	5.29
2	Average household size	6.58	6.4	6.49
3	Average land holding (ha)	1.28	1.75	1.53

4	Average wheat area (ha)	0.42	0.92	0.67
5	Average wheat yield (Kg/ha)	2254	2320	2287
6	Seed replacement (Year)	3.82	2.6	3.21
7	Participation on training (%)	28	35	31
8	Membership of organization (%)	40	23	31

Source: Household survey (2016)

Sources of seeds of wheat varieties

Farmers obtained wheat seeds from various sources such as cooperatives, agro-vets, Nepal Seed Company, other farmers, own saving, NARC stations and DADO offices. In Morang district, 55% of total farmers used their own seed whereas in Saptari district, 32.5% farmers used seed from agrovets (Table 21).

Table 21: Sources of wheat seed among farm households (hhs) in the study districts

S.N.	Sources of Seeds	Morang hhs (%)	Saptari hhs (%)	Average hhs (%)
1	Cooperatives	7.5	5	6.3
2	NSC	10	12.5	11.3
3	Agrovets	2.5	32.5	17.5
4	Other farmers	20	5	12.5
5	Own	55	25	40
6	RARS,Tarahara	5	17.5	11.3
7	DADO	0	2.5	1.3

Source: Household survey (2016)

Adoption of wheat varieties in study district

The study revealed that about 60% areas of the total wheat was covered by NL297 followed by Gautam (15%), local (12.5%), Bijay (5%) and Aditya (5%) in Morang. In Saptari, 77% area was covered by NL297, 15% by Bijay, 2.5% by Aditya and 2.5% by Gautam. Although NL 297 was found susceptible to leaf rust it was preferred by the farmers because of its good bread quality and market demand . UP 262, an old variety released in 1978 was still growing in Morang in a few areas.

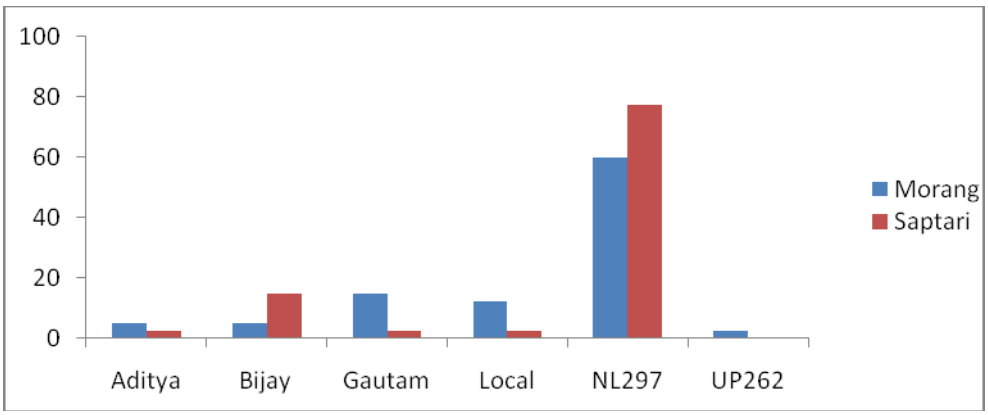


Figure 6: Adoption of wheat varieties

Factors influencing adoption of wheat varieties

Ordinary least square regression model is used to find out different factors responsible to extend wheat area. Total wheat area was used as dependent variable and different explanatory variables such as education of the household head, gender, household size, land holdings, use of own seed, involvement in organization and participation on training . The coefficient of multiple determination (R^2) is a summary measure which tells how well the sample regression line fits the data (Gujarati, 1995). The coefficient of multiple determinations R^2 of the model was 0.804 for wheat production. It indicates that about 80% of variations in wheat area have been explained by explanatory variables. The F-test (30.763) confirms the stability of overall regression equation and significant at 1% level. Out of 7 variables used in the model, only one variable i.e. farm size is found significant at 1% level. Household with larger farm size are more likely to adopt improved wheat technology.

Table 22: Multiple regression analysis for adoption of wheat varieties

Variables	Coefficient	Standard Error	T	P-value
(Constant)	2.902	6.765	.429	.669
Education	.186	.340	.546	.587
Sex	-.580	5.106	-.114	.910
Household size	-.577	.541	-1.065	.290
Farm size	.482***	.032	14.921	.000
Own# seed wheat	-1.857	2.892	-.642	.523
Membership	1.634	3.455	.473	.638
Training	-2.319	3.646	-.636	.527
F value	30.763***			
R square	0.804			
Adjusted R- square	0.778			

Source: Household survey (2016)

Cost of production

Tillage and human labor were important and largely used inputs in the production of wheat. All the farmers used tractor or bullock for their land preparation. Farmers performed two to three tillage operations for wheat production. Per hectare cost of tractor and bullock was about NRs. 10,622 which accounted about 25% of total wheat production cost. Human labor was required for different operations such as land preparation, seed sowing, fertilizer application, weeding and harvesting. It was computed in terms of man day and converted to monetary term. The cost of human labor in production of wheat per hectare was estimated NRs. 9,484.5.

Table 23: Average cost of production in wheat farming

Items of cost	Mean cost (NRs.)	Percent of total cost
Seed	7565.44	17.62
Chemical Fertilizers	7071.56	16.47
FYM	1975.00	4.60
Human labor	9484.50	22.09
Threshing	4293.75	9.99
Tillage	10622.50	24.74
Irrigation	1927.63	4.49
Total cost	42940	100.00

Source: Household survey (2016)

Per hectare cost of seed was about NRs. 7565 which accounted about 18% of total cost. Seed rate in the study area was more than the recommended dose (120 kg/ha) which was 171 kg/ha. Almost all the farmers were largely dependent on chemical fertilizers like Urea, DAP and Potash instead of farm yard manure (FYM) for wheat production. Per hectare costs of inorganic fertilizer was estimated about NRs.7072 which constituted about 17% of total cost. In the study area almost all of the farmers used thresher machine for threshing wheat grain. It accounted about 10% of total cost of wheat production. Per hectare cost of FYM was NRs. 1975, which constituted about 4.6% of total cost. Per hectare cost of irrigation was accounted about 4.5%. Irrigation cost in the study area was higher among those farmers who didn't have canal irrigation facility. About 25% farmers used pumpset for irrigation in wheat production.

Returns from wheat production

Farmers in the study area were involved in wheat farming on an average 0.67 hectare of land with per hectare production as 2.29 MT. The average farm gate price of wheat was NRs.2226 per quintal . The average per hectare price of wheat straw in the study area was NRs.. Per hectare gross return and total variable cost were estimated about NRs.53764 and NRs.42940 respectively. Per hectare gross margin of wheat production was estimated about NRs.10824. Benefit Cost Ratio (BCR) is a relative measures, which is used to compare benefits per unit of cost. It helps analyze the financial efficiency of the farmers. It was observed that the overall undiscounted BCR considering total cost was 1.25.Thus it was found that wheat production was profitable in the study area.

Table 24: Economic statement of wheat production in the study area

Measuring Criteria	Average value
Main product value (NRs.)	51002
By product value (NRs.)	2762
Gross return (NRs./ha)	53764
Total cost (NRs./ha)	42940
Gross Margin (NRs./ha)	10824
BCR	1.25

Source: Household survey (2016)

Conclusion

NL 297 in both the districts was the most popular and widely adopted variety. The adoption of newly released varieties such as Bijay, Aditya and Gautam were very minimal despite relatively higher yield of these varieties. Agrovet shops were the major sources of improved varieties in Saptari district, whereas farmers' own seed was the major source of seeds in Morang district. Households with larger farm size were more likely to adopt improved wheat technology. The wheat farming in the study area was profitable with benefit cost ratio 1.25.

3.3 Bitter Gourd

3.3.1 Varietal Evaluation of Bitter Gourd

Introduction

Bitter gourd (*Momordica charantia* L.) is one of the most popular vegetable cultivated throughout Asia and extensively grown in Nepal. In Nepal, total area under bitter gourd cultivation is 7047 with production of 100961 mt. and 14.3

mt/ha. of productivity (MoAD, 2014). Wwhereas productivity of bitter gourd in India is 17.7 mt/ha.

Low production and productivity in Nepal might be due to lack of suitable varieties. Therefore, to identify and select high yielding variety of bitter gourd, varietal evaluation of bitter gourd was carried out at HRP, RARS Tarahara. Four varieties of bitter gourd was provided by Chaudhary Group for varietal evaluation and characterization to identify high yielding variety in summer and rainy season. One registered variety of bitter gourd available in the market was selected as a check variety for comparison with other varieties.

objective:

- To identify high yielding varieties of bitter gourd.

Methodology

The varietal evaluation trial was carried out at Horticulture Research Program, RARS, Tarahara in two different seasons i.e. 2073/4/16 to 2073/7/21 and 2073/10/6 to 2074/3/5. Four different varieties of bitter gourd was provided by Chaudhary Group for variety evaluation and characterization. One registered variety of bitter gourd available in the market was selected as a check variety for comparison with other varieties. Therefore, in total five varieties was used for varietal evaluation. Each variety considered as an individual treatment and replicated thrice in Randomized Block Design as stated below:

- Treatment T1 CG 01
- Treatment T2 CG 02
- Treatment T3 Parrot
- Treatment T4 Tia
- Treatment T5 Long Green

Each treatment was replicated thrice in Randomized Block Design. Twelve raised plots of size 7.5 m x 3m (22.5 m^2) was well prepared and 10seedling of each variety was planted in two lines in each plot at a spacing 1.5 m x 1.5 m. Manuring was done at the rate compost 25 mt : nitrogen 170 kg :phosphorus 102 kg : potassium 51 kg per hectare. Nitrogen was applied in two equal split doses i.e. first as a basal and second at the time of flowering. Irrigation was provided at 10-15 days interval depending up on moisture present in soil. Insect-pest and disease was managed as and when necessary.Observation was taken on periodical basis. Observation on different parameters like time of flowering, time of fruit set, average fruit length, fruit colour, average fruit diameter, total no. of fruit/plot, individual fruit wt, fruit yield/plot and fruit yield / ha. The data taken was analyzed by Statistix10, a free software used for statistical analysis.

Result and Discussion

The varietal evaluation trial was carried out at Horticulture Research Program, RARS, Tarahara in two different seasons i.e. 2073/4/16 to 2073/7/21 and 2073/10/6 to 2074/3/5. Four different varieties of bitter gourd was provided by Chaudhary Group for variety evaluation and characterization.One registered variety of bitter gourd available in the market was selected as a check variety for comparison with other varieties. The observations taken on all the parameters in two different seasons was used for statistical analysis and the result obtained are discussed below:

Average fruit weight (g): Average fruit wt was taken by weighing randomly selected 10 fruits and average wt of all the fruits was used for analysis. The observation revealed significant result in both the season. In first season average fruit was found to be highest in CG01 (340.33 g) and CG02 (331.67 g) where as in second season highest result observed by CG01 (274.67 g), CG02 (273.33 g) and Tia (270.67 g).

Average Fruit Diameter (mm): In both the season av. fruit diameter was found non-significant with all the treatments though maximum fruit diameter was observed with CG01, Parrot and Tia in first season. Similarly in second season, maximum fruit diameter was observed in Tia.

Yield per plot (kg): Total yield per plot revealed significant result in both the season. In first season, highest yield was found in CG01 (40.44 kg). Whereas in second season highest yield was observed with CG01 (47.01 kg), Tia (46.29 kg), CG02 (41.54 kg) and Parrot (38.73 kg) repectively.

AverageFruitLength(cm): The observation revealed that average fruit length was found to be highly significant with all the treatments in both the season. In first season, maximum fruit length found to be highest in CG01 (25.63 cm), CG02 (24.84 cm) and Tia (25.25 cm). In second season also Tia (26.97 cm), CG01 (25.66 cm) and CG02 (25.50cm).

TotalNo. of Fruit Harvested per plot: First season observation revealed non-significant result. But in second season, Parrot propounded significantlymaximum number of fruit harvested per plot (252) followed by Tia (216)and Long Green (212.67)respectively.

Total No. of plant harvested per plot: Total number of plant harvested per plot gave non-significant result in all the treatments in both season.

Yield (MT / Ha): Total yield per hac revealed significant result in both season. In first season, highest yield was observed with CGo1 (18.47 mt/ha) followed by

CG02 (15.49 mt/ha). Similarly in second season, highest yield was observed with CG 01 (22.13 mt/ha) followed by CG 01(19.03 mt/ha) as stated in table .

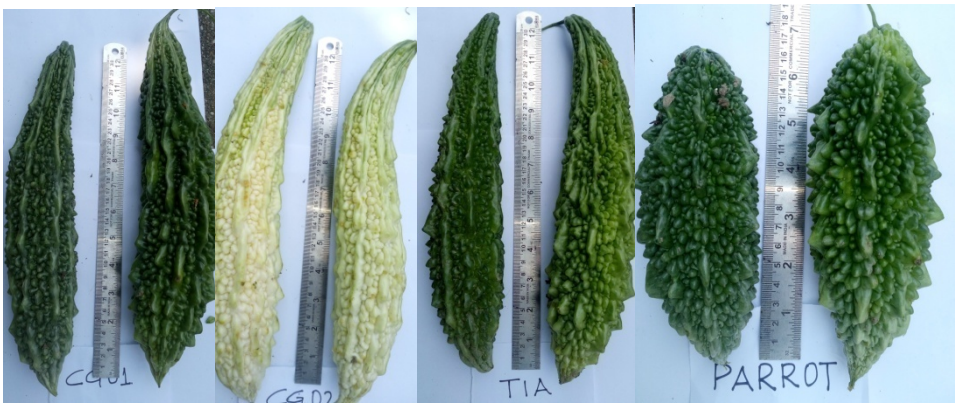


Fig 7.Varietal Evaluation of Bitter Gourd

Treatments	Average fruit weight (g)		Yield per plot (kg)		Average Fruit Diameter (mm)		Average Fruit Length (cm)		Total No. of Fruit Harvested per plot		Total No. of plant harvested per plot		Yield (MT Hac)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2n se
CG 01	340.33a	274.67a	40.44a	47.01a	50.84a	47.92ab	25.63a	25.66a	139a	210.67b	6.67a	6.86a	18.47a	22
CG 02	331.67a	273.33a	34.84b	41.54a	48.24ab	47.31ab	24.84a	25.50a	122.67a	182.00b	6.67a	6.23a	15.49b	19
Parrot	220.67c	183.33b	30.41bc	38.73a	50.07a	48.18ab	18.92b	17.18b	133a	252.00a	6.33a	7.16a	13.53bc	17
Tia	252.00b	270.67a	35.37ab	46.29a	51.36a	52.07a	25.25a	26.97a	135.67a	216.00ab	7a	6.43a	15.71b	19
Long green	149.67d	131.33c	27.15c	23.24b	42.33b	40.36b	17.66b	15.23b	125a	212.67ab	6.67a	6.26a	12.13c	10
P-value	**	**	**	**	NS	NS	**	**	NS	*	NS	NS	**	*
F – value	119.65	28.89	10.15	8.98	2.77	2.55	12.8	25.96	0.95	3.92	0.27	1.90	11.86	9.
CV	4.87	9.37	8.21	14.15	7.89	9.75	8.28	8.40	9.46	10.15	11.78	7.76	8.04	13
SEM	10.29	17.34	1.59	4.54	2.21	3.75	1.07	1.51	7.16	17.78	0.45	0.41	0.99	1.

3.4 Mango

3.4.1 Integrated Plant Nutrient Management to minimize alternate bearing in mango var. Maldah

Introduction

The genus *Mangifera* belongs to the order Sapindales in the family Anacardiaceae, with more than 40 species around the world and 15 species bear edible fruits. Common mango (*Mangifera indica* L.) originated as an alloploid from eastern India, Assam and Burma (Popenoe, 1920). Mango has rich intra-specific diversity and there are about 1600 cultivars in the world (Pandey 1998), of which some 350 cultivars are in commercial production and the rest are limited to mixed orchards or home gardens. Mango is considered as king of fruits which is predominantly cultivated from terai to mountains of Nepal. Mango occupies about 31% of the total area under fruits crops comprising of 46469.1 hectares with a total production of 270431.5 metric tonnes (MoAD, 2013/14). Central and Eastern development regions of Nepal are the major mango producing regions that occupy 17567.7 hac and 16791 ha. area, respectively. The major mango producing districts are Siraha, Sarlahi, Mahottari, Sunsari, Dhanusha, Saptari, Kapilbastu, Jhapa, Bara, Morang and some hilly districts like Kavre and Dhading. More than 56% of the production is covered by these districts. Home gardens, village gardens, commercial orchards, religious or cultural places and river gorge areas are the major habitats, where both local and commercial cultivars of mango are either cultivated or harvested from escapes from controlled cultivation (Subedi et. al. 2005).

The tree comes to full bloom and comes to optimum production in every alternate year i.e. in every alternate year, the production quantity is declined. The causes of the low yields are attributed to biotic and abiotic stress and poor nutrient status of the soil as well as use of imbalanced fertilizers. However, yield can be increased considerably by adopting judicious nutrient management and high yielding varieties (Nasreen et.al. 2014).

Fertilization is critical to obtain satisfactory mango yield. Recommendations for nitrogen (N) supply indicate that 400 g N/plant per year are needed for acceptable commercial yield (Chia et al., 1988; Wanitprapha et al., 1991; Xiuchong et al., 2001). Crane and Campbell (1994) suggested that N amounts could be increased depending on tree size and site conditions.

Application of N, Pand K fertilizer to mango tree markedly increased the number of fruit/tree, pulp content as well as fruit quality in India (Satapathy and Banik, 2002). The increased fruit yield due to frequent fertilizer application was also reported by Feungchan et al. (1989) and Sharma et al. (2002).

Three years' study revealed that application of $N_{960}P_{200}K_{300}S_{110}$g/tree along with a blanket dose of 20 kg cow dung/tree appears to be the best treatment

and economically optimum for achieving higher yield of mango in Chapai Nawabganj region (Nasreen et.al. 2014).

Sarker and Rahim (2012) proponded that applying fertilizer at 150% of the fertilizer dose in three installments improved the fruit quality with regard to TSS, pH, titratable acidity, vitamin C, moisture content, dry matter content, reducing sugar, non reducing sugar and total sugar content.

Considering poor nutrient management as one of the major problems in causing alternate bearing in mango, on farm research work on integrated plant nutrient management to minimize alternate bearing in mango cv. Maldah with the following objective:

- To identify suitable nutrient management practices to minimize alternate bearing in mango.
- To maintain production and productivity of mango every year.

Methodology

Considering poor nutrient management as one of the major cause of alternate bearing in mango, on farm research was carried out in Sripur VDC of Saptari and Raghunathpur VDC of Siraha districts for two consecutive years from 2014 and 2015 A.D. with an aim to minimize alternate bearing and gain optimum quality production. Eighteen mango trees of fifteen year old of declining stage was selected in both the VDC's. The experiment was carried out by a randomized complete block design with six treatments replicated three times. Those trees were treated as stated below:

T1 Compost @ 100 kg / tree
T2 Oil cake @ 20 kg / tree
T3 N:P:K @ 720 g: 182 g: 67 g / tree
T4 Half dose of T1 + half dose of T2 + half dose of T3 / tree
T5 Compost @ 50 kg + oil cake @ 10 kg + N: P: K @ 0.360 kg: 0.091 kg: 0.335 kg + agromin as micro nutrient @ 2 ml/L / tree
T6 Control (Farmers practice)

T1 and T2 was applied in a ring around a canopy after harvest as a basal dose. T3 was applied in two split doses i.e. full dose of P, K and half dose of N was applied as a basal dose and remaining half dose is applied at the time of flowering. T4 and T5 was applied as recommended for T2 and T3 including single spray of agromin in December. Observation on different parameters was take as stated below:

Number of fruit per plant: All the fruits from individual tree was harvested, counted and recorded.

Average fruit weight (gm) / Fruit length (cm) / Fruit diameter: From total harvest 10 fruits was selected randomly. Fruit weight, fruit length and fruit diameter was recorded of all ten fruits individually and the average of all the parameters was recorded for analysis.

Total yield / tree (kg): All the harvested fruits of individual tree was weighed and recorded the data in kg.

Total Soluble Solids (% Brix): Total Soluble Solids (TSS) was calculated with the help of hand refractometer and the value was expressed in percentage.
Total Titrable Acidity (%): It was determined by titrating a known volume of finely blended juice with 0.1 N NaOH solution using phenophthalin as an indicator. The end point was marked by appearance of pink colour which persisted for few seconds. The result were expressed as percent titrable acidity.

$$\% \text{ Acidity} = \frac{0.067 \times 0.1 \text{ N NaOH used (ml)}}{\text{Juice taken (ml)}}$$

All the collected data was statistically analyzed by free software Statistix 10.

Result and Discussion

One of the major cause of alternate bearing in mango is poor nutrient management practices. Therefore, on farm experiment was carried out in two different location of Saptari and Siraha district for two consecutive years (2014 and 2015) to minimize alternate bearing and enhance quality production all the year round. Observation on different parameters was taken, data analyzed and results are briefly discussed below:

Number of Fruit: Two years data revealed significant result in both the VDC's resulting into increased number of fruits consequently in both years. Maximum number of fruit (544 and 874) was observed with T5 followed by T4 (399 and 623) at Sripur and in Raghunathpur also maximum number of fruit observed with T5 (490 and 587) followed by T4 (396 and 533) as stated in table 1 and table 3.

Average fruit weight (gm): All the treatment gave highly significant result and highest fruit weight was gained with treatment T5 (219 gm) in first year and T1 (378 gm) in second year at Sripur condition. At the same time T5 resulted highest fruit weight in both the year (219 gm and 233 gm) at Raghunathpur condition. The results are stated in table 1 and table 3 respectively.

Fruit Yield (Kg): It also resulted highly significant result with all the treatments in both the VDC's. Fruit yield was observed to be highest with T5 (117 kg and 226 kg) in both the years in Sripur. Similar result was obtained in Raghunathpur with treatment T5 i.e. 107 kg and 141 kg in both the year respectively.

Fruit Diameter (cm): All the treatment revealed significant result with fruit diameter in Sripur where in the first year T5 generated maximum fruit diameter (5.8 cm) and in second year T3 (6.3 cm). But in Raghunathpur, T5 obtained maximum fruit diameter in both the year (6.3 cm and 5.9 cm) as stated in table 1 and 3 respectively.

Fruit length (cm): Fruit length found to be highly significant with all the treatments in Sripur and T5 produced maximum fruit length (7.4 cm and 8.4 cm) in both the year. But in Raghunathpu, non significant result was observed, though maximum

fruit length was observed with T5 (7.3 cm and 7.8 cm) in both years as stated in table 2 and 4 respectively.

Total Soluble Solids: In Sripur and Raghunathpur non significant result was observed with respect to all the treamtnets in both year though highest TSS was observed with T5 in both year as stated in table 2 and 4.

Total Acidity (%): In Sripur, first year data revealed significant result followed by non significant result in second year. In first year lowest total acidity was observed with T5 (0.53%) and highest with T6 (1 %).

But in Raghunathpur condition, total acidity in fruit gave significant result where T4 produced lowest TA (0.7%) in first year and T1 (0.7%) in second year as stated in table 2 and 4.

Conclusion

It has been observed that mango respond well to manure and fertilizer. But famers merely use manure and fertilizer to mango orchard that resulted into poor quality, uneven production, decreased yield and lastly step towards alternate bearing. Therefore, application of manures and fertilizer in optimum amount not only enhance fruit quality but increase production and productivity consequently.
Thus, an experiment was carried out in an old neglected orchard for two years in Sripur VDC of Saptari and Raghunathpur VDC of Siraha districts to minimize alternate bearing and gain optimum yield every year. The result revealed that the application of manure and fertilizer leads to quality fruit production and increase in yield every year. It was observed that the application of Compost @ 50 kg + oil cake @ 10 kg + N: P: K @ 0.360 kg: 0.091 kg: 0.335 kg + agromin as micro-nutrient @ 2 ml/L / tree significantly increased number of fruit, fruit length, average fruit weight and fruit yield in both the sites. Thus, application of such dose every year may lead to quality fruit production, gain optimum yield every year and overcome the problem of alternate bearing.

Table 26: Effect of IPNM on fruit quality and yield of mango var. Maldah in Sripur VDC.

Treatment	Number of fruit		Average fruit weight (gm)		Fruit Yield (Kg)		Fruit Diameter (cm)	
	Sripur		Sripur		Sripur		Sripur	
	2014	2015	2014	2015	2014	2015	2014	2015
compost @ 100	296c	451c	200d	378a	61d	166c	5.2b	6.2b

kg tree-1								
oil cake @ 20 kg tree-1	250e	318e	198e	281c	50f	87e	5.3b	5.9d
N:P:K @ 720 g: 182 g: 67 g tree-1	352b	620b	208c	328b	73c	203b	6.2b	6.3a
half dose of T1 + half dose of T2 + half dose of T3 tree-1	399b	623b	212b	310b	84b	192b	5.2b	6.1c
compost @ 50 kg + oil cake @ 10 kg + N: P: K @ 0.360 kg: 0.091 kg: 0.335 kg + agromin @ 2 ml/L tree-1	544a	874a	219a	260d	117a	226a	5.8a	6.2b
Control (No any application)	299d	400d	188f	271cd	56e	108d	5.1b	5.6e
Grand Mean	357	547	204	304	73	164	5.3	6.0
P (≤0.05)	**	**	**	**	**	**	*	*
CV(%)	0.66	1.3	0.23	3.3	0.43	164	2.3	0.49
SEM±	1.36	4.1	0.27	5.8	0.18	5.1	0.07	0.02

Table 27: Effect of IPNM on fruit quality of mango var. Maldah in Sripur VDC.

Treatment	Fruit Length (cm)		Total Soluble Solid (%Brix)		Total Acidity	
	Sripur		Sripur		Sripur	
	2071	2072	2071	2072	2071	2072

compost @ 100 kg tree-1	7.2b	8.2b	20b	19.33b	o.6cd	0.77b
oil cake @ 20 kg tree-1	6.8c	7.4c	19b	20.33ab	0.83b	0.75b
N:P:K @ 720 g: 182 g: 67 g tree-1	7.2b	7.0d	19b	19.66ab	0.66c	0.86ab
half dose of T1 + half dose of T2 + half dose of T3 tree-1	7.2b	7.4c	20b	20.33ab	0.56cd	0.66b
compost @ 50 kg + oil cake @ 10 kg + N: P: K @ 0.360 kg: 0.091 kg: 0.335 kg + agromin @ 2 ml/L tree-1	7.4a	8.4a	23a	21.66a	0.53d	0.73b
Control (No any application)	6.7d	8.0b	21ab	19.0b	1a	1.00a
Grand Mean	7.1	7.7	20.4	20	0.7	0.79
P (≤0.05)	**	**	NS	NS	**	NS
CV(%)	0.8	1.46	7.87	5.73	8.65	14.57
SEM±	0.03	0.065	0.92	0.66	0.03	0.067

Note: **Highly significant; NS = Non significant

Table 28: Effect of IPNM on fruit quality and yield of mango var. Maldah in Raghunathpur VDC.

Treatment	Number of fruit	Average fruit weight (gm)	Fruit Yield (Kg)	Fruit Diameter (cm)

	Raghunathpur		Raghunathpur		Raghunathpur		Raghunathpur	
	2071	**2072**	**2071**	**2072**	**2071**	**2072**	**2071**	**2072**
compost @ 100 kg tree-1	283cd	426cd	210c	203c	56cd	85c	5.1bc	5.0b
oil cake @ 20 kg tree-1	271d	400d	199d	171d	51d	68d	5.1bc	5.8a
N:P:K @ 720 g: 182 g: 67 g tree-1	325c	452c	213b	200c	62c	89c	5.4b	5.06b
half dose of T1 + half dose of T2 + half dose of T3 tree-1	396b	533b	215b	216b	86b	116b	5.1bc	5.1b
compost @ 50 kg + oil cake @ 10 kg + N: P: K @ 0.360 kg: 0.091 kg: 0.335 kg + agromin @ 2 ml/L tree-1	490a	587a	219a	233a	107a	141a	6.3a	5.9a
Control (No any application)	317cd	400d	196e	203c	60cd	81c	6.8c	5.0b
Grand Mean	347	466	209	204	70.8	97	5.3	5.32
P (≤0.05)	**	**	**	**	**	**	*	**
CV(%)	8.4	4.12	0.65	3.39	7.75	4.91	5.69	3.02
SEM±	16.84	11.09	0.79	4.0	3.17	2.75	0.17	0.09

Note: ** Highly significant; * Significant

Table 29: Effect of IPNM on fruit quality of mango var. Maldah in Raghunathpur VDC.

Treatment	Fruit Length	Total Soluble Solid	Total Acidity

	(cm)		(%Brix)			
	Raghunathpur		Raghunathpur		Raghunathpur	
	2071	2072	2071	2072	2071	2072
compost @ 100 kg tree-1	7.3a	6.5c	19a	21ab	1.2a	0.7c
oil cake @ 20 kg tree-1	6.5c	6.8bc	19a	21ab	0.8c	1b
N:P:K @ 720 g: 182 g: 67 g tree-1	7.0b	7b	21a	21ab	1.0b	1.3a
half dose of T1 + half dose of T2 + half dose of T3 tree-1	7.2a	7b	22a	20	0.7d	1.13ab
compost @ 50 kg + oil cake @ 10 kg + N: P: K @ 0.360 kg: 0.091 kg: 0.335 kg + agromin @ 2 ml/L tree-1	7.3a	7.8a	22a	23a	1.0b	1.0b
Control (No any application)	7.0b	6.0d	19a	19b	0.9bc	1.2c
Grand Mean	7.09	6.8	20.7	21	0.9	1.06
P (≤0.05)	NS	HS	NS	NS	S	S
CV(%)	1.08	3.57	14.2	6.62	7.45	8.99
SEM±	0.04	0.14	1.6	0.8	0.04	0.05

Note: **Highly significant; * Significant; NS = Non significant

3.4.2 Collection, evaluation and conservation of mango cultivars

There are 600 mango (*Magnifera indica* L.; Anacardiaceae) plants of different cultivars collected from local and exotic source have been conseved as mother stocks for research support at RARS, Tarahara. Mango cultivars conserved are Amrapali (60), Mallika (17), Neelam (21), Maldah (76), Calcuttia (85), Dasheri

(110), Bombay Green (39), Krishnabhog (39), Chausa (30), Cipia (6), Fazli (6), Alfanso (1), Pakistani (3), Gulab Khash (26), Zardalu (3), Sukul (1) and Barahmase (6). In addition, 175 seedling plants of local cultivars were collected from different pocket growing areas of Saptari, Siraha, Sarlahi, Dhanusha, Mahottari, Rautahat, Bara and Parsa districts and are conserved at HRP, RARS Tarahara.

All the cultivars have been conserved and maintained adopting agronomical practices as per developed calendar of operation by the multidisciplinary team of RARS, Tarahara. Among all cultivars, Barahmse showed peculiar characteristic. It produced 3 to 4 flushes of flower from January to August. In the first flush it produced quality fruit of medium size with an optimum weight of 100-125 gm. After ripening, peel colour of fruit was completely yellow where as pulp colour was pinkish. Later fruiting took place but dropped at pea size.

3.4.3 Response of mango to plant growth regulators and their effect in growth and development

The experiment was conducted in Sripur VDC of Saptari and Lahan municipality of Siraha and RARS, Tarahara. Eighteen healthy bearing mango tree (Maldah) was selected in each site. Single tree was selected for each treatment and replicated thrice. Six different treatments applied on selected tree as given below:

T1 : GA3 75 ppm
T2 : GA3 200 ppm
T3 : NAA 80 ppm
T4 : NAA 40 ppm
T5 : Triacantenol 1000 ppm

The above stated treatment was sprayed thrice. First spray was done 1 month prior to flower bud initiation, second spray was done at the time of flower bud development and third at the time of fruit let development. Ten liter solution of each treatment was prepared and sprayed on foliage of each tree and was repeated twice in a specified time. Observation on average fruit length, average fruit diameter, average fruit weight, fruit yield, TSS and TA was taken after fruit harvest. Eighteen healthy bearing mango tree (Maldah) was selected in each site. Single tree was selected for each treatment and replicated thrice. An observation on all the parameters was taken after fruit maturity and harvest. Average data of all the parameters was taken for discussion.

Maximum average fruit length was observed with treatment T5 (7.7 cm) followed by T3 (7.5 cm) whereas minimum fruit length was observed with T4 (4.9cm).

Similarly, highest fruit diameter was observed with T5 (6 cm) followed by T3 (5.2 cm) as stated in figure 14.

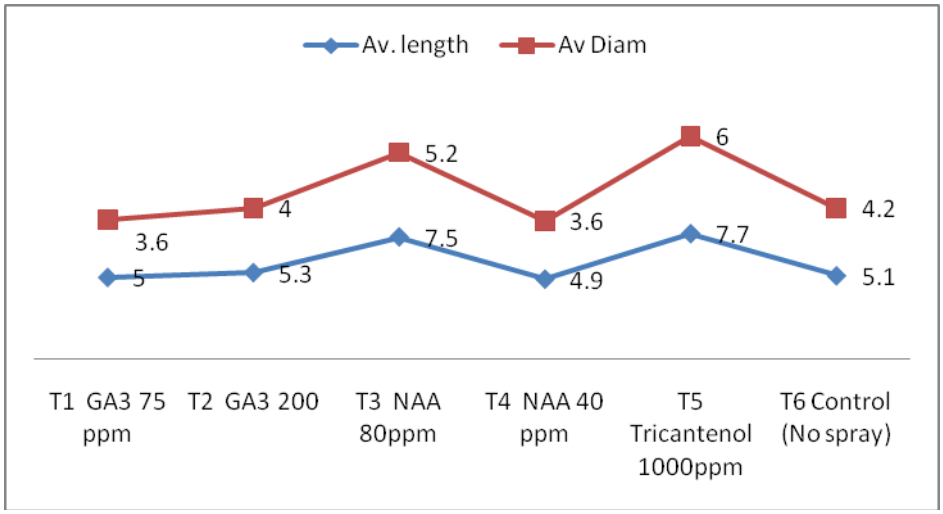


Figure 8. Effect of PGR on average length and diameter of fruit

The average fruit weight was found maximum with T5 (315 gm) followed by T3 (274 gm) and minimum fruit weight was observed with T1 (182 cm) and T4 (182 cm) as stated in figure 15.

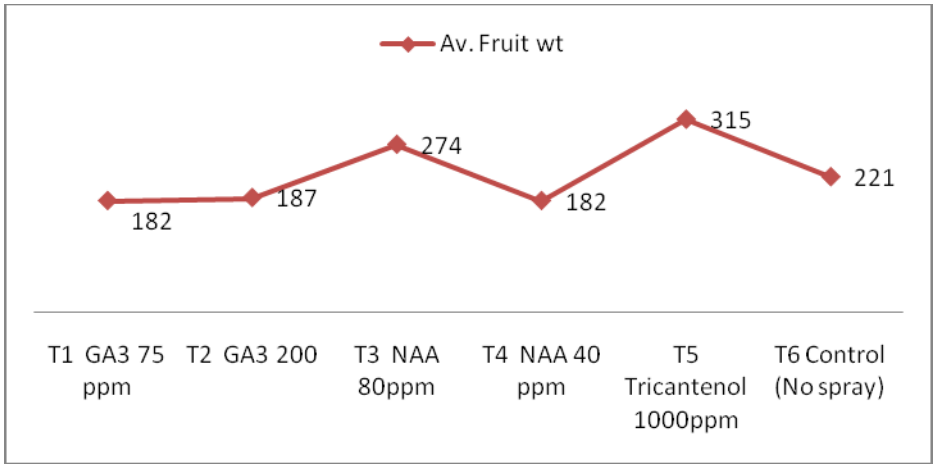


Figure 9. Effect of PGR on average fruit weight

3.4.4 Survey and identification of fruit fly infesting cucurbits and mango

An attempt was made to survey the economically important fruit fly species infesting bitter gourd in vegetable growing pocket of Sunsari district, i.e.

Kaptanganj with the help of fruit fly para-pheromones and collection of infested fruits.Likewise, a general survey was conducted in mango orchard at RARS, Tarahara with the help of methyl eugenol and cue lure following the protocol developed by Entomology division during the year 2012 and 2013. Two types of para-pheromones were used in traps for monitoring fruit fly species i.e., methyl eugenol and cue lure. Three sets of traps were used for each para-pheromones were installed in 6 hector of mango orchard. The traps were continually kept in mango orchard from 1st February 2016 to 1st September 2017 for monitoring the fruit fly species and their identification. Plastic bottle traps were used with lure and Malathion was used for knockdown.Lures were replaced in every 15 days. The prepared traps were hanged on branches at two meter height in mango orchard but one meter height in bitter gourd. Adult flies captured in trap were collected, counted and identified in fortnightly interval.

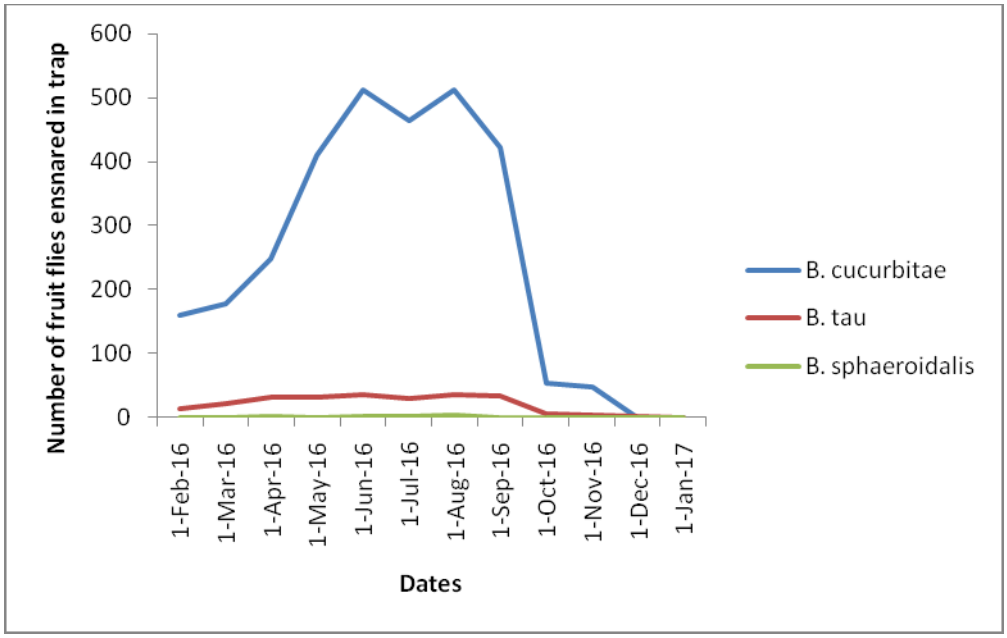


Figure 10: **Population dynamics of different fruit fly species ensnared in cue lure trap in bitter gourd of Kaptanganj**

The result of survey of the fruit fly conducted during February 2016 to 1st September 2017 showed different species of genera *Bactrocera*. Fruit flies ensnared in cue lure trap installed in bitter gourd field has been presented in Fig 1 and Fig 2 where species-wise data has been revealed.

The data presented in Fig 1 indicated highest number (512) of *B.cucurbitae* followed by *B. tau* and *B. sphaeroidalis* respectively. Though *B. sphaeroidalis* is a new species in the context of Nepal, it was identified on the basis of morphological description given by Kapoor *et al.*(1980) Agrawal and Kapoor (1988) and White and Elson- Harris (1992) but it needs to be verified from authentic body.

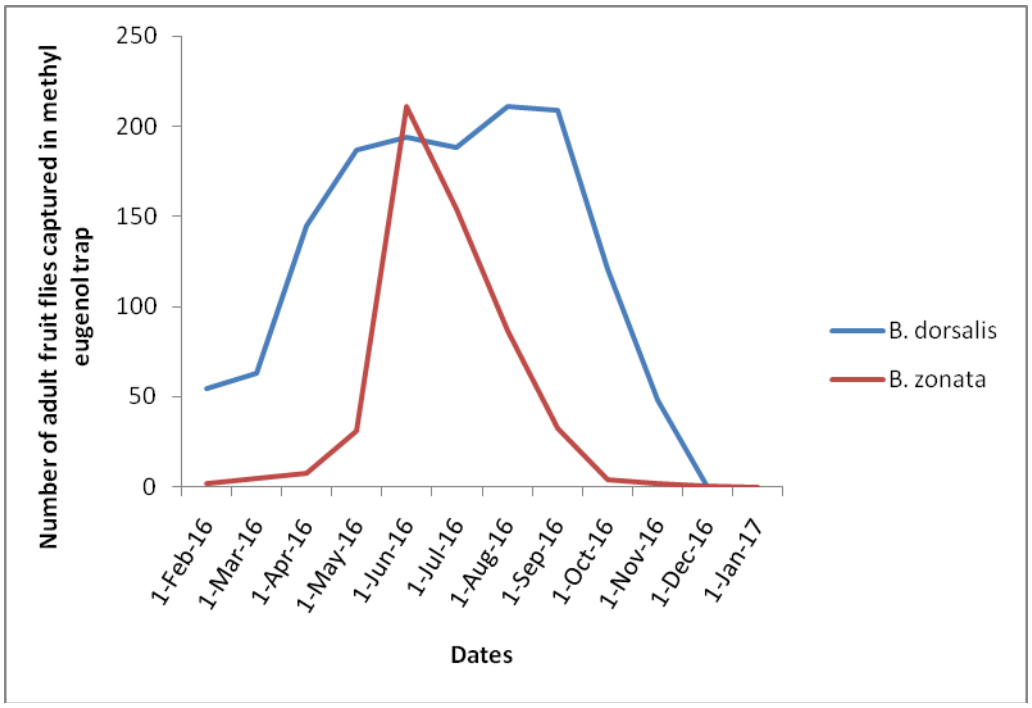


Figure 11:Fruit fly species captured in methyl eugenol trap in mango orchard of RARS, Tarahara

Similarly, population of *B. dorsalis* was observed in the methyl eugenol trap from 1st February 2016 to 1st January 2017 in mango orchard at RARS, Tarahara that reached the maximum population in 1st September. In addition to that, numbers of *B. zonata* were found to fluctuate from 1st May to 1st October which culminated in 21st July 2016.

3.5 Banana

3.5.1 Pesticide evaluation for management of Sigatoka disease of Banana

Sigatoka disease is causing serious losses in banana plantation. An experiment was conducted using randomly complete block design (RCBD) with 3 replications in Farmers field during 2016/17. Banana plants of same age were included in a block. Individual plant was treated as a unit. Pinnacle® (Propiconazole 25% EC) @ 0.5 ml/l and 1 ml/l; Titan® (Hexaconazole 5% EC) @ 0.5 ml/l and 1 ml/l and Dithane M-45® (mancozeb 75%) @ 2 g/l were evaluated along with a control (water spray). Spraying was done after the onset of the disease and repeated once at 15 days after first spraying. Severity of Sigatoka disease was lowest in Pinnacle® @ 1 ml/l which was followed by Pinnacle® @ 0.5 ml/l (Figure 19). Similarly, Titan® @ 1 ml/l, Titan® @ 0.5 ml/l and Dithane M-45® @ 2 g/l also decreased the severity of the disease as compared to the control.

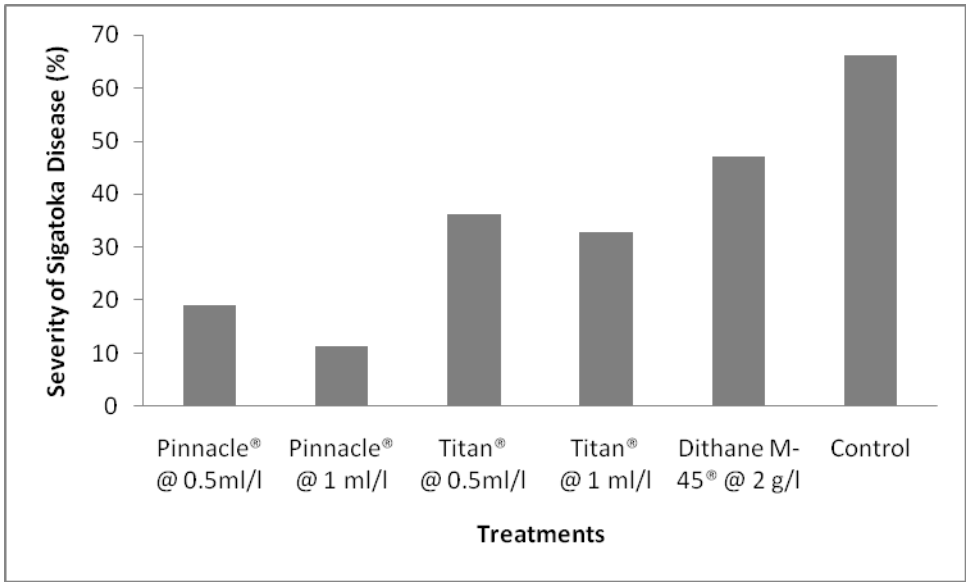


Figure12. Control of Sigatoka disease in banana by different pesticides over control.

3.6 Litchi

3.6.1 Study on management of Litchi mite:

Litchi mite is a major pest of Litchi fruits which prefer to infest new flush. Though it is not visible to naked eyes, it affects new shoots in the entire tree during sever infestation and cause abnormal development and pre-mature defoliation. Therefore, an activity was initiated to work for its management in the orchard of RARS, Tarahara during 2071/72.

An experiment was conducted to evaluate efficacy of different insecticides in orchard of RARS. The following insecticides were used for efficacy testing.

1. Dicofol @ 2ml/L
2. Spinosad @ 1ml/3 L
3. Abamectin @ 1ml/3 L
4. Dimethoate @ 1ml/L
5. Control

The experiment was laid out in Completely Randomized Block Design (RCBD) with above mentioned 5 treatments and three replications. The evaluation of the insecticides wascarried out from 7 Bhadra to 7 Asojduring flushing period. The insecticides were sprayed three times with 10 days interval. After final application of insecticides, mite-damaged leaves were recorded from each treated trees. Twenty five leaves from top, middle and bottom were picked randomly and number of damaged leaves counted per tree.

Result:

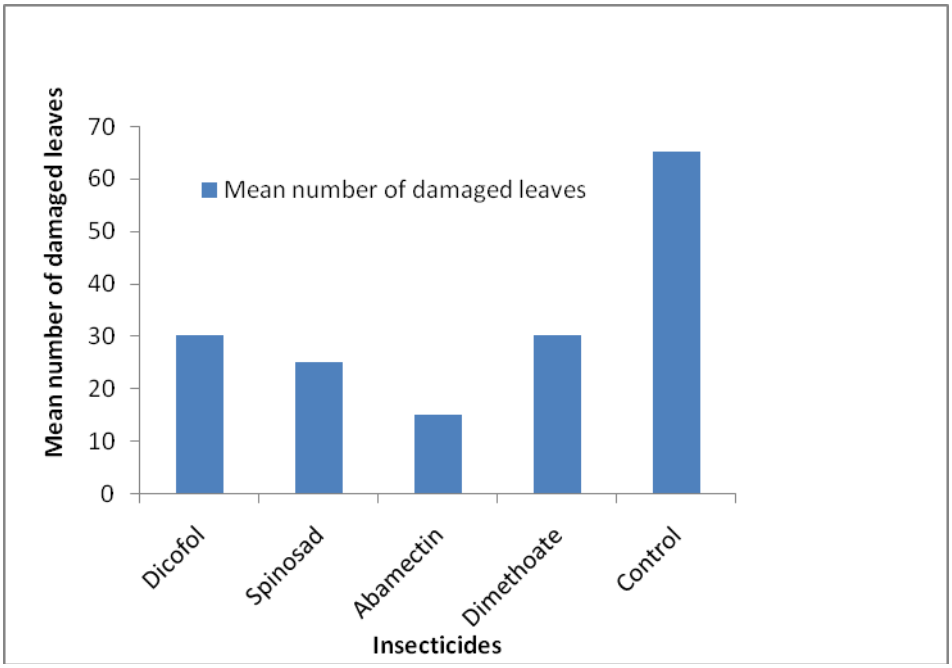


Figure13: Effect of different insecticides on infestation of litchi mite

Among four insecticides, Abamectin was found significantly more effective than other insecticides (Figure 3).

3.6.2 Management of Litchi fruit borer

Fruit borers are most important insect pest of litchi which causes extensive loss to farmers. The caterpillars enter the fruit from the pedicel end and feed on the pulp resulting in rotting and pre-mature dropping of fruits. Besides fruits, they also bore tender shoots. Presently, highly toxic insecticides like Metasystox and Thimet are being used for the management of the insect. Considering safety to the consumers and environment, an attempt has been made to screen the safety insecticides with less residue and waiting period for management of the insect. The following insecticides have been used for evaluating efficacy against the borer.

1. Corazen @ 10 Ml/50L of water
2. Neemax @ 3 Ml/L of water
3. Spinosad @ 1ml/3L
4. Dimethoate @ 1 ml/L of water
5. Malahion 50% EC @1ml/L of water
6. Abamectin @ 1ml/3L
7. Imidacloprid @ 1ml/3L
8. Thimmethoxame @ 1gm/3L
9. Flubendiamide (Fem) @ 0.2 ml/L
10. Control.

The experiment was done in Randomized Complete Block Design with three replications and ten treatments at RARS, Tarahara horticulture research unit. All above treatments were applied separately from fruit set period. The insecticides were applied three times at 10 days interval during clove-sized fruits. Before harvesting the fruits, twenty fruits from each four direction of the trees were picked and inspected for damage of the insect. Hence the data was recorded based on damaged and healthy fruits.

Result:

Among ten treatments, Corazen was recorded superior for pest management but Spinosad and Abamectin were also found similarly effective (Figure 4).

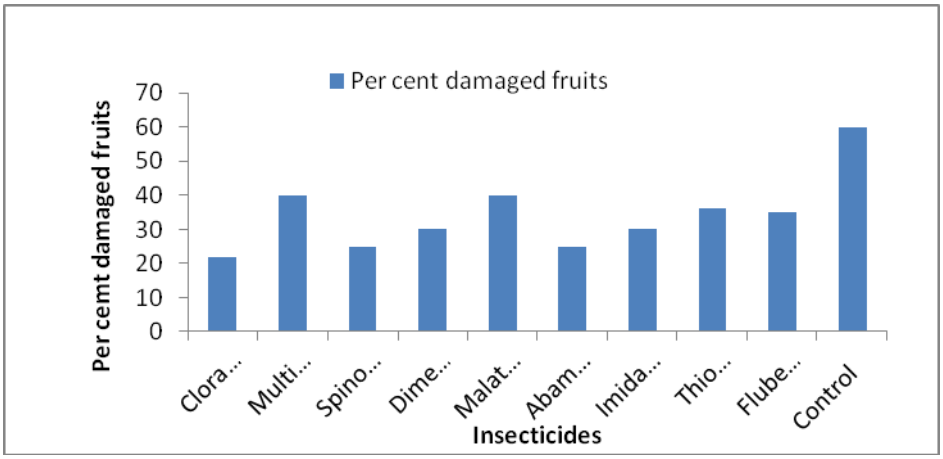


Figure14: Effect of insecticides on damage of litchi fruit borer

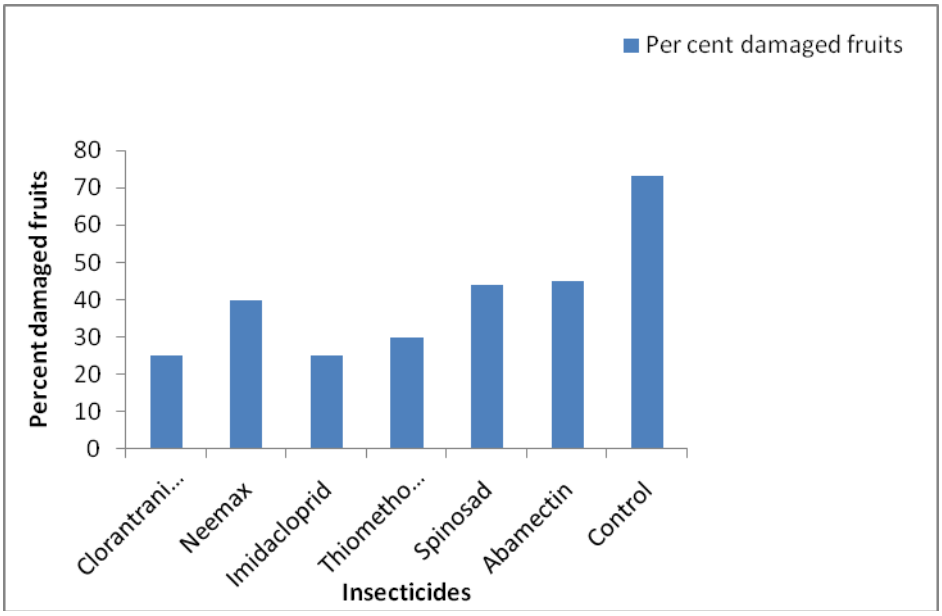


Figure15: Efficacy of different insecticides on damage of mango stone weevil

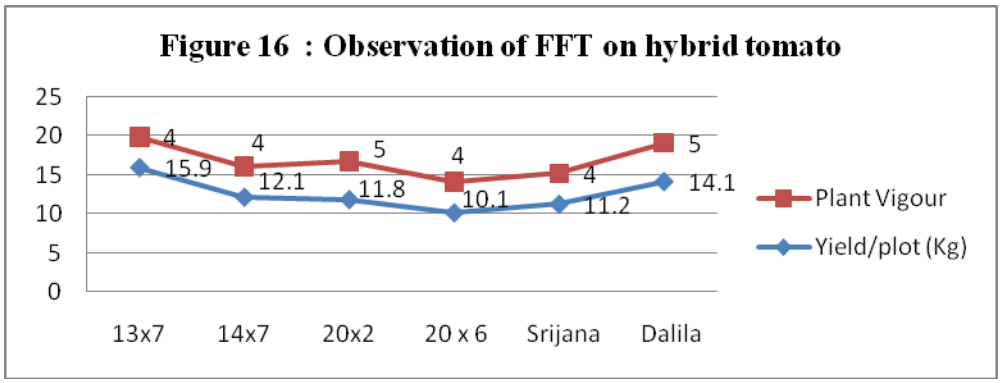
In this study, significantly low fruit drop and damage was recorded in treatment of thiomethoxame and clorantraniprol (Figure 5).

3.7 Tomato

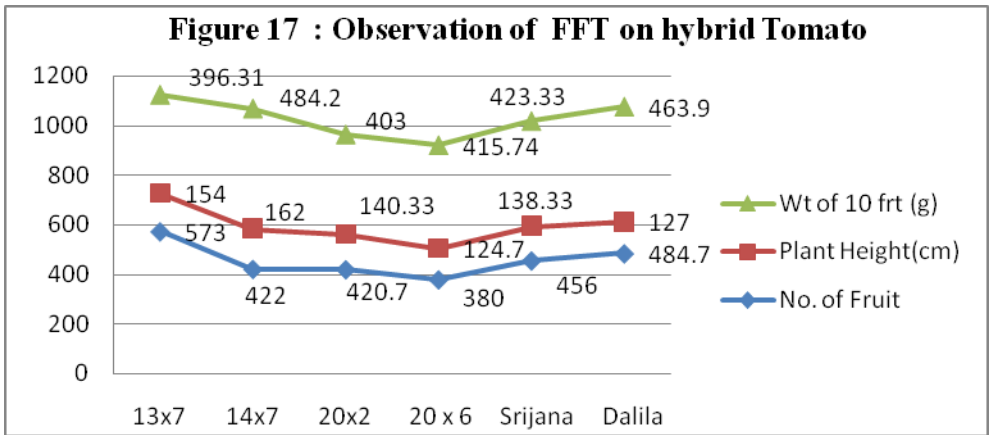
3.7.1 Evaluation of hybrid tomato Varieties in Terai (FFT)

Farmers Field trial (FFT) on hybrid tomato was carried out by Horticulture research program of RARS, Tarhara at Motipur VDC of Morang district in a fiscal

year 2073/74. Six different varieties of hybrid tomato were selected as a treatment and replicated thrice in a Randomized Complete Block Design (RCBD). Ten seedlings of each variety were transplanted in a single plot (3 m x 1.4 m) at a spacing 70 cm x 60 cm. Observation was taken at regular interval on different parameters like plant vigour, yield/plot, average weight of 10 fruits, plant height andtotal number of fruits harvested per plot. Means of all parameters was taken for discussion.



The seedling was transplanted on 2073/9/6. The result revealed that genotypes 20x2 (5) and Dalila (5) propound maximum plant vigourwhereas highest yield was observed by 13x7 (15.9 kg) followed by Dalila (14.1 kg) as stated in figure16 .

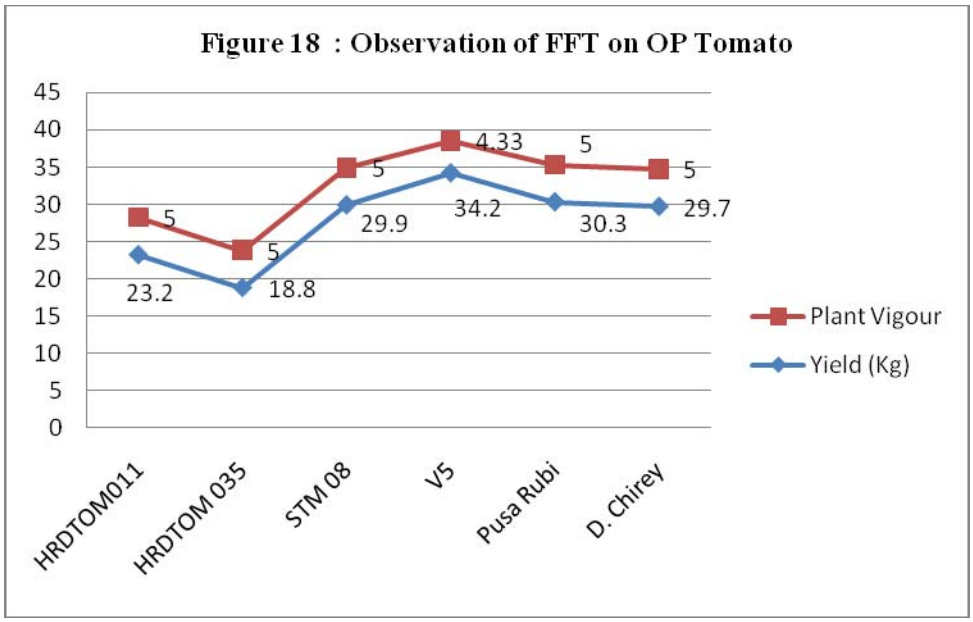


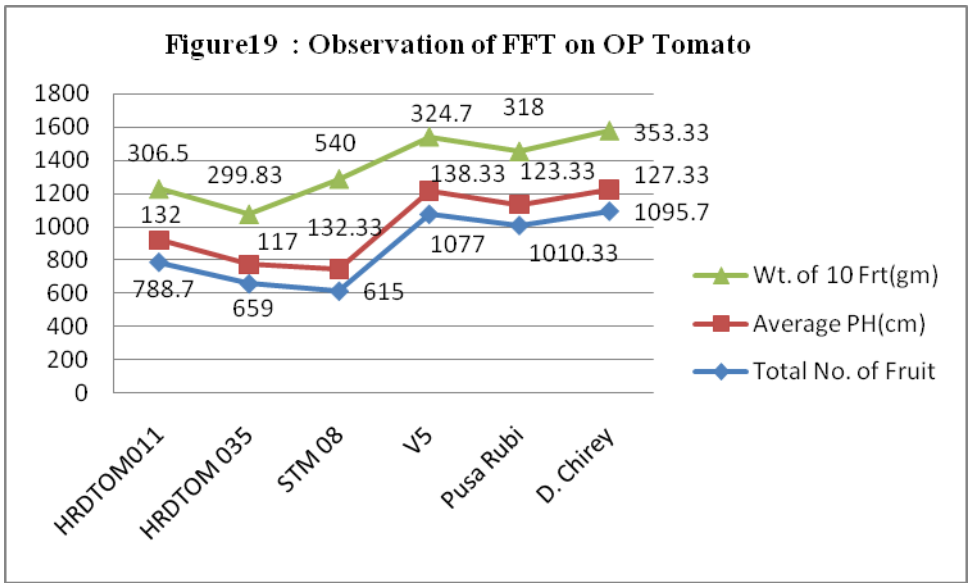
Similarly, average fruit weight (484.2 g) and average plant height (162 cm) observed to be highest by genotype 14x7. But number of fruit was highest with 13x7 (573) followed by Dalila (484.7) as stated in figure 17.

3.7.2 Evaluation of open pollinated tomato Varieties in Terai (FFT)

Farmers Field trial (FFT) on open pollinated tomato was carried out by Horticulture research program of RARS, Tarhara at Motipur VDC of Morang district in a fiscal year 2073/74. Six different varieties of hybrid tomato were selected as a treatment and replicated thrice in a Randomized Complete Block Design (RCBD). Ten seedlings of each variety were transplanted on 2073/ 9/12 in a single plot (3 m x 1.2 m) at a spacing 60 cm x 60 cm. Observation was taken at regular interval on different parameters like plant vigour, yield/plot, average weight of 10 fruits, plant height and total number of fruits harvested per plot. Means of all parameters was taken for discussion.

The result revealed that plant vigour observed to be maximum with all the treatments but highest yield (34.2 kg) was observed with V5 (Figure 18). Similarly, average fruit weight was found maximum with STM 08 (540 g). But maximum plant height was observed with V5 (138.33 cm) and maximum number of fruit observed by D.Cherry (1095.7) as stated in figure 18.





3.8 Potato

3.8.1 Evaluation of Potato Varieties in Terai (CVT)

Coordinated varietal trial of Potato was carried at HRP, RARS Tarahara in a fiscal year 2073/74.Nine different varieties of potato were selected for the trial. Each variety was considered as an individual treatment and planted in an individual plot of size 2.4m x 3m at 65 cm x 25 cm spacing i.e. 48 plants / plot / treatment. Planting was done on 2073/07/24 and harvesting was done on 2073/11/17. Each treatment was replicated four time adopting Randomized Complete Block Design (RCBD). Observation on time of emergence, uniformity, plant vigour, plant height, Average yield, Total yield per plot and incidence of late blight disease was taken in a specified time frame. Average value of all parameters is used for discussion.

The observation revealed that plant emergence at 15 days after planting found to be maximum with treatment T1 (26.25) followed by T3 (25.75) whereas maximum plant emergence at 30 days after planting observed with treatment T3 (45.75) followed by T2 (40.5), T3 (49) and T9 (49). Similarly, maximum plant vigour was observed with T3 (4) and T8 (4). Maximum plant height was observed with a treatment T8 (52.8 cm) followed by T8 (42.5 cm). Average yield per plot of 25 to 50 gram tuber observed highest with T6 (1.43 kg) followed by T3 (1.075). Similarly, highest total yield was observed with T3 (7.05 kg) kg) followed by T4 (6.2 kg). At the same time two treatments observed tolerant to blight disease that are T3 and T8.

Table 30. CVT potato carried out at HRP, RARS Tarahara in a fiscal year 2073/74.

Treatment	Emergence after 15 days	Emergence after 30 days	Uniformity (1-5)	Main stem/Plant	Plant Vigour (1-5)	Plant Height (cm)	Average yield /plot (kg.)			Total Yield/ plot (Kg.)	Late Blight (1-9)
							< 25 gm	25-50 g	> 50g		
CIP 393617.1	26.25	35.25	2.75	2.7	2	27.03	0.67	2.25	1.13	4.025	5
CIP 394613.139	17.25	40.5	3.25	2	3.25	35.9	0.5	1.1	2.2	3.8	8
CIP 395017.229	25.75	45.75	4	3.45	3.75	41.25	1.075	3.1	2.9	7.05	2
CIP 395917.242	19.5	37.5	3.25	3.65	4	49.2	0.95	3.13	2.13	6.2	1.75
PRP 136368.6	12.25	25	3.75	3.75	3.5	36.3	0.8	1.3	1.6	3.6	3.75
PRP 136368.8	21.75	33.5	3.75	4.7	4.25	41	1.43	1.81	0.8	4.04	4.75
PRP 306668.1	20	33.75	3.25	3.5	3.75	52.45	0.9	1.52	2.1	4.5	4.75
CIP 395192.1	3.25	19.75	4	3.23	3.75	52.8	0.4	0.7	0.65	1.74	4
kufri Sinduri	16.75	40.5	3.5	3.65	3.5	49.9	0.95	1.43	1.5	3.9	6.5

3.8.2 Evaluation of fungicides for management of late blight of potato

An experiment was conducted at Regional Agricultural Research Station, Tarahara during 2016/17 in order to identify effective fungicide against late blight disease of potato. The experiment was conducted under Randomized Complete Block Design with 3 replications. Plot size was 7.2 m^2. There were 4 rows comprising 60 cm row to row and 25cm plant to plant distance. Sectin® (Fenamidone 10% + Mancozeb 50% WG) and Simonil® (Cymoxanil 8% + Mancozeb 64% WP) @ 0.5, 1,1.5 and 2 g/l and Dithane M-45® [Mancozeb 75%], Saaf® (Carbendazim 12% + Mancozeb 63% WP) and Relaxyl® (Metalaxy l8% + Mancozeb 64% WP) @ 2g/l were evaluated along with a control.Spraying will be stated after the onset of late blight disease and repeated at 10 days interval. Blight was scored at 5 days interval using 0-5 scale. Lowest incidence and severity of the disease was recorded in Sectin® @ 2g/l which was followed by Sectin® @ 1.5g/l, Sectin® @ 1g/l and Sectin® @ 0.5g/l (Figure 14). Similarly, Dithane M-45®@ 2g/l), Relaxyl®@ 2g/l, Saaf® @ 2g/l and Simonil® @ 2g/l and 1.5 g/l significantly reduced the disease.

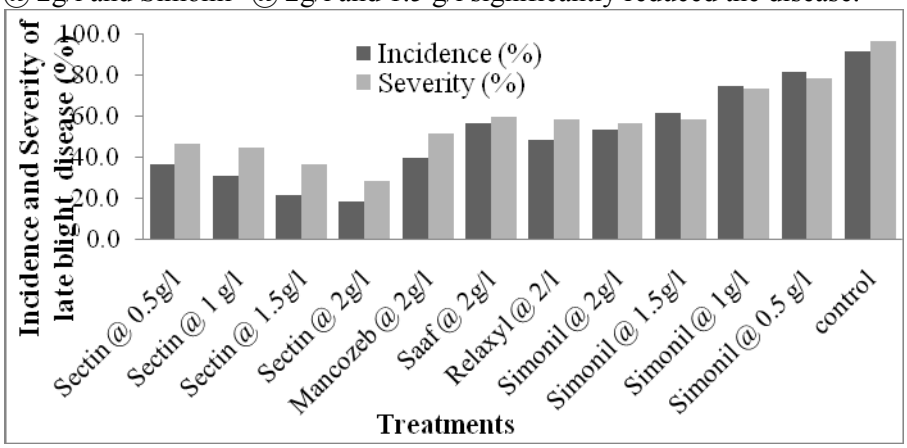


Figure 20. Effect of fungicides on incidence and severity of late blight disease in potato.

3.9 Garlic

3.9.1 Management of Stemphylum blight and purple blotch diseases of Garlic

Stemphylum blight and purple blotch are the major yield limiting diseases of garlic and onion in the eastern terai as well as other regions of the Nepal. Stemphylium blight disease is caused by *Stemphylium vesicarium* that infects garlic, onion and other herbaceous plants (asparagus, lucerne, tomato and soybean) and trees (pear, mango). Similarly, purple blotch of garlic is caused by *Alternaria porii*. An experiment was conducted during 2016-17 using randomly complete block design (RCBD) with 3 replications at RARS, Tarahara. Plot size was 3 m^2 accommodating 200 plants in each plot. Garlic sets were planted with spacing of 15cm row to row and 10 cm plant to plant. Plots were fertilized at the rate of 60 kg N: 100 kg

$P_2O_5$and 100 kg K_2O with 20 ton compost per hectare as basal dose at the time of set planting. Additionally, 60 kg N/ha was applied in two splits of 30 kg each at 30 and 60 days after set planting. Twenty nine (ARM-1, ARM-5, ARM-6, ARM-7, ARM-8, ARM-9, ARM-11, ARM-13, ARM-18, ARM-23, ARM-24, ARM-25, ARM-26, ARM-27, ARM-28, ARM-31, ARM-32, ARM-33, ARM-34, ARM-36, ARM-38, ARM-39, ARM-41, ARM-42, ARM-43, ARM-44, ARM-45, ARM-46 and ARM-48) from ARS, Malepatan and one landrace (Dhangadhi local) were collected and evaluated against Stemphylum blight and purple blotch diseases. The experiment was conducted under natural incidence of the diseases during winter season. Growth and development parameter were taken. Plant characters like plant height and yield were recorded. Foliar symptoms of infected plant were recorded. The Stemphylum blight was scored on 0-4 scale as follows: 0= No visible infection, 1= 1-25% seed-stalk area infected, 2= 26-50% seed-stalk area infected, 3= 51-75% seed-stalk area infected and 4= 76-100% seed-stalk area infected (Hussein et al 2007). Similarly, severity of purple blotch disease was recorded following a rating scale (Sharma, 1986) of 0–5 as:

0 = No symptom of disease
1 = A few spots towards the tip covering less than 10% of leaf area
2 = Several dark purplish brown patches covering less than 20% of leaf area
3 = Several patches with paler outer zone covering up to 40% of leaf area
4 = Long streak covering up to 75% of leaf area or breaking of the leaves from the centre, and
5 = Complete drying of the leaves or breaking of the leaves from the base

Percent disease index (PDI) will be calculated by the following formula given by Wheeler (1969).

$$PDI = \frac{\text{Total sum of numerical ratings}}{\text{Number of observations} \times \text{maximum disease rating}} \times 100$$

Among the 30 lines/genotypes, ARM-1, ARM-23, ARM-25 and ARM-23, ARM-36, ARM-41 and ARM-46 were tolerant to stemphylium blight. Similarly, ARM-18, ARM-26, ARM-23, ARM-25, ARM-33, ARM-36, ARM-41 and ARM-44 were tolerant to purple blotch diseases. Dhangadhi local had lower purple blotch score than ARM-6, ARM-7, ARM-8, ARM-9, ARM-11, ARM-13, ARM-31, ARM-32, ARM-31, ARM-32, ARM-34, ARM-39 and ARM-45. Similarly, Dhangadhi local had lower Stemphylum blight score than ARM-6, ARM-7, ARM-31, ARM-32, ARM-45, ARM-11, ARM-8 and ARM-34. Overall, ARM-11, ARM-13, ARM-8 and ARM-34 were highly susceptible to both the diseases and may not be suitable for cultivation in eastern terai.

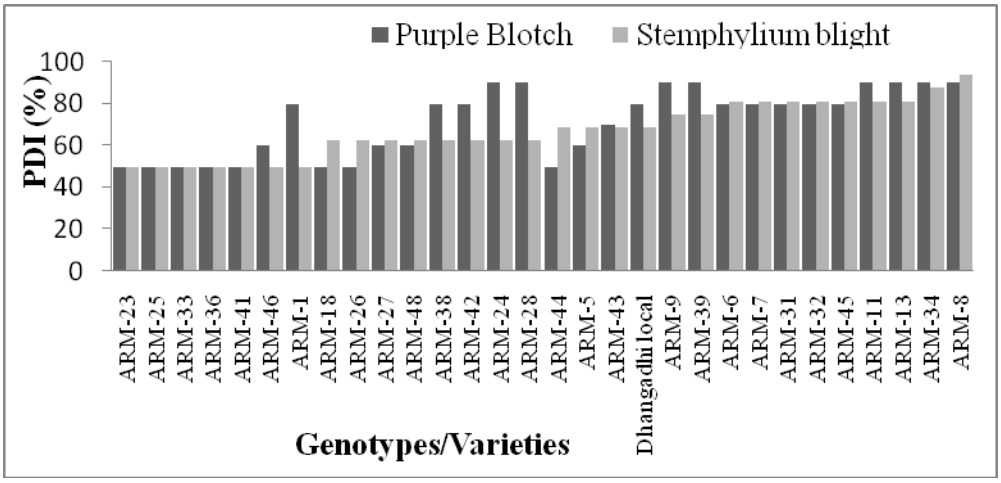


Figure 21. Stemphylium blight and purple blotch disease index in garlic genotypes.

3.9.2 Efficacy study of pesticides for controlling stemphylium blight an purple blotch disease of garlic

An experiment was conducted using randomized complete block design (RCBD) with 5 replications at RARS, Tarahara during 2016-17. Plot size was 3 m^2 accommodating 200 plants in each plot. Local garlic cloves were planted with spacing of 15cm x 10 cm row to row and plant to plant. Plots were fertilized at the rate of 60 kg N: 100 kg P_2O_5 and 100 kg K_2O and 20 ton compost per hectare as basal dose at the time of set planting. Additionally, 60 kg N/ha was applied in two splits of 30 kg each at 30 and 60 days after set planting. Pesticides (Jatayu® [chlorothalonil 75% WP], Dithane M-45® [mancozeb 75%], Bavistin® (carbendazim 50% WP), Titan® (hexaconazole 5% EC), Dhanucop® [copper oxychloride 50% WP], Avtar® [hexaconazole 4% + zineb 68% WP] and Saaf® [carbendazim 12% + mancozeb 63% WP] were evaluated along with a control (untreated plot) in the experiment. The experiment was conducted at hot spot of the disease under natural incidence during winter season. Growth and development parameter were taken. Plant characters like plant height and yield were recorded. The Stemphylium blight was scored on 0-4 scale and purple blotch was scored on 0-5 scale. Results reveal that lower severity of stemphylium blight and purple blotch disease was recorded in Jatayu® and Dithane M-45® (Table 31). Lower stemphylium blight was also recorded in Avtar® as compared to the control.

Table 31. Effect of different pesticides on severity of stemphylium blight and purple blotch disease of garlic

SN	Treatment	Av. Stemphylium score	Av. Purple blotch score
1	Jatayu®	2.3	3
2	Dithane M-45®	2.6	3.1
3	Bavistin®	2.8	3.5

4	Titan®	2.8	3.6
5	Dhanucop®	2.8	3.6
6	Control	2.8	3.9
7	Avtar®	2.6	3.8
8	Saaf®	2.7	3.6

3.10 Pig

3.10.1 Breed Improvement through Artificial insemination (A.I) using Frozen and Fresh Boar Semen on pig nucleus herd at RARS Tarahara

Pig farming is gradually emerging as commercial entity in Nepal and large commercial pig farms are being established even within the cities. It has got tremendous potential for employment and income generation. The total number of pigs in Nepal is 1.16 million, producing 18,709 metric tons pork annually that contributed 6.35% share of the total meat production in the country (MoAD, 2013). Although the number of pigs and the production of pork have been increased over the years, the contribution of pork to the total meat production in the country has decreased from 8% to 6.34% for last one decade (Premy *et al*, 2014).The statistics showed that 53%, 17%, 12%, 13% and 5% of pigs are found in eastern, central, western, mid-western and far western regions, respectively (Nirmal, 2014). In several developed countries there have existed several very long-term genetic improvement programs for efficient pork production. As a consequence of it the more advanced selected lines are dominating now a days for the pork production all over the world. It is fair to say that now a days a very large fraction of all pork produced worldwide are coming from lines developed from only five breeds: Landrace, Large White/Yorkshire, Duroc, Hampshire and Pietrain (Dempfle, 2014).Indigenous breeds of pigs like Hurrah, Bampudake, Chawanche and Nagpuri are reared by poor ethnic communities as a means of food security, livelihood, social, source of income; whereas Landrace, Yorkshire, Duroc, Hampshire etc. are the most common exotic swine breeds mostly for commercial purpose in Nepal. The sources of exotic pig seeds are mainly the government and Nepal Agricultural Research Council (NARC) farms. These improved breeds were introduced mainly by the government and NARC farms. However, the productivity of the current pig stocks of our country in general have been rated low due to poor management and haphazard breeding that prevails in small pig population (Shrestha, 2014). Recently the pig unit of Livestock Development Farm, Pokhara and the Swine and Avian Research Program, Khumaltar have been doing artificial insemination (AI) successfully and producing piglet of better quality (Annual report, SARP 2013/14; Nirmal et al, 2014). However, the farms are not giving priority for selective breeding of pure bred breeds which are necessary for commercial hybrid or crossbred pig seed stock production (Shrestha, 2014). With very

long-term genetic improvement techniques, some developed countries have generated pig breeds and lines that produce high quality lean meat (Dempfle, 2014). Small herds can take advantage of technology that can allow them to use boars of high genetic merit through AI (Bates, 2014).Regional Agriculture Research Station (RARS) Tarahara was established in 1960 AD (2013 BS) by the name of "Biratnagar Krishi Farm". Under this farm, Pig unit was started in 1965 AD (2018 BS) as a pig production program with an aim to provide genetically pure breeds to the farmers to enhance production and productivity. There are four sheds having 90 pens that are used for raring sows of different breeds, stocks of winner and gilts. Healthy piglets of 400 – 500 in number are produced annually from sows and distributed to farmers for upgrading local pigs. Farmers of Eastern Terai and Hill prefer Black Color Pigs for their social, cultural and religious purposes. So, RARS Tarahara is maintaining black color pigs of different breeds like Hampshire, Pakhribas black and some crosses since 1965 A.D. But production and maintenance of same parent stock for several years may lead to gradual deterioration of genetic character and enhance the chances of inbreeding. For this situation, Department for international development (DFID) UK agreed and funded this program to improve genetic purity of pig breeds. Therefore, Pig Research Program (PRP) at Tarahara initiated pig improvement program in partnership with CEAPRED SAMARTH-NMDP Pig sub sector project to improve pig nucleus herds. In this concern, SAMARTH-NMDP supported this program by providing A.I equipments and 180 doses of frozen boar semen of different black pig breeds.

Objective:

- To improve pig herd through A.I and reduce inbreeding chances.
- To maintain nucleus herd of pigs.
- To enhance production and productivity of pig in eastern region of Nepal.

All together 99 productive best sows of different breeds was selected from existing herd for this Study. Out of selected sows, 49 Hampshire (HS), 22 Pakhribas Black (PB) and 28 crossbreds (HS x PB) was selected on the basis of their pedigree records having 1 to 7 parity and good mothering ability of sows. CEAPRED / SAMARTH -NMDP Pig Sub Sector Project provided 180 doses (Hampshire 100, Large black 30 and Berkshire 50) of pure frozen boar semen which was imported from Swine Genetic International (SGI), USA. Those semen was stored in Dipped Liquid Nitrogen (LN2) at -196^0c temperature and inseminated to similar breed reared at PRP, RARS Tarahara i.e. Hampshire boar semen was used in Hampshire breed, Large Black boar semen was used in Pakhribas Black and Berkshire boar semen in Crossbred lines.

Semen was used for A.I. when pigs come to standing heat. Artificial insemination was done to 99 sows. Among 99 sows, 56 and 43 sows of different breeds was inseminated with imported frozen boar semen and fresh boar semen respectively.

Observation was taken on the basis of selection of best animals, semen received from pig sub sector project, number of semen dose used, number of inseminated sows, conception rate, number of sows furrowed and pregnant, number of piglets born, furrowing rate and piglets mortality rates.

Table 32: Selection of best animals:

S.N	Breeds	Numbers	Parity
1.	Hampshire	49	1-7
2.	Pakhribas Black	22	1-7
3.	Crossbreds(HSxPB)	28	1-7
Total	**-**	**99**	**-**

Table33: semen received from NMD sub sector:

S.N	Breeds	Numbers of doses	Boar line
1.	Hampshire	100	14
2.	Berkshire	50	7
3.	Large Black	30	4
Total	**-**	**180**	**-**

Table 34: Number of semen dose used for A.I. on selected breeds and lines:

S.N.	Type of semen	Number of doses used	Boar line
1.	Hampshire	77	9
2.	Berkshire	29	4
3.	Large Black	16	3
4.	Fresh semen	52	3

Table 35: Numbers of inseminated sows:

S.N	Breeds	Numbers	Parity
1.	Hampshire	49	2,5,6,7
2.	Pakhribas Black	22	5,4,7
3.	Crossbreds	28	3,5,4
Total	-	99	-

Table 36: Sows conception rate(%)

S.N.	Breed	Total inseminated		Total Conceived		Conceived %	
		Frozen	Fresh	Frozen	Fresh	frozen	Fresh
1.	Hampshire	35	25	15	22	42.85	88.0
2.	Pakhribas	10	9	6	8	60.0	88.88
3.	Crossbred	11	9	5	6	45.45	66.66
Total		**56**	**43**	**26**	**36**	**46.43**	**83.72**

Table 37: Number of sows Farrowed and Pregnant:

S.N.	Breed	Inseminated		Farrowed		Pregnant	
		Frozen	Fresh	Frozen	Fresh	Frozen	fresh
1.	Hampshire	35	25	13	10	2	12
2.	Pakhribas black	10	9	5	5	1	3
3.	Crossbred(HSxPB)	11	9	3	4	2	2
	Total	56	43	21	19	5	17

HS=Hampshire, PB=Pakhribas Black,

Table 38: Numbers of piglets born:

S.N.	**Breeds**	**Piglets born**		**Total**
		Frozen	**Fresh**	
1.	Hampshire	82	95	177
2.	Pakhribas black	27	63	90
3.	Crossbred	31	53	84
Total	**-**	**140**	**211**	**351**

3.10.2 Sustainable Income Generation of Farmers Through Exotic Pig farming.

Eight farmers randomly selectedfrom OR site of Kanchanrupmunciplity ofSaptaridistrict for this study. Each farmers was Provided two piglets (one exotic and one local). The farmer kept piglets on theirown feeding practices. Equal feeding ratio was provided to both breed. Vaccination and Drenching was done according to need. The analyzedresult between two breeds shown in table 1.

Table 39: Total body weight gain, Total feed consumed and feed conversion Ratio(FCR) at the end 12 month of age.

No. of farmers	**Weight. Gain (kg)**		**Feed Consumed(kg)**		**Feed Conversion Ratio(FCR)**	
	Exotic	**Local**	**Exotic**	**Local**	**Exotic**	**Local**
1.	87.5	56.3	287	287	3.28	5.09
2.	82.7	57.4	298	298	3.6	5.19
3.	88.2	57.9	304	304	3.44	5.25
4.	84.7	59.5	289	289	3.41	4.85

5.	86.4	52.3	291	291	3.37	5.56
6.	79.8	59.3	286	286	3.58	4.83
7.	82.4	58.5	307	307	3.73	5.24
8.	81.2	54.3	310	310	3.82	5.70
Total	**672.9**	**455.5**	**2372**	**2372**	**3.53**	**5.21**
Mean	**84.12**	**56.93**	**296.5**	**296.5**	**3.52**	**5.20**

3.10.3 Maintenance and genetic improvement of different pig breeds at Tarahara

Pig is high value domestic animal for meat purpose. It gives quick return to the farmers.It consume wastage food materials and convert in valuable meat. The total 13millions heads of pig population scattered all over in the pig keeping communities of Nepal. Which produced23059 Mt.pig meat in the country .Therefore, the demand of pig meat is increasing day by day and about 3% of pig meat is entering in Nepalese kitchen every years. This production is mostly comes from native domestic pigs which is well adopted traditional system of keeping pigs found in the country. The government through department of livestock services being started distributing improved pig breeds for many years in the country. Now a day NGO/INGOs are also involved in raising the income of farmers through pigs distribution also. This approach has expanded the improved pig raising system in the rural farmers. Therefore, RARS,Tarahara has been conserving different pig breeds for pure line parental stock and crossing some each other for research purpose. So, evaluation of Sow productivity is the most important factors contributing to total meat production from the pigs.

This study was started in piggery unit at RARS,Tarahara. A total forty eight piglets were randomly selected for this study. Hampshire n=9, Pakhribas black n=9, puri n=9, Hurrah n=9, PakhribasblackXPuri n=9 and HampXHurrah n=9 were analised .The designed was used CRD in to 6 treatment with 8 replication. The one pig considering as one replication. The feed were procured from Asian feed industry, khanar,sunsari and fed to each pigs in separate pens. vaccination and drenching were done each and every pigs according to need .The shed management were similar. The evaluation were done after birth of piglets upto twelve month age of pigs.Data were analysed using MSTAT. After analyzed data's the mean body weight 1st month of hampshire piglets found higher 8.6±1.14kg compared to

8.4±1.55,4.28±0.57,3.33±0.28,5.93±0.66 and 6.23±0.97kg of pakhribas,puri,hurrah,hampXhurrah and PACXPuri piglets. Similarly the final weight upto age of 12 month piglets/pigs also found larger of Hampshire 125±0.10 kg as compared pakhribas,puri, hurrah, hampshireXhurrah and pakhribasXpuri as 115.6±18.42±, 59.8±8.4, 55.9±4.0, 81.0±7.9 and 85.33±4.29kg respectively. It was Significant difference each other (0<0.5)level. The mean body weight(kg) of different pig breedsshowed on Table 1.

Table 40: Mean body weight (kg) of different pig breeds upto age of 12 month

Month	Pakhribas Mean±SD	Hampshire Mean±SD	Puri Mean±SAD	Hurrah Mean±SD	Hamp× Hurrah Mean±SAD	PAC×Puri Mean±SAD	F-Test
1st month	8.4±1.55	8.6±1.14	4.28±0.57	3.33±0.28	5.93±0.66	6.23±0.97	*
2nd month	12.43±1.72	14.04±3.75	9.25±4.66	6.73±0.68	9.33±1.97	11.97±2.33	*
3rd month	17.25±±2.25	18.64±3.73	14.08±4.82	10.33±0.7	14.93±2.0	17.97±3.37	**
4th month	22.12±3.83	24.24±4.28	17.6±4.82	14.33±0.57	17.78±2.68	22.39±4.32	**
5th month	27.62±4.20	29.1±4.24	20.8±4.72	18.0±2.64	22.53±2.84	30.97±4.83	**
6th month	36.62±6.34	39.08±4.50	25.2±6.14	21.33±3.21	30.33±1.52	37.33±3.33	**
7th month	46.12±7.16	48.2±14.80	30.6±6.73	26.16±2.24	33.0±4.33	47.2±4.33	**
8th month	61.87±8.38	65.0±15.78	35.64±7.36	31.33±2.51	44.0±5.29	52.31±3.32	**
9th month	70.62±7.0	79.8±17.12	43.0±8.8	38.33±1.52	52.66±8.02	65.0±4.33	**
10thmonth	88.25±8.43	98.0±13.54	48.4±8.58	41.66±3.78	69.65±5.33	73.33±5.97	**
11thmonth	107.87±9.03	115.25±17.37	53.0±9.05	49.0±4.32	75.0±5.97	80.2±2.29	**
12thmonth	115.6±18.42	125.6±21.49	59.8±8.4	55.9±4.0	81.0±7.9	85.33±4.29	**

Notes: NS= Non significant, *= significant at 5% level, **+significant at 5% level

3.11 Poultry

3.11.1 Effect of different levels of green grass in turkey production

Trial was conducted for 140 days followed with 2 weeks of adjustment period in laying turkey. Duration of the experiment was divided into 5 periods, each period comprising 28 days. Three dietary treatments were used with 3 replications. Three female and one male turkey was used in each experimental unit. Commercial layer ration was used ad lib as basal diet (T1), where as T2 and T3 group received 90% and 80% of basal diet with supplementation of green grass (GG). Egg production and egg weight were recorded daily and hen day egg production was calculated.

Table 41: Egg production (Mean ±SE) of turkey with different dietary treatments

Age(wk)		**Egg/hen/28 days**		
		T1 (Basal diet)	T2 (90% feed + GG)	T3 (80% feed + GG)
41-44	Feb-14 to March-13	9.9 ± 1.6*	4.9 ± 0.6	2.0 ± 0.4
45-48	March-14 to April-10	14.1 ± 1.3	15.0 ± 0.84	10.4 ± 0.7
49-52	April-11 to May-8	13.3 ± 1.6	14.8 ± 0.9	13.3 ± 0.5
53-56	May-9 to June-5	12.1 ± 1.4	12.4 ± 1.1	11.1 ± 0.8
57-60	June-6 to July-3	7.4 ± 1.3	8.4 ± 0.5	8.2 ± 0.5
Total		**57.7 ± 5.6**	**53.7 ± 2.5**	**46.3 ± 2.8**

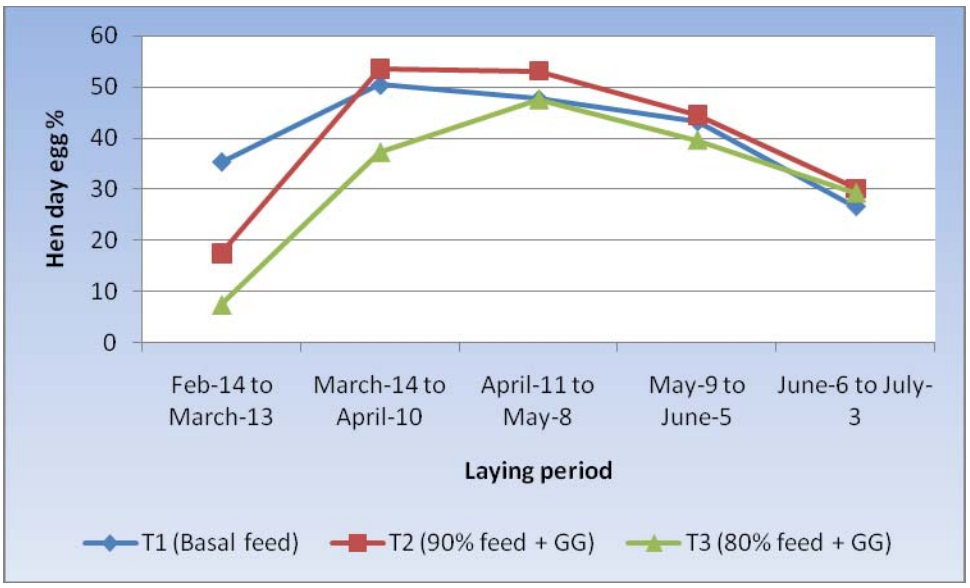


Fig. 22: Hen day egg production of turkey

Except at initial period (41 to 44 week), no significant difference for egg production was observed during entire observation period which indicating potentiality of reducing up to 20% commercial feed with green grass supplementation in laying turkey.

3.11.2 Scaling up Giriraja chicken for wider adoption

Six weeks age of 10 giriraja chicks were distributed to each 10 selected farmers of Maharanijhoda, Jhapa; Singhiya, Sunsari and Kanchanpur, Saptari. The main objective was to evaluate performance of Giriraja under local management condition. Commercial feed was used by most of the farmers to fed their chicks at initial stage and raised with using local feed at later stage. An average 6 kg commercial feed was fed by each farmers. At 16 week of age, weight of male and female was observed 2.6 kg and 1.7 kg, respectively. At 28 weeks, average weight of male and female was observed 3.3 kg and 2.5 kg respectively. Average weight of bird found to be varying with feed and system of management. Highest body weight was observed for the bird which received commercial feed with semi scavenging management system; however cost of production was also higher. Selling price was found Rs 300-350 per kg live weight basis. Though, the selling price is little bit less than the local, farmers preferred Giriraja because of fast growing nature and heavy body size even under scavenging management condition.

3.12 Fisheries

3.12.1 Genetic improvement of indigenous major carps (Rohu)

Introduction

Carps are the major species which occupied over 95% of total production in Nepal. Major Carps are emphasized and being cultured in polyculture fish farming. Indigenous major carp is very old stock in Nepal (60 yrs. stock) without genetic management. Seed production through induced breeding of IMC and Chinese carp in Nepal since 1970 (Karki, 1998). The hatcheries contributed 76% to the total seed production (75 million), the rest coming from the public sector (DoFD, 2002). Broodstock management in hatcheries in Nepal is not sound with respect to maintenance of genetic Variation. Each hatcheries considered as an isolated, self-sustaining and genetically closed system (Eknath and Doyle, 1990). The priority or need of genetically improved brood fish of different culture fish species. Very few numbers of brooders have been used to meet the target of hatcheries over the year. Using very few numbers of brood significantly reduces the effective number parents (Ne, low gamatic contribution in each generation). Haphazard breeding resulted in stock deterioration, inbreeding depression in term of growth, high FCR, disease susceptible. No brood exchange and out crossing occurred. Each hatchery, therefore, can be considered closed relation of breeding. This result the rate of inbreeding from 1.6% to 27.6% per year and rapid inbreeding of hatchery stocks of carp is appeared (Wagle and Pradhan, 2003). Thus, objective of present study was to compare and evaluate the growth and yield performance of GIR and FR at initial stage of development.

Methodology

An experiment was conducted at Regional Agriculture Research Station (RARS) Tarahara for 90 days. Germplasm of geneticallyimproved rohu (GIR) was introduced in Nepal in 2013/14. The genetically improved rohu (20-30 g) was received from Fisheries Development and Training Centre, Janakpur, Nepal. The stocking pond size was 600 m2. The stocking densities of fish was 1f/m^2 and stocking size was 20-30 g. After about 18 months of introduction, the FIR became mature and the fry were obtained through captive breeding.The experiment was conducted in completely randomized design (CRD). There were two treatments with three replications of each. The stocking pond size was 100 m^2 each. Treatments included T1: Farmed rohu (FR) and T2: genetically improved rohu (GIR). The stocking densities of both fishes were 20,000 f/m2. The mean stocking size of farmed rohu was 1.35±0.4 and genetically improved rohu was 1.74±0.4. The fish were fed with pellet at 5% of their total body weight containing 22% of crud protein. At least 20% of sample fish biomass were netted monthly for growth check. Water quality parameters: temperature measured daily at 8:00 -10:00 am and dissolved oxygen (D0) and pH were measured weekly at 8:00 -10:00 am.. Data processing and figure preparation were performed using Microsoft excel and statistical analysis of data was done using differences between treatments were analyzed with t-test using SPSS ver. 20.

Result and Discussion

The weight gain, length, absolute growth, relative growth, specific growth, survival and gross biomass are presented in Table 1, 2, 3, 4, 5, 6 and 7 respectively. The value of water quality parameters of the ponds was ranged between 15 to 24 ^{o}C temperature, 4.0 to 8.3 mg/L dissolved oxygen and 7.2 to 8.5 pH during the experimental period.

Table 42: Weight gain of GIR and FR at different time interval

Day	GIR (Mean±SD)	FR (Mean±SD)	p-value
1	1.74±0.45	1.35±0.45	0.000
30	5.83±1.58	4.07±1.50	0.000
60	92.08±37.66	14.96±11.77	0.000
90	126.6±48.07	22.9±12.9	0.000

Weight gain was significantly (P<0.05) different in GIR1.74±0.45, 5.83±1.58, 92.08±37.66 and 126.6±48.07than in FR1.35±0.45, 4.07±1.50,14.96±11.77 and 22.9±12.9 at different time interval i.e 0, 30, 60 and 90 days. The growth rate superiority of upto 75% was observed by improved rohu over local rohu (Das Mahapatra et. al. 2007).

Table 43: Length of GIR and FR at different time interval

Day	GIR (Mean±SD)	FR (Mean±SD)	p-value
1	4.77±0.52	4.27±0.59	0.000
30	7.43±0.76	6.14±1.15	0.000
60	19.36±2.71	10.76±3.12	0.000
90	21.08±2.49	12.08±2.49	0.000

The length was significantly (P<0.05) higher in GIR4.77±0.52, 7.43±0.76, 19.36±2.71 and 21.08±2.49 than in FR 4.27±0.59, 6.14±1.15, 10.76±3.12 and 12.08±2.49 at different time interval i.e 0, 30, 60, and 90 days.

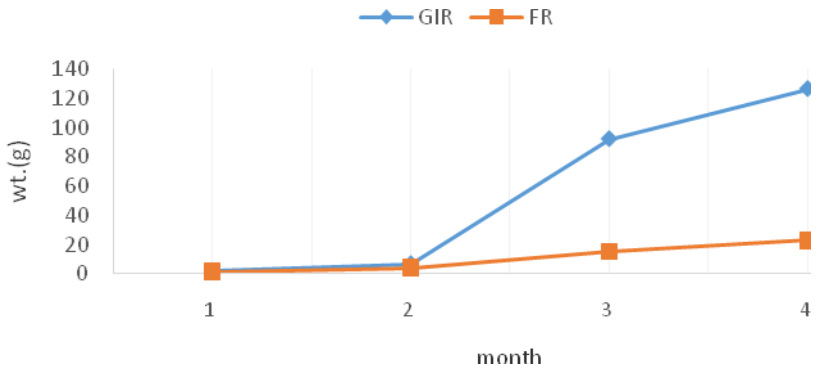


Figure 23: Growth trend of genetically improved rohu (GIR) and farmed rohu (FR) during the experimental period

The preliminary study has shown growth of genetically improved rohu was 0.280±0.0141 g and 0.380±0.0295 g in farm pond and farmer's pond in 1.5 months period respectively (Roy *et. al.* 2013).

Table 44: Absolute growth rateof GIR and FR at different time interval

Day	GIR (Mean±SD)	FR (Mean±SD)	p-value
30	0.13±0.05	0.09±0.05	0.000
60	2.87±1.27	0.36±0.39	0.000
90	1.09±2.15	0.28±0.61	0.006
Whole growing period	1.37±0.52	0.24±0.14	0.000

Absolute growth was significantly (P<0.05) higher in GIR (1.37±0.52) than in FR (0.24±0.14) on whole growing period.

Table 45: Relative growth rate (% weight gain day-1= $[(W_t - W_0)/ (W_0 \times days)]$ 100)of GIR and FR at different time interval

Day	GIR (Mean±SD)	FR (Mean±SD)	p-value
30	8.69±4.6	8.04±6.9	0.512
60	54.97±31.7	10.41±11.7	0.000
90	10.35±26.3	6.39±9.5	0.204
Whole growing period	83.45±38.3	19.64±13.3	0.000

Relative growth was significantly (P<0.05) higher in GIR (83.45±38.3) than in FR (19.64±13.3) on whole growing period.

Table 46: Specific growth rate (SGR)=[($lnW_t - lnW_0$)/days] l00of GIR and FR at different time interval

Day	GIR (Mean±SD)	FR (Mean±SD)	p-value
30	4.03±0.95	3.67±1.24	0.005
60	9.19±1.13	4.34±1.43	0.000
90	1.06±1.7	1.42±2.46	0.000
Whole growing period	4.17±0.48	2.72±0.62	0.000

Specific growth was significantly (P<0.05) higher in GIR (4.17±0.48) than in FR (2.72±0.62) on whole growing period.

Table 47: Survival rate% of GIR and FR during the research period

GIR	FR	P-value
90.16±4.46	79.16±3.74	0.068

Survival rate of GIR and FR was 90.1±4.4% and 79.1±3.7%, respectively, at harvest after 90 days of rearing and the differences in survival rate was not significantly different (P>0.05) during the research period. The mortality of fishes were occurred during the experimental period due to predation by birds.

Table 48: Gross biomass at harvest (kg/ha) during the research period

GIR	FR	P-value
2223±82.1	338.4±5.98	0.001

The fishes were fed 22% of crude protein containing diet during the experimental period showed gross yield of GIR 2223.8 kg/ha was significantly (P<0.05) higher than the gross yield of 338.4 kg/ha for FR. The genetically improved rohu fed to 15, 20, 25 and 30% crude protein in diets results 25% CP containing diet grew the higher (14.19±0.011) g than other diets (Sarkar *et.al.*2015).

Conclusion

Genetically improved rohu is one of the preferred strain and it is economically viable and acceptable to the hatcheries and grow-out farmers. Gross yield of genetically improved rohu was significantly higher than the gross yield of Farmed rohu. The phenotypic appearance of both GIR and FR are same. So tagging to genetic improvement of rohu is necessary for distribution to the hatcheries. Need to research pond covered by bird prevention nett. Further experiments are recommended to polyculture of carp with genetic improvement of rohu.

3.13.2 Improvement of Tilapia strains (all male) and Farming Technology

Tilapia (*Oreochromisniloticus*) they rank second to carps for total production in the world. They are often called "aquatic chicken" and "poor men's fish". It is now spread across a wide range of culture system from small to large ponds and reservoirs and in fresh and sea waters within peri-urban to rural areas. Therefore tilapia has become "everyone's fish". Tilapia matures and spawning ages of 2-6 months and size of less than 20 g. Breeding of tilapia may not occur every time but under favourable environment condition , a female will normally produce several batches of young's in a year. The overpopulation encountered is the big problem in commercial production. The overpopulation of tilapia in ponds caused stunted growth due to shortage of natural food and space. This studied has been more focus of mass all male fry production through sex-reversal using MT hormone.

Methodology

An experiment was conducted at RARS, Tarahara for 180 days in hapa culture. The size of nylon hapa was 3×2×1 m3. The stocking size of both monosex tilapia and mixed sex tilapia was 1-5 gm. The stocking densities of tilapia was 50 f/m3 for 3 months. After then 10 f/m3 for 3 months. The crumbled pellet feeding @ 3% body weight of fish was givento both fishes. Water quality (temperature, DO, pH) were measured weekly.

Result and Discussion

The weight gain of monosex tilapia was higher (107.86 g) than mixed sex tilapia (58.30 g) during the experimental period.

Table 49: Weight gain of monosex tilapia and mixedsex tilapia at different time interval

Month	Mono sex tilapia (av.growth) gm	Mixed sex tilapia (av.growth)gm
0	3.2	3.6
30	9.35	6.2
60	14.59	8.70
90	49.52	12.15
120	65.16	18.72
150	84.83	35.32
180	107.86	58.30

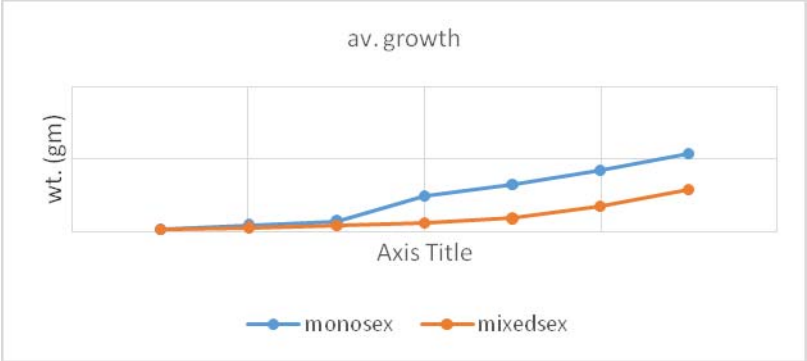


Figure 24: Growth trend of monosex tilapia and mixedsex tilapia during the experimental period

Conclusion

The stocking density of tilapia 2f/m^2 showed better performance than highly stocking 50f or 10f in hapa. The further study of carp polyculture is needed. This research, mono sex tilapia showed better performance than mixed sex tilapia. And the farmers are recommended to culture mono sex ttilapia.

3.12.3 Carp feed and feeding practices in Nepal

Supply of quality fish seed and feeding play central and essential role in the sustained development of carp aquaculture.In Nepal, most aquaculture fish production is based on low-input systems relaying on low protein agricultural by-products. It has been observed that farmers relying on single ingredient, and mash feed prepared from several ingredients to feed the farmed fish. Feeding practices are not well developed to satisfy the need of fish, and both underfeeding and overfeeding is common. There is large information and data gap on feed management and feeding practices adopted by the farmers and their impact on fish production. A reliable database in these aspects is an essential prerequisite for planning sustainable aquaculture development. The present survey attempted to document feeding practices in carp polyculture in eastern Terai region, and to identify the major issues that need to be addressed to build the capacity of aquafarmers to optimize the use of feed and feed additives.

A semi-structured questionnaire survey of 18 randomly selected farmers was carried out in four districts viz. Jhapa, Sunsari, Morang and Sarlahi between July 2016 and June 2017 to understand the on-farm carp feed management and feeding practices that are applied to the various production systems adopted by the farmers. Primary data collection included information related to mash feed ingredients, commercial

pellet feeds, feeding practices, feeding methods, feeding rates, FCR, on-farm storage, and issues related to feed quality. Eighteen feed samples including individual ingredients, mash feed comprised of different ingredients and pelleted feed were collected directly from the farm sites for proximate analysis. Nutrient composition of all collected feeds were analyzed in Animal Nutrition Division of NARC, Khumaltar. The data pertaining to the different stages of production, i.e. grow-out, fingerling, fry and larvae, were analyzed independently. Data were processed using Microsoft Excel and analyzed by using tabular and descriptive statistical methods. The technique of analysis included the classification of tables into consequential results by arithmetic mean, percentage and ratios.

The survey revealed that 83.3% of farmers used mash feed as their sole feed source for the production of fish (Figure 1). A further 11.1% of farmers used a combination of mash and pelleted feeds, and 5.6% of farmers reported using pellets as their sole feed source.

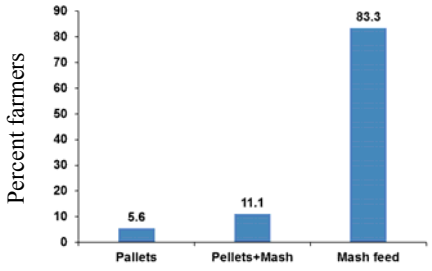


Figure 25.Types of feed used by farmer in carp

Rice bran and mustard/linseed oil cake was used by most of the surveyed farmers (94.4%), followed by wheat flour (41%) and soybean flour (22.2%) (Figure 2). The data of present survey indicate that rice bran, oil cake and wheat flour were the primary three ingredients used in mash feeds. The survey also revealed that the use of mass feed was gradually declining in areas where commercial pellet feeds are available, which was demonstrated by the facts that 11.1% and 5.6% of the farmers reported using combinations of pelleted and mash feeds, and pelleted feeds, respectively as sole source of feed.

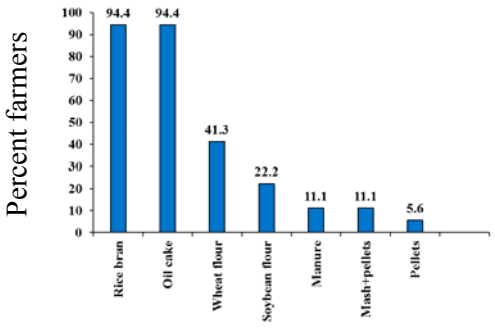


Figure 26. Feed ingredients used in carp polyculture by the farmers

Figure 27. Mustard oil cake

All the farmers, irrespective of stages of fish, reported feeding carps at least once a day (Figure 4). Two time feeding for rearing fry was practiced by the majority of farmers (65%). Fingerling and grow-out fish were fed once in a day by more than 70% of the farmers. feed utilization can be optimized by increasing feeding frequencies, and that the growth response to differential feeding frequencies is both species-specific and specific to the life history stage of the fish. However, effects of such feeding frequency on fish growth and yield has not yet been evaluated in carp polycultures of the country to best utilize the given feed.

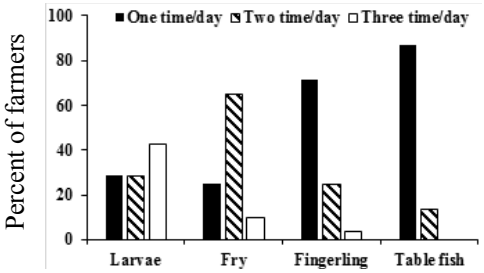


Figure 28. Feeding frequency used by the farmer for different development stages of carp fish

Feed additives that were used by the farmers using mash feed are illustrated in Figure 5. The most common feed additive was vitamin mix used by 16.7% of the farmers. The second frequently used feed additive was antibiotics that were used by 11.1% of the farmer. Antibiotics were used to treat bacterial diseases (red spot and epizootic ulcerative syndrome, EUS).The requirement of vitamin and mineral in fishes varies with species, age, environment and culture system as well. Many farmed fish species, including carps, are filter-feeders and derive much of vitamin and mineral requirements by consuming fine particulate matter such as phytoplankton, zooplankton, bacteria and detritus. Taking into account of availability of particulate matter and biosynthesis of some vitamins by fish itself, further study is warned on whether the addition of mineral and vitamin mixtures to the mash diets has any measurable effect in terms of increasing feed efficiency and optimizing growth.

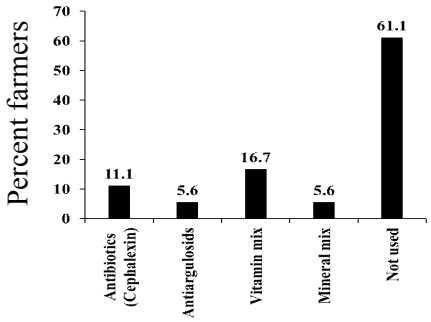


Figure 29. Usage of feed additives by carp farmers

Proximate composition of ingredients used for mash feed preparation, major groups of mash feed and pelleted feeds are presented in Table 1. Proximate analysis in laboratory revealed that meanmoisture content of mash feed was 11.1%. The mash feeds used by majority of farmers comprised of oil cake+ rice bran at proportion 40:60 contained 20.0% crude proteinand 7.6% crude fat. Survey revealed that the commercial pellet feeds used by the farmers were originated from Nepal (5 brand) and India (5 brand). These pellet feeds contained over 90% dry matter, 16.1% to 21.5% crude protein and relatively high levels (9.8 to 12.2%) of crude fat. Survey data indicated that the large variation exist in dry matter and nutrient composition of feed ingredients and prepared mash feed. These differences are supposed to be largely governed by ingredients type and quality, composition of mash feed, storage condition and weather condition at times when feed samples were collected.

Table 50: Proximate composition analysis (% as fed basis) of mash feed and pelleted feed

Nutrients	Carp			Pangas (India, 3)
	Mash feed (10)	Pelleted feed		
		Nepal(5)	India (5)	
Moisture, %	11.1	8.6	9.6	7.5
Crude protein, %	20.0	16.1	19.7	21.5
Ash, %	11.5	6.7	9.3	14.5
Crude fat, %	7.6	12.2	11.1	9.8

The combined production characteristics of the different aquaculture production systems that were surveyed are presented in Tables 2. Basically two types of culture systems adopted by the surveyed farmers, viz. low density carp polycultures with yearlings, and high density carp polycultures using fingerlings. In high and low density semi-intensive polyculture systems, seven (Indigenous major carp, Chinese carp and common carp) carp species are cultured. Irrespective of production systems, the ponds received 2.5 to 6.0 tons of cow dung/ha/annum and 55 to 122 kg of inorganic fertilizer/ha/annum. The recorded productivity was varied greatly among production systems and the types of feed applied. The survey data indicated that the production volume range between 5.25 tons/ha with mash feed to 6.35 tons/ha with combination of mash and pellet feed in low density while the production volume was relatively low in high density polyculture system ranging from 4.48 tons/ha with mash to 4.75 tons/ha with mash+pellet feed.

Table 51: Production characteristics of semi-intensive carp aquaculture production systems

Type of culture	Feed type	Feeding frequency, times/day	FCR	Organic manure, tons/ha	Inorganic fertilizer, kg/ha	Average production (t/ha)
Low density carp polyculture	Mash	1-2	2.6-4.2	2.5-5.6	60-90	5.25
	Mash +Pellet	1-2	1.9-2.7	2.8-4.3	55-85	6.35
High density carp polyculture	Mash	1	2.2-3.8	3.0-6.0	60-122	4.48
	Mash +Pellet	1-2	1.8-3.1	2.5-4.0	55-90	4.75

The FCR recorded across all the culture systems ranged between 1.8 to 4.2:1. The most efficient food conversion was recorded in the low density polyculture using mass+pellet feed. Irrespective of culture systems, the combination of maas and pellet feed gave the lowest FCR (1.8:1) followed by mash feed (2.2:1) comprised of oil cake (40%) and rice bran (60%). In all the production systems, the FCR cannot be recognized to the single use of the external feeds. In every production system, phytoplankton and zooplankton and other natural food organisms significantly contribute to the nutrition of the fish. Considering the FCR and lower feed wastage that is attained by feeding commercial pellets, priority could be given to developing high quality pellet feeds to be used in combination with the feed ingredients used in the traditional mash feeds.

Farmers complained about the quality of the rice bran and oil cake that they contained high moisture and adulteration with rice husk in rice bran and contamination with fungal growth in oil cake. Farmers also responded on the quality of pelleted feed, that they had doubt on protein content labeled in feed bag in the background of poor growth of fish and high FCR from pellet feeding experienced by them. The monitoring mechanism of feed quality and adulteration of feed ingredients remains an important issue that needs to be resolved.

The following recommendations can be derived based on the issues and constraints highlighted in this study:

- Undertake research on improving the nutritional quality of farm-made mash feeds.

- Conduct research on nutrient requirements of seven species carp polyculture system under intensive pond culture conditions, including the role of natural productivity.
- Establish the dose, efficacy and cost-effectiveness of the chemicals and materials used as feed additives.
- Improve feed and feed management practices. Optimize feeding schedules, and develop protocols to reduce feed losses.
- Train the farmers about the importance of feed management practices in optimizing production parameters.

3.12.4 Effect of feed forms and feeding frequency in carp polyculture

Carp pond polycultures are the major source of aquaculture production in Nepal. As carp poycultures are gaining attention all over the country as mean of improving national fish production, one problem facing fish farmers is the need to obtain a balance between rapid fish growth and efficient use of the supplied feed. The common practice of fish feeding is to use moist feed mass prepared mostly from agriculture byproducts. There are unsubstantiated claims that the production cost of fish are high accompanied with high feed conversion ratio (FCR) because of the disintegration of the major part of the provided moist feed is not utilized by the fish. Recently, feed manufactures have initiated the production of fish feed with binding agent gelatin in the forms of crumbles and pellets for the carp fish to prevent dispersal loss when feed comes to contact with water. With the lack of evaluation, these forms of feed are not as popular as the traditional practice of moist feeds. The optimal form of feed for feeding fish species especially carps is to be clearly defined and this has led to high FCR in the feeding form used by many farmers. Inappropriate feed form associated with feed loss can be detrimental to the health of the fish and may cause a marked deterioration in water quality, reduced weight, poor food utilization, and increased susceptibility to infection The present research attempt to provide basic data and information on the efficiency of commercial pelleted and moist feeds, and feeding frequency in terms of utilization, growth and yield.

Figure 30. Experimental cages

Study of the effect of different feed forms and feeding frequency on fish yield was carried out for 198 days from September 2016 to March 2017 in pond at RARS, Tarahara. Two forms of feed (mash and pellet) and three levels of feeding frequency (one, two and three times/day) was established as treatments in 2x3 factorial design with three replicates. Five species of carps, common carp, grass carp, silver carp, bighead carp and rohu with a mean initial weight of 35.5 g at proportion of 3.4: 0.7:

1.9: 2.5: 1.5, respectively, were stocked in 2x3 m^2 nylon cages established in o.5 ha earthen pond. The stocking density maintained was 15 fish/m^2 of cage. The fish were fed with a ration containing 25% crude protein in respective feed forms and feeding frequency. Water quality of rearing pond was monitored at different time interval based on characteristics of parameters such as temperature daily, dissolve oxygen and pH at weekly and water nutrients at monthly interval. Fish were sampled at monthly intervals for the estimation of growth, and final yield and fish survival was calculated upon harvest. Treatments difference in terms of fish growth and yield was analysed with ANOVA using SPSS ver 20.

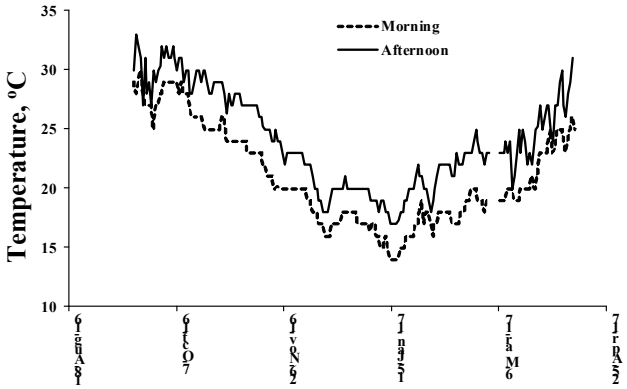


Figure 31. Morning and afternoon water temperature of experimental cages

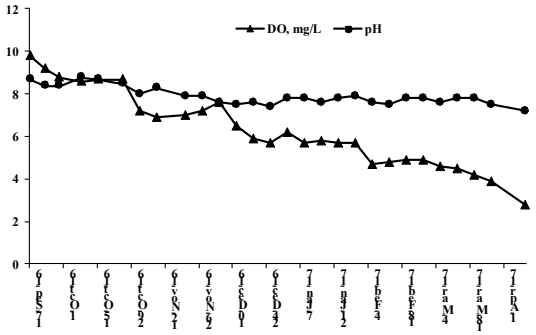


Figure32. Dissolve oxygen (DO) and pH trend in experimental pond

Water temperature (14-33 ^oC)varied greatly during the growing period of fish (Figure 2). Dissolve oxygen was decreased as the fish growing progressed while the pH remained constant (Figure 3). Total alkalinity and hardness of the water was also decreased at the end of experiment. At the end of experiment, dissolved nutrients (NO_2,NO_3, NH_4, PO_4) in the fish rearing water were found at increased level compared to the levels at the start of experiment (Table 1). The decrease in DO level and increasing trends of all measured nutrients could have resulted from the elevated metabolic activity of experimental fish which demanded increasing amount of feed at the later period of fish rearing. However, the relation between changes in water quality and fish growth could not established.

Table 52: Water quality of pond at beginning and termination of the experiment

Parameters	Beginning (17 Sep 2016)	Termination (9 Apr 2017)	Mean	Range
Total alkalinity, mg/L	117	92	115.14	92-137
Total hardness, mg/L	98	67	93.57	67-114
Nitrite (NO2), mg/L	0.03	0.16	0.053	0.01-0.16
Nitrate (NO3), mg/L	0.05	0.16	0.114	0.04-0.16
Ammonium (NH4), mg/L	0.03	0.05	0.055	0.03-0.09
Phosphate (PO4), mg/L	0.022	0.07	0.064	0.020-0.12

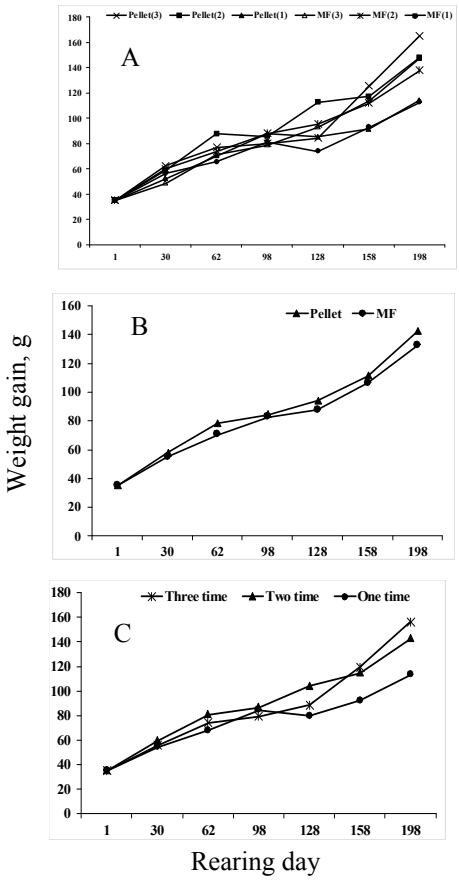


Figure 33. Fish weight gain in response to feed forms and feeding frequency

Figure 3A revealed that the weight gain of fish was highest in treatment fed with pelleted feed at frequency 3 times/day. The second highest weight gain was for the fish receiving feed two times/day irrespective of feed forms. Feed forms did not influence the growth of fish (Figure 3B). The weight gain of fish was lowest in single feeding (Figure 3C). High feeding frequency had significant ($P<0.05$) positive impact on body relative and specific growth of carps. Both reative (0.97%) and specific growth (0.57%) was high for fish fed with mash feed at frequency three times/day followed by the fish fed for two times/day with pellet feed (Table 2). However, specific growth rate of fish species was not significantly ($P>0.05$) different among feeding treatments (Table 3). Absolute groth rate (0.37 g/day) was highest in fish fed with pelleted feed at three times/day. These findings clearly indicated that high feeding frequency had affected the growth performance in carp fishes.

Table 53: Growth of carps fed with different forms of feed at different frequency

Feed form	Feeding frequency (times/day)	Growth		
		Absolute growth rate (AGR, % day^{-1})	Relative growth rate (RGR, % day^{-1})	Specific growth rate (SGR, % day^{-1})
Mash feed	1	0.19^{a}	0.56^{b}	0.39^{b}
Mash feed	2	0.33^{ab}	0.72^{ab}	0.49^{ab}
Mash feed	3	0.34^{ab}	0.97^{a}	0.57^{a}
Pellets	1	0.24^{bc}	0.60^{b}	0.40^{b}
Pellets	2	0.37^{c}	0.63^{ab}	0.44^{ab}
Pellets	3	0.25^{abc}	0.48^{b}	0.37^{b}

Table 54: Species wise SGR among treatments

Feed form	Feeding frequency (times/day)	Specific growth rate (SGR, % day^{-1})					
		Common carp	Grass carp	Silver carp	Bighead carp	Rohu	Naini
Mash feed	1	0.53	0.61	0.32	0.19	0.23	0.49
Mash feed	2	0.71	0.70	0.37	0.25	0.39	0.53
Mash feed	3	1.21	0.74	0.29	0.24	0.44	0.49
Pellets	1	0.69	0.25	0.49	0.13	0.45	0.38
Pellets	2	0.86	0.31	0.34	0.23	0.44	0.49
Pellets	3	0.37	0.36	0.38	0.25	0.32	0.55

* not significant within species among treatments

Feed forms and feeding frequency did not affect ($P>0.05$) the survival of fish at harvest. The survival of fish was ranged between 95.5% to 98.8%, irrespective of treatments. In contrast to growth rates, fish yields were significantly higher ($P<0.05$) in treatment of pellet feed with two times/day feeding (Table 4). The highest net yield of 0.97 kg/m^2 recorded was for treatment pellet feed with two times feeding followed by mash feed with three times feeding (0.84 kg/m^2) and the lowest (0.39 kg/m^2) was for fish fed single time with mash feed. Feed conversion ratio was also affected by the feeding frequency. FCR between 1.9 and 2.1 obtained in treatments of two and three feedingwith mash feed, and two feeding with pellet feed was significantly low ($P<0.05$) that rest of the feeding treatments (Table 4).

Table 55: Yield and recovery rates of fish in different feed forms and feeding frequency

Feed form	Feeding frequency (times/day)	Survival, %	Total yield, kg/m^2	Net yield, kg/m^2	FCR
Mash feed	1	98.8	1.08^{b}	0.39^{b}	4.1^{b}
Mash feed	2	95.5	1.48^{ab}	0.80^{ab}	2.1^{a}
Mash feed	3	96.1	1.45^{ab}	0.84^{ab}	1.9^{a}

Pellets	1	97.2	1.24 [ab]	0.53 [ab]	3.8[b]
Pellets	2	95.5	1.84[a]	0.97 [a]	1.9[a]
Pellets	3	95.5	1.48 [ab]	0.48 [ab]	3.8[b]

Feeding presents the largest part of expenses in intensive and semi-intensive aquaculture, so fish feed must be of good quality to assure high utilization, high growth rate, and good health, and at the same time to protect the water environment. The findings of present study suggested that the impact of feed forms on growth and yield of carp fish was insignificant. This was indicated by poor growth rates, high FCR and low yield attributed to single feeding with mash and pellet feed. Present study revealed that feeding frequency had the significant positive impact on body weight gain, specific growth rate, efficient feed conversion and yield of fish. In literatures, feeding frequency has been reported to affect feed intake and growth performance in fishes. This may also affect the specific growth rates and the efficiency of feed conversion. General conclusion drawn from the findings of present study may be that two to three times feeding with mash feed could enhace the growth of carp fish and improves the efficiency of feed. Since the most of the study period represents winter season, low water temperature during this priod did not support for potential growth of fish. Thus, further study with high feeding frequency in favorable environment has been suggested to exploit growth potential of carps and feeding impact on rearing environment.

4. PRODUCTION

4.1 Parental line and stock

During establishment of horticulture unit (1965) various fruit species/cultivars were collected and established the fruit orchard as parental (mother) stock. At that time major objectives of horticulture unit was service oriented which produced and supplied fruit saplings and vegetable seeds to growers as foundation seed/saplings.

During orchard establishment, mango, litchi, coconut, sapota, mangosteen, etc. were introduced. Among them mango and litchi were the major fruit crops and covered more area than others. More than 600 plants of mango, 300 litchi, 53 coconut, 50 sapota and 20 mangosteen were planted. Amrapali, Mallika, Neelam, Krishnabhog, Cipia, Bombay green, Alfanso, Maldha, Dasheri, Fazli, Totapuri, Gulabkhash, Langara, Chausa, Pakisthani, Calcuttia and Aman Dashari cultivars of Mango were planted. Likewise, Mazzafarpur, Chinese, Shahi and seedless variety of litchi are conserved in the orchard. Singapuree, West-coastal, costal and Hajaree variety of coconut and Cricket ball and Jhumkiya of sapota are maintained.

Later on, various other mango cultivars like Amrapali, Mallika, Neelam, Baramase, Haden, Florida were introduced and conserved as foundation stock. Besides these fruit crops, guava, lemon, jackfruit, lime, arecanut, papaya, dragon fruit were introduced and conserved as foundation stock. At present, more than 2500 different horticultural important fruits and ornemantal plants have been conserved.

Giriraja breed of Poultry have been maintained in the station. Pakhribas black pig, Hampshire, Nagpuri (local) and their crosses have been maintained in the farm as well.

4.2 Production and distribution

The major seed produced at RARS, Tarahara includes source seed of rice, wheat and maize. Maize seed is given comparatively less priority. The seed produced here is well maintained in quality aspects and thus this station has its own reputation for quality seed production and supply in the region. Farmers have given high priority in purchasing seed directly from this station. That's why there is a high pressure of seed demand and has been a major problem to fulfill the seed demands of the region which is further determined by budget allocation for seed production. Sometimes demand of wheat seeds from other regions are also received during winter season.

This station has given emphasis in selling seeds mostly to seed growers' group as per recommendation of DADO of command districts and to the farmers who come to buy seeds during selling period. Despite limited resources and other technical facilities at the station, the seeds are given priority in production process. The seed quality is tested by Regional Seed Testing Laboratory, Jhumka, Sunsari operated under Seed Quality Control Centre. The seeds with seed standard are sold to the clients. Seeds of recommended varieties for sale and seeds of promising genotypes for research purpose are produced and maintained. Seed production both for early and summer season rice are produced and maintained. Seed production both for early and summer season rice are produced depending upon budget allocation. The wheat seeds are not produced in the entire field due to limited facilities of irrigation.

Horticulture Research Program is one of an important section of RARS, Tarahara accentuating problem based research activities on major tropical fruit and vegetable crops cultivated in eastern terai region of Nepal. It occupy 21 hectare of land comprising of tropical fruit germplasm block, production block, nursery block and research block of fruits and vegetables including office and residential area.Various fruits saplings, vegetable seeds, seed potato, few ornamental flower plants and different vegetable seedlings are produced and supplied to farmers of command districts (Jhapa, Morang, Sunsari, Saptari, Siraha and Udaypur) as foundation seed

materials since its establishment. Thus, this program is a continuous program which has been conducted since establishment of the horticulture unit.

Genetically pure and quality foundation stock of different fruit species/cultivars, vegetable seeds and seed potato were produced and distributed to the farmers by following different production and propagation methods. Fruit saplings of papaya, coconut, arecanut and jack fruit were produced by sexual propagation method and guava, mango, litchi, lemon, black pepper and ornamental plants by vegetative methods (inarching, layering, grafting and cuttings). Genetically, pure and quality seed potato was produced by using PBS (pre basic seed). Likewise, vegetable seed of bottle gourd, ladies finger, cucumber and cowpea were produced by following appropriate package of practices.

Due to availability of the pure planting genetic materials (fruit saplings, vegetable seed and seed potato) in the research farm, farmers' pressure could be felt. The demand of quality fruit saplings, vegetable seeds and seed potato is increasing every year. Demanded commodities could not be fulfilled by HRP alone. Therefore, many private nurseries and vegetable seed and seed potato growers are involved in this region for horticultural development. 450 bottles of mushroom spawn were successfully produced and supplied.

Foundation seed of rice, wheatand maize of different varieties was produced in the fiscal year 2073/74. Highest amount of foundation seed was produced for rice (62.5 t) followed by wheat (23.54t) and maize (1.81 t) as per the demand and target. Similalry, breeder seed of rice (3.93 t), wheat (1.78 t) and maize (1.00 t) was produced. The seeds of rice, wheat and maize were supplied to different GO/NGOs, seed growers, farmers according to the balance sheet, farmers and private seed growers demand in the command district.

This station is carrying out activities on warm water fishery. Fish seeds like hatchlings, fry and fingerlings of different species are produced and sold in different season. Similarly, table fishes are also produced, but it is not under priority as the production of fry and fingerlings are mostly emphasized. Off season production of fish seeds are also performed and fry, fingerlings are produced accordingly. A total of 5,45,0000hatchlings 21,11,300 fry and 2,01,710 numbers of fingerlings were produced.The 4343 kg of fish were sold as the production purpose.

In poultry section, 29446 eggs, 18174 chicks and 402kg of giriraja meat were sold to stakeholders.524 turkey chicks were produced and distributed to the farmers.Total 4150 kg fodder seeds of teosinte and oat were produced in fiscal year 2073/74.

Pig farming is a good source of income for every category of the farmer right from landless to commercial or large farmers. Landless can farm it simply by making small hut near by the residence while commercial farmers use to well maintain sheds. Black pigs are mostly preferred by the consumers in the region. This station has also given priority to produce black pigs as these pigs are supplied to Kathmandu and neighboring Indian states too. Farmers are generally encouraged to improve their local breed by using improved male produced at the farm. Pig Research Program has initiated breed improvement program through artificial insemination. Fresh semens are collected from improved breeds and distributed to private technicians at nominal cost. In f.y. 2073/74, 182 dose of fresh semen from improved breeds were collected and distributed to the technicians.

A large number of poultry chicks, eggs and meat produced were also supplied to the farmers, command districts of the station. Similarly, a total of 441 piglets was produced from pig. Seeds of winter forage like oat and summer forage like teosente were produced and sold to the farmers.

5. TECHNOLOGY TRANSFER AND SERVICES

5.1 Training/Workshops

Land Lazor Levelar Training was provided to 15 tractor driver and 10 superzone staff for two days. For demonstration of Land Lazor Levellar 0.27 ha area was used. Similarly, training on Quality seed production of rice was carried out involving farmers of Jhapa, Morang, Sunsari and Saptari.

5.2 Services

Suggestions and recommendation on plant disease after diagnosis were provided to the farmers. Services on insect identification and management of crops were provided to farmers. Minikits containing quality seeds of different varieties of rice was distributed to 378 farmers. In total 1890 kg of seeds of different varieties of rice was distributed to the farmers of Jhapa district.

Stool test and parasite identification services in livestock were provided to farmers. Similarly counseling service about mushroom production, disease and pest management, pig production, poultry production, fish culture etc was provided to farmers. Moreover, veterinary service, castration, artificial insemination service etc were provided to animals.

5.3 Information through media

Various types of news on updated activities of RARS, Tarahara was aired by local FM, regional TV Channels and national TV channels. Programs on fresh semen collection and artificial insemination in pig were highlighted by National TV channel. Activities such as RATWG meeting, program planning meeting, celebration of NARC Day, National Rice day were aired by various print media and TV channels.

5.4 Visits

Farmers from Jhapa, Morang, Sunsari, Saptari, Siraha, Udayapur, Chitwan, and Bhaktapur visited RARS, Tarahara. Major interest of the visitors was plant protection, offseason vegetable production, fishery and livestock production. Similarly, students, extension officials, NGOs officials and other entrepreneurs also visited the station and collected necessary information.

6. BUDGET AND EXPENDITURE

Annual budget of the FY 2073/74 was Rs. 10,66,16000 (Annex 5.1). However, Rs. 10,58,000 was spent in the same year (Annex 5.2). Total revenue collected in the year was Rs. 1,21,11,918 (Annex 5.4).

Till last year, beruju was Rs. 4,66,180in which Rs. 1,38,000 was cleared in the current fiscal year (Annex 5.5). Now remaining beruju is Rs. 328180.

7. KEY PROBLEMS

Insufficient trained manpower, infrastructure, local encroachment, insufficient laboratory facility etc are the major problems in the station. These problems can be managed by regular recruitment of Scientists and other technicians, regular transfer, renovation of infrastructures, provision of fencing, increment of farm's security, construction and empowerment of laboratory facilities etc. are the suggestions to minimize or resolve the problems.

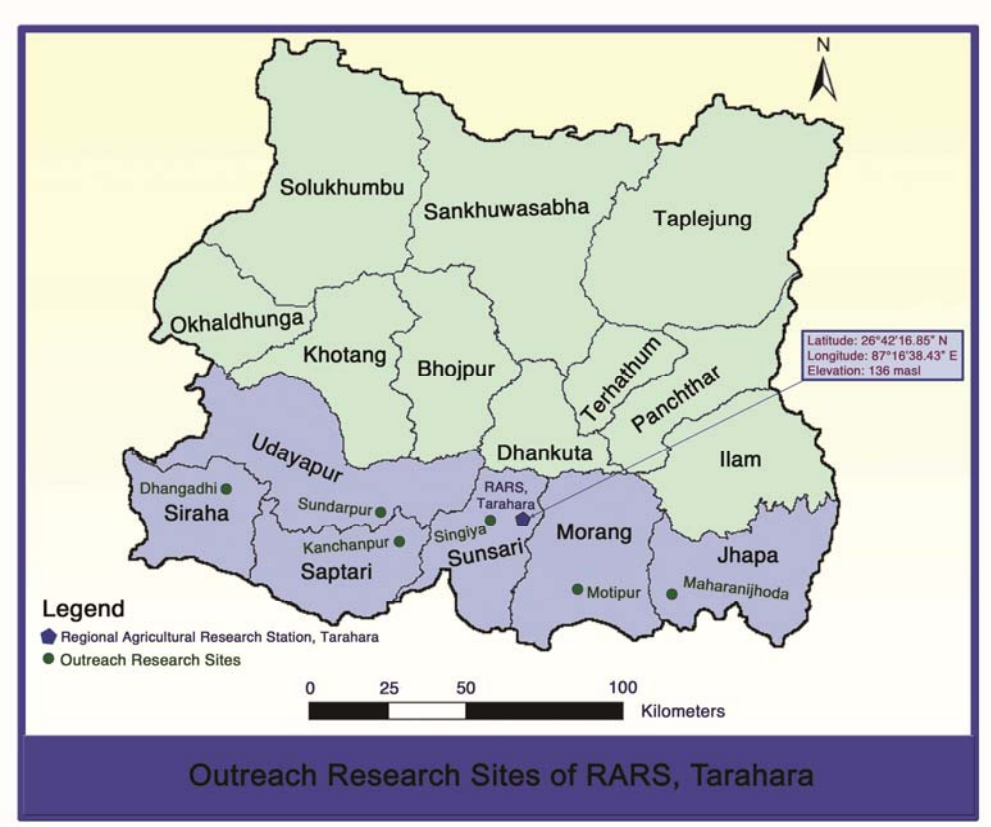
8. WAY FORWARD

- ✓ Trained scientists and technical staff need to be increased to plan, implement and draw relevant outputs in order to address stakeholders' requirement.
- ✓ Resource allocation should be done based on focused research programs in all four sectors viz. crops, horticulture, livestock (piggery, poultryand pasture) and fishery.

- ✓ Incentive and facilities need to be increased to improve efficiency of working staff.
- ✓ Testing and dissemination of hybrid rice and hybrid maize for increased food grain production to achieve food security.
- ✓ Testing and promotion of cost effective abiotic stress tolerant technologies need to be addressedfor climate change issue and livelihood improvement.
- ✓ Development and dissemination of high value commodities need to be focused for higher income; and replacing import volume and increasing export volume.

ANNEX

Annex 1.1 Map of the Command Area

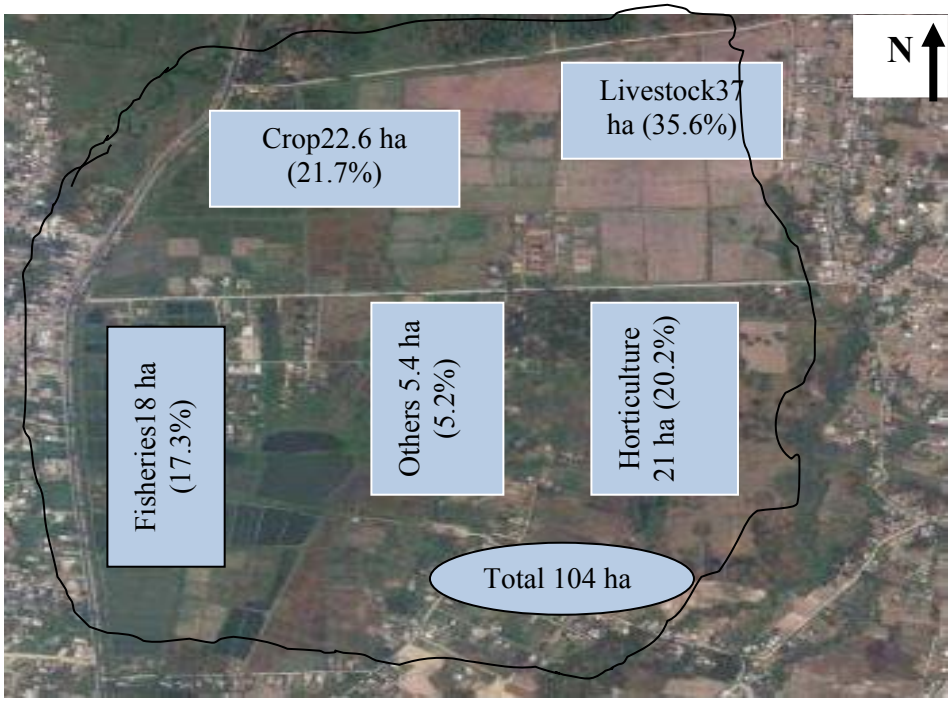


Annex 1.2 Production of major food crops in eastern Terai Region of Nepal during 2072/73

Districts	Rice (All Season Rice)		Wheat		Maize	
	Area (ha)	Production (t.)	Area (ha)	Production (t.)	Area (ha)	Production (t.)
Jhapa	83000	361175	9000	29700	NA	NA
Sunsari	68100	200780	14500	34800	8350	50100
Morang	78000	312000	16100	34615	1650	5775
Saptari	32900	82250	2500	45000*	600	1500
Siraha	39010	117030	15210	30420	1750	3500
Udayapur	13465	53958.5	5100	12240	17388	35123

Source: Regional Agriculture Directorate, Biratnagar

Annex 2.1 Map of the Office/Station



Annex 2.2. List of Laboratory Facilities

SN	Name of laboratory	Major instruments	Manpower in laboratory	Testing facilities
2.	Crop	Digital balance D.O. Meter Thermometer Lux meter D.O. Meter pH meter Thermometer Vernier Caliper Tensiometer D.O. Meter	Mr. H.K. Prasai Mr. R. Bhattarai Ms. S. Manandhar Y.P. Yadav Mr. D. P. Shrestha	Crossing, Germination test
3.	Fisheries	Electronic balance (5 Kg) Refrigerator Oxygen cylinder Aerator Refrigerator Air compressor Oxygen cylinder	Ms. U. Sah Ms. A. Jha Mr. S.N. Mehata Mr. P.K. Sah Mr. Y.L. Mukhiya	DO, pH, Ammonia, etc
4.	Plant	Microscope	Mr. N.K. Dangal	Disease

	Pathology	Laminar flow cabinet	Ms. P. Joshi	diagnosis,
		Refrigerator		
		Hot Air Oven		
		Autoclave		
		Oven (Old)		
		Triple beam balance		
		Incubator		
		Refrigerator (new)		
5.	Entomology	Microscope	Mr. K. Bhandari Mr. S.S. Bishwakarma	Insect identification
		Hand Lens		
		Light trap		
		Insect rearing cage		
		Insect cabinet		
		Refrigerator		
6.	Poultry	Egg Hatcher	Mr. M. Karki	Egg fertility, hatchability and post mortem
		Refrigerator (FF 165l)		
		Electric balance		
		Debeaker		
7.	Soil Lab	Spectrophotometer	Mr. Shukra Raj Shrestha	NPK test, Soil texture, structure test, pH test, Organic Matter
		Dailtype Soil Moisture Tensio Meter		
		Soil Moisture Meter Temperature		
		Soil moisture meter digital		
		Shaker		
		Laboratory baygum		
		Slide tray		
		Soil Agar		
		Conductivity meter		
		Soil tensio meter		
		Nitrogen digestion apparatus		
		Nitrogen distilig		
		Hot plate		
		Humidity slide rule		
		Zeldal digestion apparatus		
		Calorie meter		
		Magnetic stereo		
		Oven		

Annex 2.3. Human Resource in 2073/74 (2016/17)

S.N.	Name	Position	Qualification	Specialization/ Working area
Crop Research Program				
1.	Dr. Hari Krishna Shrestha	Senior Scientist	M Sc Ag	Agri. Economics
2.	Mr. Hari Kumar Prasai	Senior Scientist	MSc Ag	Plant Breeding
3.	Mr. Nabin Kumar Dangal	Scientist	M Sc Ag	Plant pathology
4.	Mr. Kishor Bhandari	Scientist	M Sc Ag	Entomology
5.	Mr. Rudra Bhattarai	Scientist	M Sc Ag	Plant Breeding
6.	Ms. Sarita Manandhar	Scientist	M Sc Ag	Agronomy
7.	Mr. Shukra Raj Shrestha	Scientist	M Sc Ag	Soil Science
8.	Mr. Surya Prasad Adhikari	Scientist	M Sc Ag	Agri. Economics
9.	Yukti Prasad Yadav	Sr. Technical Officer	B Sc Ag	Plant Breeding
10.	Ms. Parbati Joshi	Technical Officer	B Sc Ag	Plant Pathology
11.	Ms. Vidhya Maharjan	Technical Officer	B Sc Ag	Agronomy
12.	Mr. Mohan Prakash Shrestha	Technical Officer	B Sc Ag	Agronomy
13.	Mr. Dhruba Prasad Shrestha	Technical Officer		
14.	Mr. Shiva Shankar Bishwakarma	Technical Officer		
15.	Mr. Bir Bahadur Masrangi	Junior Technician	SLC, JTA	
16.	Mr. Bikash Dahal	Junior Technician	I Sc. Ag	
17.	Ms. Nar Maya Shrestha	Junior Technician	T. SLC, B.A.	
18.	Mr. Bidur Prasad Raut	Jr. Technical Assistant		
19..	Ms. Samjhana Sunuwar	Jr. Technical Assistant		
20.	Ms. Shasi Kala Rai	Jr. Technical Assistant		
21.	Mr. Dilli Prasad Chamlagain	Light Driver Level-3		
22.	Mr. Bhim Prasad Dahal	Light Driver Level-3		
23.	Mr. Nir Kumar Shreshta	Tech. Assistant Level-5		
24.	Mr. Gopal Joshi	Tech. Assistant Level-5		
25.	Mr. Gyan Bahadur Magar	Tec. Assistant Level-4		
26.	Mr. Dil Bahadur Sarki	Tech. Assistant Level-4		
27.	Mr. Chandeshwar Yadav	Tech. Assistant Level-3		
Livestock and Forage Research Program				
28.	Mr. Ram Dev Pandit	Scientist (S3)	M Sc. Ag.	Animal Science
29.	Mr. Rabin Acharya	Scientist (S1)	M Sc. Ag.	Animal Science
30.	Mr. Mukesh Karki	Technical Officer	M Sc. Ag.	Animal Science
31.	Ms Sakuntala Rai	Technical Officer		
32.	Mr. Prakash Kumar Yadav	Junior Technician	B V. Sc.&A.H.	Animal Science
33.	Mr. Rudra Prasad Sapkota	Jr. Technical Assistant		
34.	Ms. Pratima Rai	Jr. Technical Assistant		
35.	Mr. Raj Kumar Shrestha	Light Driver Level-4		
36.	Mr. Ram Bahadur Darjee	Technical Assistant Level-5		
37.	Mr. Mahendra Kumar Shakya	Tech. Assistant Level-4		
Horticulture Research Program				
38.	Mr. Manish Kumar Thakur	Scientist	MSc Ag	Horticulture

39.	Mr. Pradeep Kumar Karki	Sr. Technical Officer	M Sc Ag	Horticulture
40.	Mr. Anil Kumar Jha	Sr. Technical Officer	B Sc Ag	Horticulture
41.	Mr. Dilli Prasad Bhattarai	Technical Officer	M. A.	
42.	Mr. Bahnu Prasad Chaudhary	Technical Officer	I Sc. Ag	
43.	Mr. Ram Bahadur Basnet	Tech. Assistant Level-5	Literate	
44.	Mr. Ramesh Bhujel	Tech. Assistant Level-4	Literate	
45.	Mr. Ram Chandra Pokhrel	Tech. Assistant Level-3	Literate	
Fisheries Research Program				
46.	Ms. Umita Sah	Scientist	M Sc.	Fisheries
47.	Mr. Pradeep Kumar Sah	Sr. Technical Officer	I Sc. Ag	
48.	Mr. Shiva Narayan Mehata	Technical Officer	B Sc. Ag	Fisheries
49.	Ms. Avilasha Jha	Technical Officer	B Sc. Ag	Fisheries
50.	Mr. Yukti Lal Mukhiya	Technical Officer	I Sc. Ag	
51.	Mr. Suraj Kumar Singh	Technical Officer	B Sc. Ag	Fisheries
52.	Mr. Pawitra Raj Khatri	Junior Technician	SLC	
53.	Mr. Mahendra Kumar Shakya	Tech. Assistant Level-4	Literate	
54.	Mr. Shree Prasad Khatwe	Tech. Assistant Level-4	Literate	
Administrative Program				
54.	Mr. Tilak Prasad Rajbansi	Account Officer	B Com.	
55.	Mr. Krishna Prasad Pokhrel	Administrative Officer	I.Com	
56.	Mr. Dharma Prasad Sharma	Computer Officer	M.A., B.Ed.	
57.	Mr. Govinda Pyakurel	Technical Officer (Eng.)	Eng. Diploma	
58.	Mr. Agam Bahadur Basnet	Admin Assistant Level-4	Test Pass	
59.	Mr. Ram Kumar Sah	Admin Assistant Level-4	Test Pass	
60.	Mr. Ganga Prasad Ghimire	Admin Assistant Level-4	Test Pass	
61.	Mr. Mohan Mahaseth	Admin Assistant Level-4	Literate	

Annex 3.1 PRODUCTION PROGRAM (name of commodities/products) IN FY 2073/74

SN	Commodity	Varieties/ Breeds	Unit	Target quantity (F)	Produced Breeder seed	Produced Foundation seed	**Others**
1	**Rice**	**Total**	**Mt.**	**59.97**	**3.93**	**62.5**	
1.1	Rice	Radha-12	Mt.		0.42	11.69	
1.2	Rice	Kanchi Mansuli	Mt.		0.00	1.6	
1.3	Rice	Hardinath-1	Mt.		0.46	10.3	
1.4	Rice	Tarahara-1	Mt.		0.11	1.5	
1.5	Rice	Chaite-2	Mt.		0.63	5.67	
1.6	Rice	Mithila	Mt.		0.11	0.60	
1.7	Rice	Sukkha Dhan-3	Mt.		0.46	8.10	
1.8	Rice	Sukkha Dhan-1	Mt.		0.14	1.20	
1.9	Rice	Masuli	Mt.		0.63	8.09	
1.10	Rice	Swarna Sub1	Mt.		0.7	7.30	
1.11	Rice	Sambha Masuli Sub1	Mt.		0.42	1.80	
1.12	Rice	Lalka Basmati	Mt.		0.28	1.75	
1.13	Rice	Sukhha Dhan -2	Mt.		0.14	1.70	
1.14	Rice	NR 1190	Mt.		0.00	0.12	

1.15	Rice	Sukha dhan-4	Mt.		0.10	0.60	
1.16	Rice	Sukha dhan-5	Mt.		0.35	1.20	
1.17	Rice	Sukha Dhan-6	Mt.		0.14	0.98	
1.18	Rice	Cheheran Sub 1	Mt.		0.00	0.20	
1.19	Rice	Garima	Mt.		0.00	0.2	
1.20	Rice	Ramdhan	Mt.		0.05	0.2	
1.21	Rice	Mahima	Mt.		0.07		
2	**Wheat**	**Total**	**Mt.**	**34.8**	**1.78**	**23.54**	
2.1	Wheat	Aditya	Mt.		0.45	3.20	
2.2	Wheat	Gautam	Mt.		0.50	5.65	
2.3	Wheat	NL-297	Mt.		0.10	6.15	
2.4	Wheat	NL-971	Mt.		0.80	0.00	
2.5	Wheat	Vijaya	Mt.		0.15	7.50	
2.6	Wheat	WK 1204	Mt.			3.98	
2.7	Wheat	Tillottoma	Mt.		0.50		
3	**Maize**	**Total**	**Mt**.	**7**	**1.00**	**1.81**	
3.1	Maize	Rampur Composite	Mt.		0.00	1.00	
3.2	Maize	Arun-2	Mt.		0.00	0.81	
4.0	**Lentil**	**Total**	**Mt.**	**0.500**	**0.00**	**0.36**	
5.0	**Dhaincha**		**Mt.**	**0.5**		**0.26**	
6.0	**Seed Potato**		**Mt.**	**5.0**		**4.9**	
7.0	**Fruit sapling**		**No.**	**5500**			**4789**
8.0	**Vegetable seeds**		**Kg.**	**115.4**		**168.1**	
8.1	Okra	Parwati	Kg		2.0	55	
8.2	Cowpea	Meterlong/Sarlahi Tane	Kg	40		52.1	
8.3	Bittergourd		Kg		0.2		
8.5	Cauliflower	Pusha Dipali	Kg.		0.2		
8.6	Radish	Pusa Chetki	Kg			5	
8.7	Pea	Arkel	Kg	5		5	
9.0	**Fresh Fruit**		**Kg.**				
10.0	**Fresh Vegetable**		**Kg.**				
11.0	**Summer & Winter Vegetable Seedlings**		**No.**	**3000**			**5033**
12.0	**Fruit seedling**		**No.**	**5200**			**5254**
13.0	**Poultry**						
13.1	Chicks	Giriraja	No.	15000			18174
13.2	Meat	Giriraja	kg.	800			402
13.3	Eggs	Giriraja	No.	5000			29446
14.0	**Pig**						
14.1	Piglets		No.	200			441
14.2	Meat		Mt				
14.3	Culled Piglets		No.	20			83
15.0	**Forage seeds**		**Mt.**	**5.5**			**4.15**
16.0	**Fish**						
16.1	Fish Fry		No	2000000			2111300
16.2	Fingerling		No	200000			201710

16.3	Hatchling		No	5000000			5450000
16.4	Table Fish		Kg	3000			4343
17.0	Mushroom		Packet				

Annex 3.2 Distribution of (commodity/product) in FY 2073/74

SN	Commodity/ product	Type (Breeder/ Foundation)	Quantity	Major stakeholder(s)	Distributed districts
1	Rice	FS	51.1 Mt	DADO's, Farmers Groups & Seed company	Jhapa, Morang, Sunsari, Saptari, Siraha,Udayapur
		BS	3.47 Mt.	Farmers & Farmers Group	Jhapa, Morang, Sunsari, Saptari, Siraha, Udayapur, SSNP
2	Wheat	FS	24.2 Mt.	DADO's, Farmers Groups & Seed company	Jhapa, Morang, Sunsari, Saptari, Siraha,Udayapur
		BS	5.5 Mt.	Farmers & Farmers Group	Jhapa, Morang, Sunsari, Saptari, Siraha,Udayapur,
3	Maize	FS	6.2 Mt.	Farmers & Farmers Group	Jhapa, Morang, Sunsari, Saptari, Siraha,Udayapur, SSNP
		BS	0.6 Mt.	Farmers & Farmers Group	Morang, Sunsari, Jhapa, Udayapur
4	Lentil	FS	235 Kg.		
5	Seed potato	Foundation	600 Kg.	Farmers and Farmers Group	Jhapa, Morang, Sunsari and DKT
6	Fruit saplings		4789 No.	Farmers and Farmers Groups	Jhapa, Morang, Sunsari, Saptari, Siraha,Udayapur
7	Vegetable seeds		368.43 Kg.	Farmers and Farmers Groups	Jhapa, Morang, Sunsari, Saptari, Siraha,Udayapur
	Vegetable seedlings		2000 Nos	Farmers	Sunsari
8	Fish		No.		
8.1	Hatchlings		6200000	Farmers	Morang
8.2	Fry		1711610	Farmers	Jhapa, Morang, Sunsari, Saptari, Siraha,Udayapur

8.3	Fingerlings		142444	Farmers	Jhapa, Morang, Sunsari, Terhathum Dhankuta,Siraha
8.4	Table fish		3331 Kg	Farmers	Morang, Sunsari
5	Forage seeds		3.05 Mt.	DLSO's & Farmers group	Sunsari, Jhapa, Ilam, Siraha, Terthum, Rasuwa, Morang, Lalitpur
6	Pig		No.		
6.1	Piglets		178	Farmers and Farmers Groups	Sunsari, Jhapa, Morang, Udaipur, Dhankutta, Taplejung, Ilam, Sakhuwasabha,, Saptari, Siraha, Bara, Kanchanpur Solu, Khotang, Okhaldhunga, Bhojpur
6.2	Meat	Unproductive	4.995 Mt.	Butchers	Dharan, Tarahara, Itahari
6.3	Culled	Unproductive	77	Butchers	Dharan, Tarahara, Itahari
7	Poultry				
7.1	Chicks	Giriraja	15233 No	Farmers	Sunsari, Jhapa, Morang, Saptari, Udaypur,
7.2	Chicks	Turkey	548	Farmers	Sunsari, Jhapa, Morang, Saptari, Udaypur,
7.3	Eggs	Giriraja	42443 No	Farmers	Sunsari, Morang, Jhapa, Saptari, Siraha, Udaypur,
7.4	Meat	Giriraja	1435.2 kg	Staff, Farmers	Sunsari.
7.5	Meat	Turkey	216 Kg	Staff, Farmers	Sunsari.

Annex 3.3. Rice seed distribution to CBSP

SN	Variety	Sahalesh Fulbari, Siraha	Mahila jagriti, Sunsari	Sayapatri, Babiyabirta	Dihibar baba, Saptari	Total (Kg)
A.	**Foundation Seed**	**70**			**25**	**95**
1	Hardinath 1	70				70
2	Samba masuli Sub-1				25	25

B.	Breeder seed	630	350	490	210	1680
1	Hardinath 1			70		70
2	Sukhadhan 1	35			35	70
3	Sukhadhan 2	35			35	70
4	Sukhadhan 3	105	35		35	175
5	Lalka basmati	105	70	105		280
6	Kanchhi masuli	350				350
7	Radha 12		70			70
8	Masuli		35			35
9	Chaite 2		35	70		105
10	Samba masuli Sub-1		35	35		70
11	Swarna Sub 1		70	210	105	385

Annex 3.4 .Rice seed production in CBSP

SN	Variety	Sahalesh Fulbari, Siraha	Mahila jagriti, Sunsari	Sayapatri, Babiyabirta	Dihibar baba, Saptari	Total (t)
1	Hardinath 1	1.5		5.2		6.7
2	Sukhadhan 1	2			1	3
3	Sukhadhan 2	2			1	3
4	Sukhadhan 3	10	3		0.8	14
5	Lalka basmati	10	4	4.4		18
6	Kanchhi masuli	30		20		50
7	Radha 12		6			6
8	Masuli		2			2
9	Chaite 2		2	6		8
10	Samba masuli Sub-1		2	2.4	0.6	5
11	Swarna Sub 1		7	3	16	26
	Total (t)	**55.5**	**26**	**41**	**19.4**	**142**

Annex 3.5 Wheat seed distribution to CBSP

SN	Variety	Sahalesh Fulbari, Siraha	Mahila jagriti, Sunsari	Sayapatri, Babiyabirta	Dihibar baba, Saptari	Total (Kg)
A.	**Breeder Seed**	**410**	**120**	**210**	**0**	**740**
1	Vijaya		60			60

2	Gautam		60			60
3	NL 297	130		130		260
4	WK 1204	280				280
5	Aditya			80		80
B.	**Foundation seed**	**200**	**0**	**600**	**1000**	**1800**
1	NL 297			200	1000	1200
2	Vijaya			200		200
3	Gautam	200		200		400

Annex 4.1 Training/Workshop/Seminar Organized in FY 2072/73 (2015/16)

SN	Name of Training/ Workshop/ Seminar	Duration	Target group	Location	No. of participants
1	Training on lazor leveler	2 day	Tractor Driver and Technician	Jhapa	25
2	Training on Quality Seed Production of rice	1 day	Farmers/consumers	Biratnagar	NA
3	NARC Day celebration	1 day	NARC staff	Tarahara	45
4	National Rice Day celebration	1 day	Farmers, students, and other stakeholders	Tarahara	120

Annex 4.2 Services Provided in FY 2073/74 (2016/17)

SN	Laboratory/field test/ counseling services provided	Numbers	Major clients
1	Plant disease & Insect diagnosis and recommendation	80	Farmers
2	Counseling about mushroom production	27	Farmers
3	Counseling for pest management	80	Farmers
6	Counseling about Pig production	75	Farmers
7	Counseling about Livestock production	260	Farmers
8	Counseling about fish culture	82	Farmers

Annex 4.3 Visits of the Office/Station by Farmers, Extension Officials / Technicians, Entrepreneurs, Cooperatives, Farmer Groups, NGO/CBO Officials etc.

SN	Category	Number	Districts	Area of major interest
1	Farmers	1000	Morang, Terhathum,	Plant protection, soil sample collection, off season

			Nawalparasi and other districts	vegetable production Fishery and livestock production
2	Entrepreneurs	85	”	Off season vegetable production
3	Extension officials	175	”	Research findings
4	NGOs officials	75	”	Crops, horticulture, fisheries and livestock
5	Students	1200	”	Crops, horticulture, fisheries and livestock
Total		1535		

Annex 5.1. Regular Annual Budget Record of FY 2073/74 (2015/16) *(Nepalese Rupees)*

Code	Budget Heads	Annual budget	Budget released	Expenses	Balance
	Recurrent expenses				
21111	Staff Salary	20757000	22927120	22927120	
21113	Dearness Allowance	744000	656000	656000	
21121	Staff Uniform Expenses	465000	375000	375000	
2119	Other Allowance	50000	50000	50000	
22211	Vehicle Fuel & Lubricants Cost	1486000	1316960	1316960	
22312	Feed (Animal/Fish)	7905000	7904935	7904935	
22411	Contract and Colaborative research				
22512	Training / Seminar	540000	271815	271815	
22521	Farm expenses	27643000	27641284	27641284	
22612	Travel expenses	4500000	4497695	4497695	
22111	Electricity & water supply	2400000	2352232	2352232	
22112	communication expenses (telephone, internet, post, courier and others)	252000	251894	251894	
22122	Other rent (vehicle, land, farm machinery and others)				
22212	Repair & maintenance of vehicle, funiture, farm machinery, laboratory equipment, computer and others	1915000	1896044	1896044	
22213	Insurance	225000	224000	224000	
22311	Office expenses (publication, office supplies, stationary, printing, newspaper & books, advertisement & others.	1000000	991163	991163	
22314	Fuel for other use (except vehicle fuel)	599000	598916	598916	
22321	Maintenance of public	3500000	3493363	3493363	

	property (painting & regular maintenance of buildings & others)				
22412	Contract for other services	775000	774215	774215	
22711	Miscellaneous expenses (tea , snacks & others)	300000	300000	300000	
	Capital expenses				
29111	Land purchase				
29221	New construction of buildings & others	13800000	13799597	13799597	
29231	Renovation works of buildings & others	3200000	3189776	3189776	
29311	Furniture and Fixturess	500000	499995	499995	
29411	Vehicles	30000	29999	29999	
29511	Equipment, machinery and tools (office, lab & farm equipment, computer & others)	2800000	2798701	2798701	
29611	public construction (pond, fencing, boring, spur, land development, compound wall & other)	9060000	8959487	8959487	
29712	software development / purchase				
	Grand Total	**104446000**	**105800191**	**105800191**	

Annex 5.2 Special Project Budget and Expenditure Record of FY 2073/74(2016/17) *(in Nepalese Rupees)*

Name of the project	Funded by	Project period	Annual budget	Expenses
Hybrid Maize	NMRP		509422	352071
Hybrid Rice	NRRP		1097707	938113
SRFSI	CIMMYT		2590540	2286552
IRRI/STRASA	IRRI		1028420	676516
ADB	IRRI		129672	35448
CSISA	CIMMYT		397010	324956
KASP			277180	267237
CSCIP			400000	400000
USAID			514360	299303
UK (Fruit Fly)			21125	15295
SAMARTH- Nepal	DFID		402572	398630
Total				
			7368008	5994121

Annex 5.3 Revenue Status of FY 2073/74 (2016/17) *(in Nepalese Rupees)*

Source	Total (Rs)	Remarks
Crop	6048940	
Livestock	2963026	
Horticulture	448077	
Fisheries	2291999	
Other	349946	
Total	**12111918**	

Annex 5.4 Beruju Status of FY 2073/74 (2016/17)

Beruju	Amount	Remarks
Beruju till last year	466180	
Beruju cleared this FY	138000	
Remaining Beruju	32818	
Document processed for clearance of Beruju	-	