NPSN: 006/080/81

Annual Report

2079/80 (2022/23)

Government of Nepal
Nepal Agricultural Research Council
National Agricultural Environment Research Centre
Khumaltar, Lalitpur, Nepal

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Cover page photo: The NAERC office in the NAHRC building

FOREWORD

The National Agricultural Environment Research Centre (NAERC), Khumaltar under the Nepal Agricultural Research Council, is mainly involved in agricultural research activities which is related to weather/climate and environmental concerns in agriculture. Greenhouse gas (GHG) emissions and their impact on climate change are one of the major global issues. Although Nepal is not a significant contributor of GHGs, it is the fourth most vulnerable country to climate change. In this context, NAERC has been collaborating within and outside NARC for the development and dissemination of the most effective adaptation and mitigation measures to limit the negative impacts of climate change and other environmental concerns. The NARC has developed many climate-resilient crop varieties and technologies. This centre has published a compilation of these technologies in the Nepali language. We are publishing agro-met advisory bulletins on a regular basis with the support of agricultural and weather/climate experts. The centre is also conducting activities on assessment of farmers' perspectives on the consequences of climate change; calculation of GHG emissions and carbon sequestration; effect of pesticide use; and the impact of increased temperature on cereal and vegetable crops. Now, the centre has focused on the identification, participatory research, and dissemination of climate-smart agricultural technologies to address the vulnerability of climate change in agriculture.

This annual report provides a detailed look at the activities and outcomes of the research undertaken by the centre during the fiscal year 2079/80. Researchers, extension staff, students, and national policymakers are likely to find this report valuable in their research and decision-making processes.

I would like to extend my sincere thanks to Mr. Bishnu Prasad Paudel, Dr. Pradeep Shah, Mr. Alok Sharma, Mr. Rameshwar Rimal, and Mr. Hem Lal Bhandari for their efforts to bring this annual report into publication. I would also like to thank Mr. Krishna Prasad Pokhrel, Mr. Ram Kumar Rai, Mr. Raj Kumar Chalise, and Mrs. Rina Maharjan for their hard work in the areas of administrative assistance, accounting, and other services. In acknowledgment of its financial support, the Nepal Agricultural Research Council (NARC) has been praised. I would greatly appreciate constructive comments and suggestions for how to make the report better.

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LIST OF ABBREVIATIONS

°C	Degree Centigrade
AAB	Agromet Advisory Bulletin
AGB	Above Ground Biomass
AWS	Automatic Weather Station
BGB	Below Ground Biomass
CO_2	Carbon dioxide
Cm	Centimetre
DAP	Dia-Ammonium Phosphate
DAS	Days After Sowing
DAT	Days after Trasplanting
DBH	Diameter at Breast Height
DoAR	Directorate of Agricultural Research
F.Y.	Fiscal Year
GDP	Gross Domestic products
GHGs	Greenhouse Gases
Ha	Hectare
HRS	Horticulture Research Station
Kg	Kilogram
m^2	Square meter
masl	Meter above sea level
MOP	Muriate of Potash
NAERC	National Agricultural Environment Research Centre
NARC	Nepal Agricultural Research Council
NMRP	National Maize Research Program
NRRP	National Rice Research Program
$N:P_2O_5:K_2O$	Nitrogen, Phosphorous, Potash
NRs	Nepalese Rupee
OTC	Open Top Chamber
t/ha	tonne per hectare

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ANNEXES

सार संक्षेप

यो वार्षिक प्रतिवेदनमा राष्ट्रिय कृषि वातावरण अनुसन्धान केन्द्रले आर्थिक वर्ष २०७९/८० मा सम्पन्न गरेको अनुसन्धानात्मक र प्रवर्धनात्मक कार्यहरू समेटिएका छन् । यस अवधिमा बारा जिल्लामा धान–गहुँ बाली प्रणालीमा मौसमी चक्र विश्लेषण बारे कृषकहरूको ज्ञान, गर्मीयाममा तापक्रम बृद्धि गरी खेती गर्दा गोलभेंडाका जातहरूमा पर्ने प्रभाव, लिची र आँप फलको बोटमा हुने कार्वन स्थिरीकरणको मात्रा, मकैबाली खेती गर्दा हुने कार्वन उत्सर्जन जस्ता कार्यक्रमहरू सञ्चालन गरिएका थिए। विगत वर्षमा जस्तै यो वर्ष पनि कृषि मौसम सल्लाह बुलेटिनको प्रकाशन र सरोकारवालाहरुलाई वितरण गरियो । यस वर्ष सवै ७५३ वटै स्थानिय तहमा वुलेटिनको पहुँच स्थापित गरियो । यस वर्ष प्राप्त भएका मुख्य उपलव्धिहरूलाई यहाँ छोटकरीमा प्रस्तुत गरिएको छ ।

❖ धान–गहुँ बाली प्रणालीमा मौसमी चक्र विश्लेषण बारे जानकारी सङ्कलन गर्न बारा जिल्लाका १०० कृषकहरुसंग घरधुरी सर्वेक्षण गरियो । जसमा जीतपुर सिमरा उपमहानगरपालिका वडा नं ११ का ३१ जना, फेटा वडा नं १ का ३५ जना र करैयामाई गाउँपालिका वडा नं ५ का ३४ जना घरधुरी समावेश गरिएको थियो । यस सर्वेक्षणमा सहभागी कृषकहरु मध्ये ८% लाई मात्र जलवायु परिवर्तनको बारे यथेष्ट जानकारी भएको पाइयो भने ५१% लाई यस बारे केहि जानकारी नभएको, २८% लाई थोरै मात्र जानकारी भएको र १३% लाई स्पष्ट जानकारी भएको पाईयो ।

❖ जलवायु परिवर्तनका कारण ग्रीष्मकालीन तापक्रम बढेको भन्दै सबै (१००%) किसानहरुले प्रतिक्रिया दिए। त्यस्तै १८% कृषकहरूले हिउँदको तापक्रम १० वर्ष पहिलेको जस्तै भएको प्रतिक्रिया दिएका छन् भने ६८% ले हिउँदको तापक्रम बढेको र १४% ले हिउँदको तापक्रम घटेको प्रतिक्रिया दिएका छन् । अहिलेको तापक्रमको अवस्थालाई १० वर्ष अघिको तापक्रमसंग तुलना गर्दा १% कृषकले मात्रै एकै किसिमको रहेको प्रतिक्रिया दिए भने जबकि ९४% ले बढेको र ५% ले घटेको प्रतिक्रिया दिए ।

❖ वर्षाका दिन तुलना गर्दा, १० वर्षअघिको तुलनामा ४% कृषकले वर्षाका दिन बढेको प्रतिक्रिया दिएका छन् भने ९६% ले वर्षाका दिन घटेको प्रतिक्रिया दिएका छन् । चरम मौसमी घटनाहरूको बारेमा धारणा राख्दा, १% कृषकले १० वर्ष अघिको तुलनामा समान खडेरी वा सुख्खा रहेको प्रतिक्रिया दिए भने ९६% ले खडेरी वा सुख्खा बढेको र ३% ले खडेरी वा सुख्खा घटेको प्रतिक्रिया दिए । मनसुनको सन्दर्भमा, २% कृषकले १० वर्ष अघिको तुलनामा मनसुनको वर्षा बढेको प्रतिक्रिया दिएका छन् भने ९८% ले मनसुन वर्षा घटेको प्रतिक्रिया दिएका छन् । त्यसैगरी, १% कृषकले हिउँदको वर्षा १० वर्ष अघिको तुलनामा समान रहेको प्रतिक्रिया दिएका छन् भने ३% ले हिउँदको वर्षा बढेको र ९६% ले हिउँदको वर्षा घटेको प्रतिक्रिया दिएका छन् ।

- १० वर्ष अघिको तुलनामा बाढीको तीव्रता समान रहेको भनी ११% कृषकहरूको प्रतिक्रिया थियो । त्यस्तै ५२% ले बाढीको तीव्रता बढेको र ३७% ले बाढीको तीव्रता घटेको प्रतिक्रिया दिएका छन् । माटोको उर्वरा शक्ति १० वर्ष अघिको जस्तै रहेको भनी ५% उत्तरदाताले प्रतिक्रिया दिए भने १% ले बढेको र ९४% ले घटेको प्रतिक्रिया दिएका छन् । त्यसैगरी ४% कृषकले जमिन मुनि पानीको सतह १० वर्ष अघिको जस्तै समान रहेको प्रतिक्रिया दिए भने ९६ प्रतिशतले घटेको भनी प्रतिक्रिया दिए ।

- धान–गहुँ बाली प्रणालीमा जलवायु परिवर्तनको प्रभावबारे कृषकको अनुभव पनि खोजिएको थियो । ८५% कृषकले १० वर्ष अघिको तुलनामा धान–गहुँ बाली प्रणालीमा जलवायु परिवर्तनको गम्भिर प्रभाव रहेको महसुस गरेका छन् जसले गर्दा धान उत्पादनमा कमी आएको, अन्नको गुणस्तरमा कमी, बाली भित्र्याउने समयमा पानी पर्ने गरेको, खडेरी बढेको, बीउमा बाँझोपनको समस्या बढ्दै गएको, कीरा र रोगको प्रकोप बढेको, रोपाई ढिलो हुने गरेको, झारपातको समस्या बढेको तथा बालाको लम्बाई घटेको भनि प्रतिक्रिया दिएका छन् । त्यसैगरी अधिकांश कृषकले दस वर्षअघि जेठ महिनामा मनसुन सुरु भएको महसुस गरे पनि अहिले असार पहिलो वा दोस्रो हप्तामा मनसुन सुरु हुने गरेको बताएका छन् । त्यसैगरी, पहिले मनसुनको समाप्ती असोजको अन्तिम साता तिर हुने गरेकोमा अहिले मनसुनको समाप्ती असोजको पहिलो साता तिर रहेको छ भनि प्रतिक्रिया दिएका छन् ।

- खुमलटारको ६.२ देखि ६.५ सम्म अम्लीयपन र ७.५ देखि ७.८ पानीको सूचकाङ्क रहेको मकै खेती गरिएको जग्गामा कार्वन उत्सर्जन मापन गर्दा, २१० कि. ग्रा. नाइट्रोजन (युरियाबाट उपलब्ध) प्रति हेक्टर प्रयोग गरेको जग्गामा सबैभन्दा बढी ११८.४ मि.ग्रा/हे./घण्टाको दरले कार्वन उत्सर्जन भैरहेको पाइयो । त्यसैगरी प्रति हेक्टर १२० कि. ग्रा. नाइट्रोजन प्रयोग गरिएको जग्गामा सबैभन्दा कम (५६.२ मि.ग्रा/हे./घण्टा) कार्वन उत्सर्जन भएको पाइयो ।

- आँप र लिची फलको रुखमा स्थिरीकरण हुने कार्वनको मात्रा मापन गर्न रौतहट जिल्लाको विभिन्न आँप र लिची वगानमा रहेका बोटहरूको तथ्याङ्क लिइयो । यसरी नमूनाको रुपमा तथ्याङ्क सङ्कलन गरिएका आँपको वोटको उमेर १८ देखि ३० वर्षसम्म र लिचीको वोटको उमेर १२ देखि ३० वर्षसम्म रहेको थियो । यस्तो तथ्याङ्क १४५ वटा आंपका रुखहरुबाट र १२६ वटा लिचीका रुखहरूबाट लिईएको थियो । आँप र लिचीको रूखहरूमा स्थिरिकरण हुने कार्वनको मात्रा, बोटको उमेर र काण्डको व्यासमा निर्भर हुने देखियो ।

- सोलुखुम्बु जिल्लाको चरन क्षेत्रमा जलवायु परिवर्तनको प्रभाव मुल्याङ्कन गर्न दुधकुण्डका १२, टाकसिन्धुका ६ र नेलेका ५ जना गरी २३ कृषक घरधुरी सर्वेक्षण गरियो । सहभागी कृषकहरू मध्ये १७.४% लाई जलवायु र जलवायु परिवर्तन सम्बन्धि ज्ञान भएको पाईयो भने ८२.६% लाई ज्ञान नभएको पाईयो । ६०.९% ले गर्मीको तापक्रम पहिलेको तुलनामा

उस्तै रहेको प्रतिक्रिया दिए भने ३९.१% ले जलवायु परिवर्तनका कारण गर्मी तापक्रम बढ्दै गएको प्रतिक्रिया दिए। त्यस्तै, ५६.५% ले हिउँदको तापक्रम पहिलेको जस्तै रहेको प्रतिक्रिया दिए भने ३४.८% ले बढेको र ८.७% ले घटेको प्रतिक्रिया दिए। अधिकांस किसानहरू (६९.७%) ले हिउँ पग्लने प्रवृत्ति बढ्दै गएको तर थोरै किसानहरू (३१.३%) ले कुनै परिवर्तन नभएको प्रतिक्रिया दिए। ६५.२% किसानहरूले आफ्नो गाईवस्तुलाई चराउने र स्टल फिडिंग दुवै गराउने गरेका छन् भने ३४.८% ले चराउने मात्र गरेको जानकारी गराएको थियो। त्यसैगरी, ५२.२% कृषकले चरन जग्गा घटेको, २६.१% समान रहेको र २१.७% ले बढेको जानकारी दिएका छन्।

❖ तापक्रम बढाउँदा गोलभेंडाको उत्पादनमा पर्ने प्रभाव वारे जानकारी हासिल गर्न, गोलभेंडाका ४ वटा जातहरु (एच.आर.डि.टी.एम., ए.भि.टि.ओ. १७०५, ए.भि.टि.ओ. ०९२२ र ए.भि.टि.ओ. १४२२) लाई खुला ठाउँमा र माथि खुला भएको प्लाष्टिकको भकारी जस्तो संरचना (Open Top Chamber) भित्र रोप्दा, जातहरू मध्ये ए.भि.टि.ओ. ०९२२ ले वढी उत्पादन दियो भने वाहिरको तुलनामा OTC भित्र वढी उत्पादन हुने अध्ययनले देखायो।

❖ यस वर्ष कृषि मौसम सल्लाह बुलेटिनका ५२ अङ्क तयार गरी वितरण गरियो। यस बुलेटिनमा पशुपालन, घाँसेवाली, मत्स्यपालन, खाध्यान्न वाली, फलफूल तथा तरकारी वाली सम्बन्धि प्राविधिक जानकारी लगायत आउँदो हप्ताको मौसमी पूर्वानुमान समेटिएको हुन्छ। यस केन्द्रले हरेक शनिवार ८:०० बजेको समाचार पछि “NTV News Channel” बाट प्रसारण हुने कृषि गतिविधिको लागि आवश्यक सूचनाहरू उपलब्ध गराउँदै आएको छ।

❖ इन्डो–ब्लाइट कास्ट (IBC) लेट ब्लाइट पूर्वानुमान मोडेल प्रयोग गरी NAERC, खुमलटार, NMRP, रामपुर, NWRP, भैरहवा र DoAR, नेपालगन्जमा आलुमा पछौटे डढुवा रोग परिक्षणको लागि पूर्वानुमान मोडेल सञ्चालन गरिएको थियो।

यो परिक्षण Split plot design मा गरिएको थियो। Main plot मा तीन वटा treatment हरुः (i) कुनै स्प्रे छैन, (ii) सिफारिस गरिएको स्प्रे अर्थात् पहिलो स्प्रे म्यानकोजेब रोपेको ३५ दिनमा, दोस्रो स्प्रे डाइमेथोमोर्फ ४५ डीएपी, तेस्रो स्प्रे सेक्टिन ५५ डीएपी, र चौथो स्प्रे डाइमेथोमोर्फ ६५ डीएपीमा र (iii) प्रणाली निर्देशित स्प्रे (मोडेल आधारित) थिए भने sub–plot मा चारवटा treatment हरु (आलुका जातहरु) कुफ्री ज्योति, जनकदेव, डेजिरे र खुमल उज्वल थिए।

❖ परिक्षणको क्रममा खुमलटार क्षेत्रमा ब्लाइट देखा परेन। परिक्षणमा आलुक जातहरु मध्ये डेजिरे जातमा आलुको उच्च उत्पादन (९९७१ केजी/हेक्टर) देखिएको थियो जुन कुफ्री ज्योति (९०१७ केजी/हेक्टर) र जनकदेव (८७७३ केजी/हेक्टर) जातसँग पनि मिल्दोजुल्दो

थियो र सबैभन्दा कम उत्पादन खुमल उज्वल (७११० केजी) मा पाईएको थियो । स्प्रे प्रणालीको मामलामा non–significant प्रभाव देखियो ।

❖ हेलिल्यूरको मोहिनी पासो राखेर गोलभेडाको फलको गवारोको संख्या पत्ता लगाउने उद्देश्यले यस केन्द्रमा गरिएको अध्ययनमा *H. armigera* वयस्कहरूको थोरै संख्या पासोमा फसेको पाईएको थियो । मार्च, मे र जुनमा क्रमशः एक, दुई र एक कीरा मात्र पासोमा फसेको पाइएको थियो ।

❖ विशेष परियोजना (सि–सक्सेस) अर्न्तगत नेपालमा विकास गरिएका जलवायु मैत्री कृषि प्रविधिहरूको इन्भेन्टरी रिपोर्ट तयार गरियो । सहभागितामूलक अनुसन्धान कृयाकलापहरू अन्तर्गत चितवनको हरनरी र कठारमा चैते धान खेतमा पालो–पालो सिंचाई गर्ने र सुकाउने प्रविधि र पर्सा जिल्लाको बिजबनियामा छरुवा धान खेती प्रविधि, शुन्य खनजोतको गहुँ खेती प्रविधि र धान खेतमा पालो–पालो सिंचाई गर्ने र सुकाउने प्रविधि कृषकको सहभागितामा कृषकको खेतमा गरियो । त्यस्तै धादिंग जिल्लाको जुगेडीमा तरकारी बालीमा थोपा सिंचाई र काभ्रे जिल्लाको ठकुरीछापमा तरकारी बालीमा थोपा सिंचाई र मकैसंग भटमासको अन्तरबाली प्रविधिको सहभागितामूलक अनुसन्धान गरियो ।

❖ तनहुँ जिल्लाको बरादी र काभ्रे जिल्लाको ठकुरीछापमा तरकारी बालीमा जलवायु मैत्री कृषि प्रविधिहरू र पर्सा जिल्लाको औरैयामा छरुवा धान खेती प्रविधि र शुन्य खनजोतको गहुँ खेती प्रविधि सम्बन्धि एक दिने किसानहरूको सहभागितामूलक तालिम सम्पन्न गरियो ।

EXECUTIVE SUMMARY

This annual report summarizes all the research and promotion activities completed by the National Agricultural Environment Research Centre (NAERC) during the fiscal year 2079/2080 (2022/2023). During this period activities like assessment of weather pattern analysis uinder rice-wheat cropping system in Bara district, performance of tomato genotypes under elevated temperature, carbon sequestration, and GHG emission estimation were carried out. The Centre has regularly published agro-met advisories and distributed to the concerned stakeholders including all 753 local bodies (governments). NAERC also published compilation of climate smart technologies developed by NARC along with the agro-met advisory. The following are some of the centre's major research outputs and other noteworthy accomplishments in fiscal year 2022/23:

- To assess weather pattern analysis under rice-wheat cropping system in Bara district, the overall climate patterns of weather variables like temperature (maximum and minimum) and rainfall of past 33 years of Bara district was analyzed and a household survey was conducted using semi-structured questionnaire consisting of 100 farmers i.e. 31 from Jeetpur Simara Sub-metropolitan city, ward no. 11; 35 from Feta ward no.1; and 34 from Karaiyamai Rural Municipality, ward no. 5.
- In case of climate change information, among the participating farmers, only 8% responded to know more clearly, while 51% responded to do not know, 28% know a little bit only and 13% responded to clearly know. All the farmers (100%) responded as summer temperature was increased due to climate change as compared to 10 years back. 18% of the farmer responded as winter temperature is same, while 68% responded to increased, and 14% responded to decreased as compared to 10 years before.
- In case of hotter days, only 1% farmer responded as same as compared to 10 years back, while 94% responded as increased and 5% responded as decreased. According to rainy days, 4% responded to increased rainy days while 96% responded to decreased rainy days as compared to 10 years back. Likewise, 4% responded increased rainfall, while 96% responded decreased as compared to 10 years before. Similarly, 61% faremrs responded the same humidity, while 29% responded increased, and 10% responded decreased humidity as compared to 10 years before. In case of perception about extreme weather events, 1% responded as same drought or dry spell, while 96% responded as increased, and 3% responded decreased as compared to 10 years back.
- Same floods intensity was responded by 11% farmers, while 52% responded to increased, and 37% responded to decreased flood intensity. Soil fertility level as same as before 10 years responded by 5% of respondent, while 1% responded to increased soil fertility and 94% responded to decreased soil

fertility. Similarly, 4% responded to same water table, while 96% responded to decreased water table.

- ❖ Experience of farmers on climate change impacts on rice-wheat cropping system was also explored. 85% farmerst realized that there is severe impacts of climate change on rice-wheat cropping system as compared to 10 years before and it was realized by decreased rice yield, decreased grain quality, untimely rainfall during harvesting stage, increased drought, sterility problem in seed, increased infestation of insects, pest and disease, delayed planting, weeds problem, decreased panicle size etc. Similarly, majority of respondent realized onset of monsoon on Jestha month before 10 years back but nowadays it is on the month of Asar first or second week and the reason for this late onset of monsoon was due to climate change. Similarly, withdrawal date of monsoon was Asoj last week but nowadays it is in Asoj first week.

- ❖ In a maize experimental field, where a soil pH ranged from 6.2 to 6.5 and a soil moisture index ranged from 7.5 to 7.8, the CO2-C flux was recorded at the highest of 210 mg/ha/hr from the field with 210 kg/ha of nitrogen applied through urea. The lowest (56.2 mg/ha/hr) was found with the application of 120 kg/ha of Nirtogen.

- ❖ The carbon sequestrating capacity of the mango (*Mangifera indica*) and litchi tree (*Litchi chinensis*) were measured from the different farms of Rautahat districts of Nepal. The age of the sample Mangeo trees ranged from 18 to 30 years while it was ranged from 12 to 30 years in case of litchi trees. A total of 145 of mango and 126 of litchi trees were sampled from different farms. The carbon sequestration by litchi trees (ton/tree) was found based on diameter and the age of the trees.

- ❖ To assess effect of climate change on pasture grazing area of Solukhumbu district, a household survey was conducted using semi-structured questionnaire consisting of 23 farmers i.e. 12 from Dudhkunda, 6 from Takasindhun and 5 from Nele. Among the participating farmers, 17.4% had the knowledge on climate change, while 82.6 % did not have knowledge on climate and climate change. 60.9% responded that the summer temperature was similar as 10 years before, while 39.1% responded that it was increasing due to climate change. Similarly, 56.5% farmers considered as winter temperature is same as before, while 34.8% considered as it was increased, while 8.7% considered as it was decreased. Higher number of farmers (69.7%) believed as increasing trend of snow melting, while few farmers (31.3%) did not find any changes as compared to 10 years before. Higher number of farmers (65.2%) reported both grazing and stall feeding of their livestock, while 34.8% of farmers stated feeding on grazing land only. Similarly, 52.2% of farmers reported problem of decreasing grazing land, while 26.1% of farmers reported similar grazing land and 21.7% reported increased grazing land as 10 years before.

- ❖ Four tomato genotypes (HRDTOM, AVTO 1705, AVTO 0922, and AVTO 1422) were evaluated in open top chamber (OTC) and open field conditions. The average maximum and minimum air temperatures were higher inside OTC. All the observed parameters had higher values inside OTC than in the open field. Among the varieties, AVTO 0922 provided the highest yield. Higher tomato yield was observed in OTC as compared to open field condition.

- ❖ During the fiscal year, 52 episodes of the weekly agro-met advisory bulletin were prepared and distributed by the centre. The bulletin comprises agro-advisories for livestock, pasture and fodder, fisheries, food crops, fruits and vegetables, and weather forecasts for the upcoming week. The centre is assisting the NTV NEWS program after eight p.m. to broadcast agro-met advisories. The centre is helping to prepare the necessary materials to broadcast the bulletin through NTV NEWS after eight p.m. Prime News.

- ❖ The population dynamics of tomato fruit borer using helilure pheromone traps showed the lowest population of the pest (1 or 2 moths/month) in March, May and June month at Khumaltar, Lalitpur of Nepal.

- ❖ Under C-SUCSes project, inventory of CSA technologies and practices in Nepal is prepared. Participatory research on AWD in spring rice was initiated in Harnari and Kathar of Chitwan district, while DSR, AWD and ZT wheat was initiated in Bijbania of Parsa district. Similarly, drip irrigation technology in vegetable crops was initiated at Jugedi of Dhading district; and drip irrigation and intercropping of maize with soybean at Thakurichhap of Kavre district. Participatory training on CSA technologies of vegetable crops at Baradi of Tanahu and Thakurichhap of Kavre district was accomplished. Similarly, participatory training on DSR and ZT wheat technology was accomplished at Auraiya of Parsa district.

1. WORKING CONTEXT

About two-thirds of Nepalese people work in agriculture, which accounts for about one-third of the nation's gross domestic product. Moreover, as the population and food demand grow, it becomes imperative that the country achieve food security. Warming in the climate, in time and space, along with other abnormalities, is beginning to be a problem for all agricultural production. The collection of agro-meteorological records (Annex 1) from numerous stations is a good source for researching the causes and effects of weather and the relationship between different weather patterns and crop yield. The crop modelling can also be aided by agro-meteorological datasets. Crop production is a result of crop genetic make-up, the environment, and the methods used for management.

An open-top chamber study of crop performance on high temperatures might aid agricultural researchers with their breeding and crop management plans. GHG emissions are of major concern and are exacerbating climate change. Agriculture has also an important role in the emission of CO_2 by agricultural practices. Some of these experiments are being conducted at Khumaltar representing mid-hill condition (Annex 2). Similarly, horticultural fruit crops help to sequestrate the CO_2 in the form of trees and organic matters in soil. Currently, the centre is tracking CO_2 emissions from various types of crops and pastureland that are grown under various management practices across the country. Another objective of the centre is to create an inventory of carbon sequestration of different types of fruit tree.

Nepalese agriculture is deeply affected by climate change effects like increased temperature, unpredictable rainfall patterns, increasing drought, and heat wave events. In order to limit the adverse impact, the centre is cooperating with the Ministry of Agriculture and Livestock Development (MoALD) and the Department of Hydrology and Meteorology (DHM) to prepare and distribute the agro-met advisory bulletin to farmers since 2071/72. After starting with one district, the bulletin has grown to seventy-seven districts and Nepal Agricultural Research Council (NARC) has internalized AAB generation process by its internal fund after termination of PPCR project. In addition to upcoming weather forecasts, this bulletin also has other agricultural resources such crops, fruits, vegetables, livestock, grazing, and fisheries agro-advisories. The centre is helping to prepare the necessary materials to broadcast the bulletin through a national broadcaster (NTV NEWS).

The centre is currently collaborating with several national and international organizations on various areas of researchable subjects as part of its collaboration strategy.

2. INTRODUCTION

2.1 History of National Agricultural Environment Research Centre

The Agricultural Environment Unit was established in the fiscal year 2000 AD in Khumaltar, Lalitpur under the Directorate of Planning and Coordination, Nepal Agricultural Research Council (NARC). It was upgraded to Agricultural Environment Research Division (AERD) in the F.Y. 2013 AD. Further, the division has been upgraded as National Agricultural Environment Research Centre (NAERC) from 1st Shrawan 2077 BS (2020 AD).

2.2 Vision

A climate resilient agriculture with maximum system productivity for transformed livelihoods of farmers.

2.3 Mission

National Agricultural Environment Research Centre (NAERC) strengthens the development and adaptation of the environment-friendly, accessible and affordable improved agricultural technologies through collaborative research to advance and promote on right solutions to climate-related issues in the agriculture sector.

2.4 Mandate

The overall mandate of NAERC is to act as a key institution within NARC to develop and promote agricultural technologies adaptive to climate change and support on policy guidelines.

The specified mandates are:

- Involve in agricultural environment related research, education, monitoring, and coordination activities
- Generation and promotion of technologies for climate change related daptations
- To help central, provincial and local governments to prepare policy guidelines related to environment-related issues in the agriculture sector
- Human resources development to work on agro-environment related issues Coordinate and co-operate with national and international organizations

2.5 Current Thrust Areas for Research

- Understand farmer's perception on climate change
- Climatic variability of various locations and response of crop
- Crop performance under simulated environment (e.g. elevated temperature)
- GHGs emission under different agricultural land and system.
- Carbon sequestration in horticultural crops
- AAB preparation and its performance and efficacy at farmers' field

2.6 Infrastructure and Facilities

Automatic weather stations (11): Daily agro-meteorological data recording (Temperature, rainfall, solar radiation, relative humidity, soil temperature etc.)

NAERC has installed 11 meteorological stations on various locations of the Nepal (Table 1).

Table 1. Automatic weather stations installed by NAERC on different NARC research stations.

S.N.	Station Name	Sensor Used	**Remarks***
1	NAgRC, Khumaltar	Temperature Humidity Sensor - HC2 Tipping Bucket Pyranometer (LICOR)	
2	NRRP, Hardinath, Janakpur	Temperature Humidity Sensor - HC2 Tipping Bucket Pyranometer (LICOR) Soil Sensor (HydraProbe)	
3	Pasture FRC, Rasuwa	Temperature Humidity Sensor - HC2 Tipping Bucket Pyranometer (LICOR) Soil Sensor (HydraProbe)	
4	CRP, Baletaksar, Gulmi	Temperature Humidity Sensor - HC2 Tipping Bucket Pyranometer (CMP3) Soil Sensor (HydraProbe) Wind Speed & Direction Sensors (FST) Leaf Wetness Sensor	
5	NGRP, Bandipur	Temperature Humidity Sensor - HC2 Tipping Bucket Pyranometer (CMP3) Soil Sensor (HydraProbe) Wind Speed & Direction Sensors (FST) Leaf Wetness Sensor	
6	NCRP, Paripatle, Dhankuta	Temperature Humidity Sensor - HC2 Tipping Bucket Pyranometer (CMP3) Soil Sensor (HydraProbe) Wind Speed & Direction Sensors (FST) Leaf Wetness Sensor	
7	ORP, Nawalpur, Sarlahi	Temperature Humidity Sensor - HC2 Tipping Bucket Pyranometer (CMP3) Soil Sensor (HydraProbe) Wind Speed & Direction Sensors (FST) Leaf Wetness Sensor	
8	NSRP, Jitpur, Bara	Temperature Humidity Sensor - HC2 Tipping Bucket Pyranometer (CMP3) Soil Sensor (HydraProbe) Wind Speed & Direction Sensors (FST) Leaf Wetness Sensor	
9	NMRP, Rampur, Chitwan	Temperature Humidity Sensor Tipping Bucket Pyranometer Soil Sensor Wind Speed & Direction Sensors	
10	DoAR, Bhagetada, Doti	Temperature Humidity Sensor Tipping Bucket Pyranometer Soil Sensor Wind Speed & Direction Sensors	
11	DoAR, Tarahara, Sunsari		

* None of these 11 stations are under working condition.

- Open Top Chamber (3): Experimentation on elevated temperature and CO_2 level
- CO_2 Monitor: Measuring CO_2 emission
- GPS meter: Taking coordinates of different locations
- Soil pH and moisture meter: Measuring soil pH and moisture
- Leaf area index meter
- Multi-gas analyzer

2.7 Organizational Structure and Human Resources

The organogram of this centre is given in Fig. 1 and detail of human resources in 2079/80 has been presented in Annex 3.

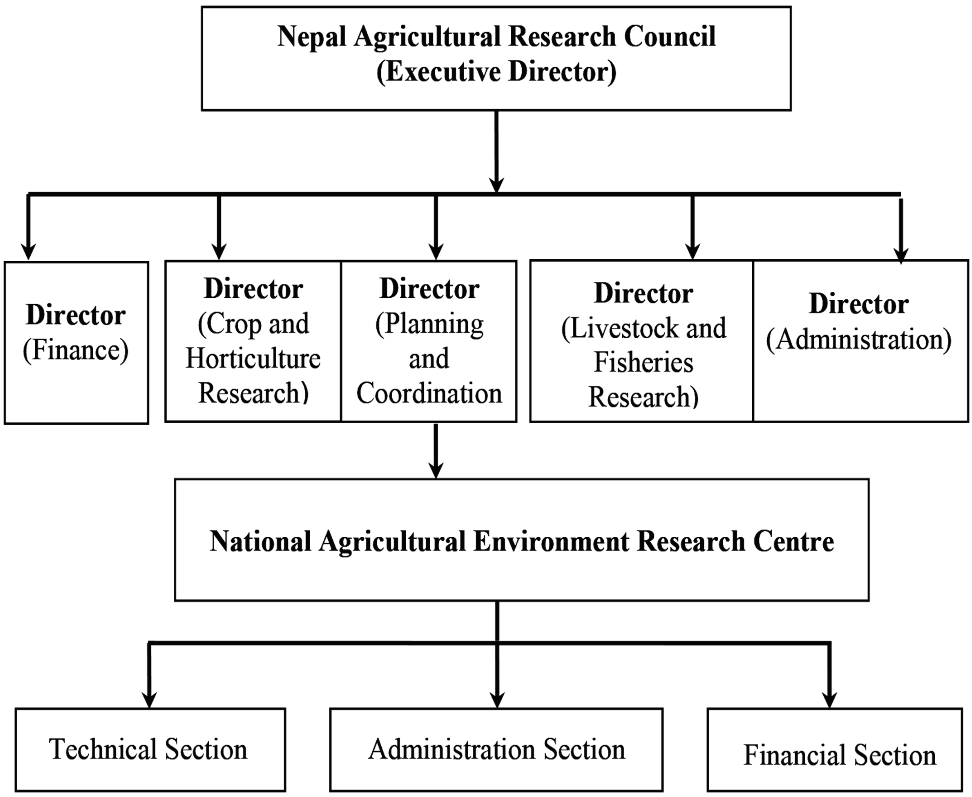

Fig. 1: Organizational structure of National Agricultural Environment Research Centre

3. RESEARCH HIGHLIGHTS

The summary of the research highlights mentioned below are presented in Annex 4.

3.1 Collection, Processing and Dissemination of Meteorological Data of Various Location of Nepal

NAERC purchased the daily weather data of 40 meteorological stations on various weather parameters from the Department of Hydrology and Meteorology (DHM) in March 2023 (Table 2).

Table 2. Description of daily weather data purchased by NAERC from DHM

S.N	Station Name (Index)	Parameters e.g. temperature, rainfall	Period e.g. 1990-1995	Frequency e.g.Monthly, daily, hourly
1	(105)	Rainfall, Temperature (T_{max} & T_{min}) & RH	2009, 2014-2022	Daily
2	409	Rainfall, Temperature (T_{max} & T_{min}) & RH	2009, 2014-2022	Daily
3	419	Rainfall, Temperature (T_{max} & T_{min}) & RH	2009, 2014-2022	Daily
4	604	Rainfall, Temperature (T_{max} & T_{min}) & RH	2009, 2015-2022	Daily
5	707	Rainfall, Temperature (T_{max} & T_{min}) & RH	2009, 2014-2022	Daily
6	809	Rainfall, Temperature (T_{max} & T_{min}) & RH	2009-2022	Daily
7	811	Rainfall, Temperature (T_{max} & T_{min}) & RH	2001-2022	Daily
8	814	Rainfall, Temperature (T_{max} & T_{min}), RH, and Sunshine	1980-2022	Daily
9	902	Rainfall, Temperature (T_{max} & T_{min}), RH, and Sunshine	2009, 2014-2022	Daily
10	904	Rainfall	1990-2022	Daily
11	905	Rainfall, Temperature (T_{max} & T_{min}) & RH	1990-2022	Daily
12	906	Rainfall	1990-1999, 2009-2022	Daily
		Temperature (T_{max} & T_{min})	1990-1999, 2015-2022	Daily
		RH	1990-2022	Daily
13	907	Rainfall, Temperature (T_{max} & T_{min}) & RH	1990-2022	Daily
14	909	Rainfall	2002-2022	Daily
		Temperature (T_{max} & T_{min})	2015-2022	Daily
		RH	1990-2022	Daily
15	910	Rainfall	1990-2022	Daily
16	911	Rainfall, Temperature (T_{max} & T_{min}), RH, and Sunshine	2009-2022	Daily
17	912	Rainfall	1990-2022	Daily
18	915	Rainfall	1990-2022	Daily
19	918	Rainfall, Temperature (T_{max} & T_{min}) & RH	1990-2022	Daily
20	919	Rainfall	1990-2022	Daily

S.N	Station Name (Index)	Parameters e.g. temperature, rainfall	Period e.g. 1990-1995	Frequency e.g.Monthly, daily, hourly
21	920	Rainfall	1990-2016	Daily
22	921	Rainfall, Temperature (T_{max} & T_{min}) & RH	1990-2022	Daily
23	922	Rainfall, Temperature (T_{max} & T_{min}) & RH	1990-2022	Daily
24	923	Rainfall	1990-2022	Daily
25	925	Rainfall	1990-2022	Daily
26	930	Rainfall	1990-2022	Daily
27	933	Rainfall	1990-2022	Daily
28	1029	Rainfall, Temperature (T_{max} & T_{min}), RH, and Sunshine	2009, 2015-2022	Daily
29	1103		2009, 2014-2022	Daily
30	1124	Rainfall, Temperature (T_{max} & T_{min}) & RH	2001-2022	Daily
31	1202	Rainfall	1997-2022	Daily
32	1203	Rainfall	1990-2022	Daily
33	1217	Rainfall	1990-2001	Daily
34	1219	Rainfall	1990-2022	Daily
35	1220	Rainfall	1990-1998	Daily
36	1224	Rainfall	1990-2022	Daily
37	1225	Rainfall	1992 only	Daily
38	1304	Rainfall, Temperature (T_{max} & T_{min}), RH, and Sunshine	2009, 2014-2022	Daily
39	1320	Rainfall, Temperature (T_{max} & T_{min}), RH, and Sunshine	2009, 2014-2022	Daily
40	1421	Rainfall, Temperature (T_{max} & T_{min}) & RH	2009, 2014-2022	Daily

3.2 Weather Pattern Analysis under Rice-Wheat Cropping System in Bara District

Rice-wheat cropping system is one of the most important crop production system covering 0.5 million hectares area in Nepal (Nadeem and Farooq 2019). Growth and development of rice and wheat crops are highly correlated with weather parameters like temperature and rainfall pattern. Prevalence of disease and pest also depends on prevailing weather condition. Bara district lies in Madhesh province of Nepal which is central Terai region of Nepal. The threshold daytime maximum temperature for rice is 29.9^{0}C for Terai but it was already crossed this limit in Terai region of Nepal which caused the productivity to be declined (Adhikari et al 2017). The weather information collection and interpretation help to take crop production decisions. However, the patterns of weather parameters over the cropping season have been less explored under rice-wheat cropping system in mid-Terai region of Nepal including Bara district. It is necessary to analyze the overall climate patterns of weather variables like temperature, rainfall and relative humidity of area and to know the prevailing weather condition and changes in rice and wheat growing season.

Study site

Under this activity, the overall climate patterns of weather variables like temperature, rainfall and relative humidity of past 33 years of Bara district was analyzed. Similarly, the prevailing weather condition and changes in rice and wheat growing season of Bara district was evaluated by using household survey by using semi-structured questionnaire. Total of 100 farmers, 31 from Jeetpur Simara Sub-metropolitan city, ward no. 11; 35 from Feta ward no.1; and 34 from Karaiyamai Rural Municipality, ward no. 5 was included in the survey.

Major findings of the survey

Climate patterns of past 33 years

The climate patterns of weather variable like daily temperature (maximum and minimum) and rainfall of past 33 years (1990-2022) from Parwanipur weather station was recorded. The annual average, winter season (December, January and February), pre-monsoon (March, April and May), monsoon (June, July and August) and post-monsoon (September, October and November) season of maximum and minimum temperature was analyzed. Similarly, the annual total rainfall, and winter, pre-monsoon, monsoon and post-monsoon season total rainfall was analyzed.

The highest annual average maximum temperature (33°C) was observed in 1998. In winter season, the highest maximum temperature (25.73°C) was observed in 1993; in pre-monsoon season, it was highest (35.8°C) in 1996; in monsoon season, it was highest (35.1°C) in 1998, and in post-monsoon season, it was highest (33.5°C) in 1998 (Fig. 2-6).

The lowest annual average minimum temperature (17.85°C) was observed during 1997. In winter season, the lowest minimum temperature (9.54°C) was during 1998; in pre-monsoon season, it was lowest (17.72°C) in 1993; in monsoon season, it was lowest (24.70°C) in 1991, and in post-monsoon season, it was lowest (15.64°C) in 1994 (Fig. 7-11).

The highest total annual rainfall (2380.4 mm) was observed during the year 2007. In winter season, the highest total rainfall (103.7 mm) was recorded in 1998; in pre-monsoon season, it was highest (376.6 mm) in 2020; in monsoon season, it was highest (2185.7 mm) in 2007, and in post-monsoon season, it was highest (213.9 mm) in 2013 (Fig, 12-16).

Level of education

Majority of the farmers were literate in this study. Out of 100 farmers, 50% were literate, 26% were high school attended, 22% were illiterate, and only 2% were university degree holder.

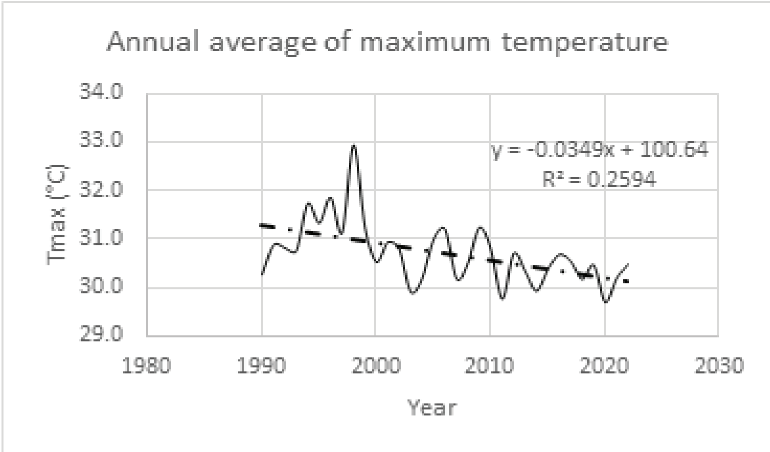

Fig. 2: Annual average of maximum temperature from 1990 to 2022, Parwanipur, Bara, Nepal

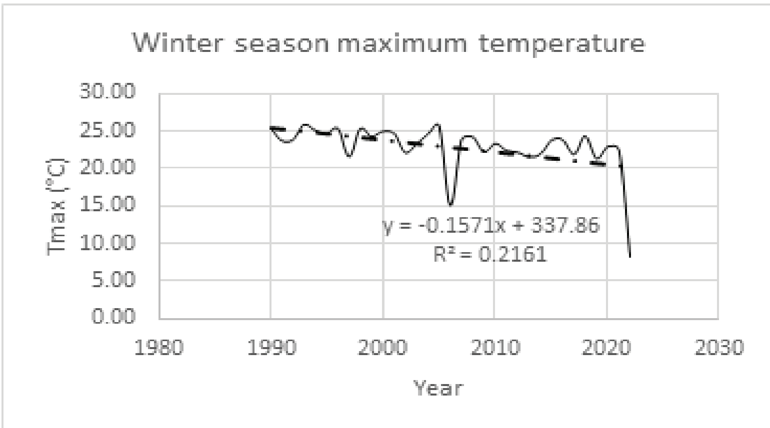

Fig. 3: Winter maximum temperature from 1990 to 2022, Parwanipur, Bara, Nepal

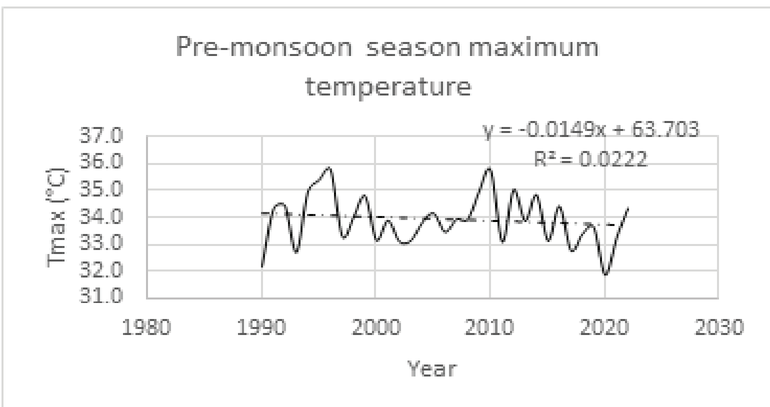

Fig. 4: Pre-monsoon maximum temperature from 1990 to 2022, Parwanipur, Bara, Nepal

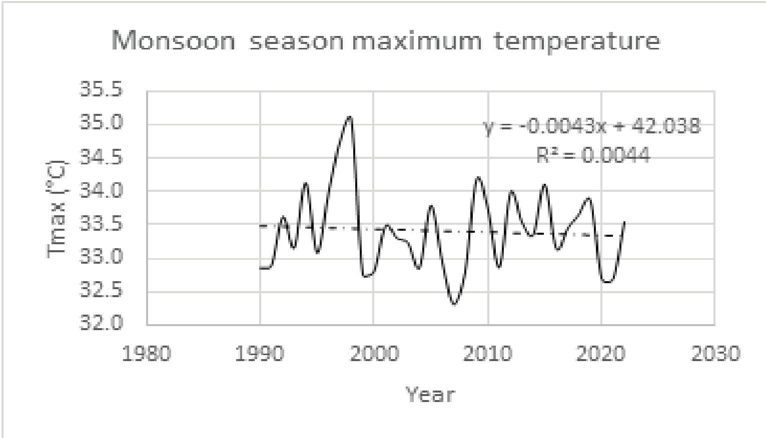

Fig. 5: Monsoon maximum temperature from 1990 to 2022, Parwanipur, Bara, Nepal

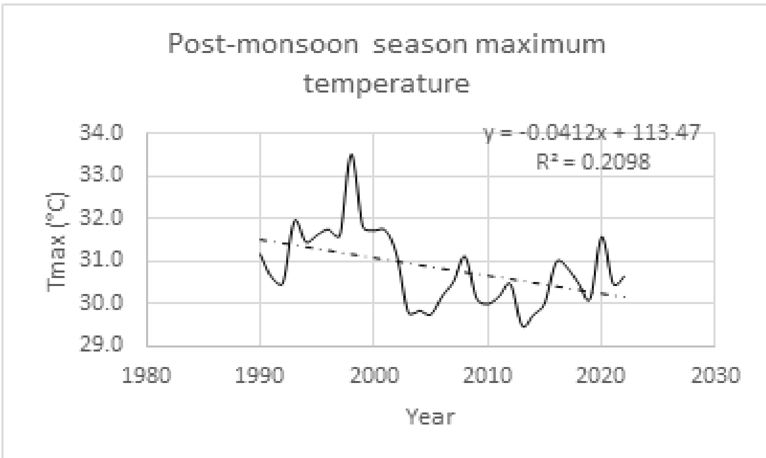

Fig. 6: Post-monsoon maximum temperature from 1990 to 2022, Parwanipur, Bara, Nepal

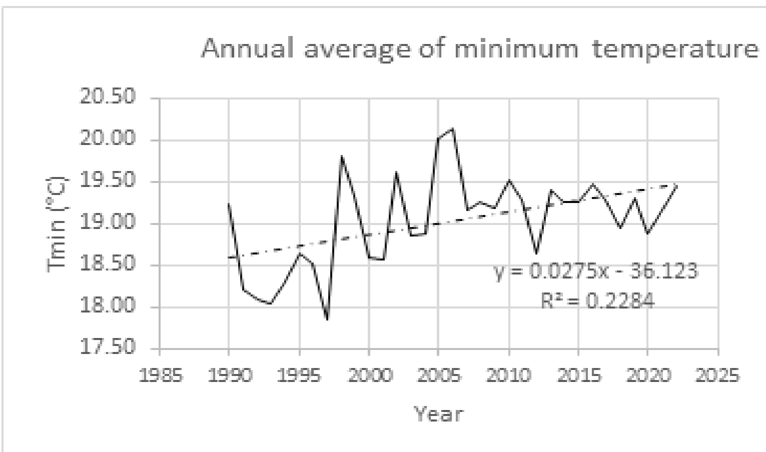

Fig. 7:Annual average of minimum temperature from 1990 to 2022, Parwanipur, Bara, Nepal

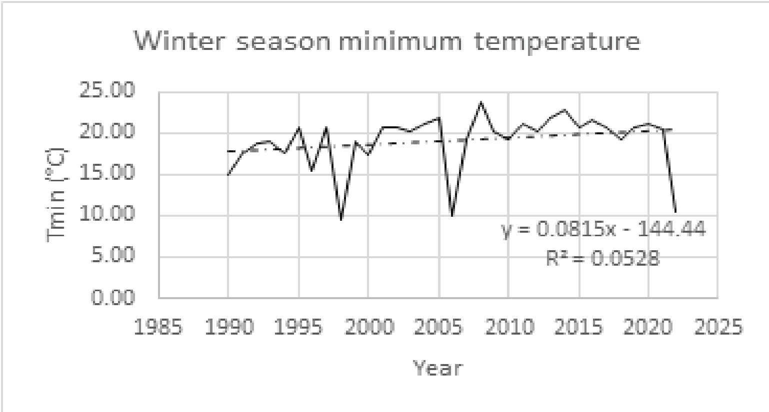

Fig. 8: Winter minimum temperature from 1990 to 2022, Parwanipur, Bara, Nepal

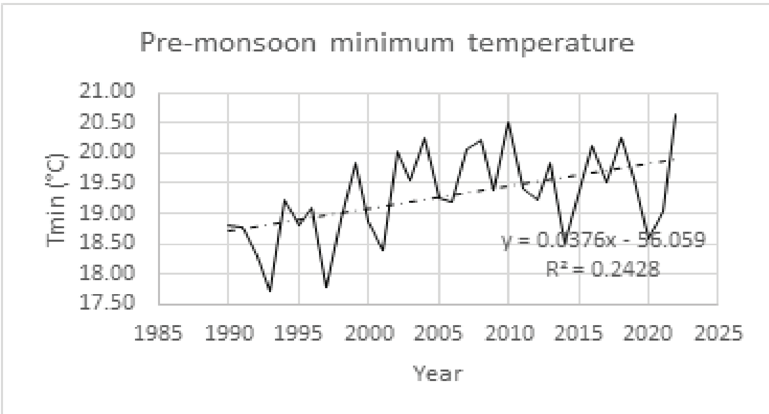

Fig. 9: Pre-monsoon minimum temperature from 1990 to 2022, Parwanipur, Bara, Nepal

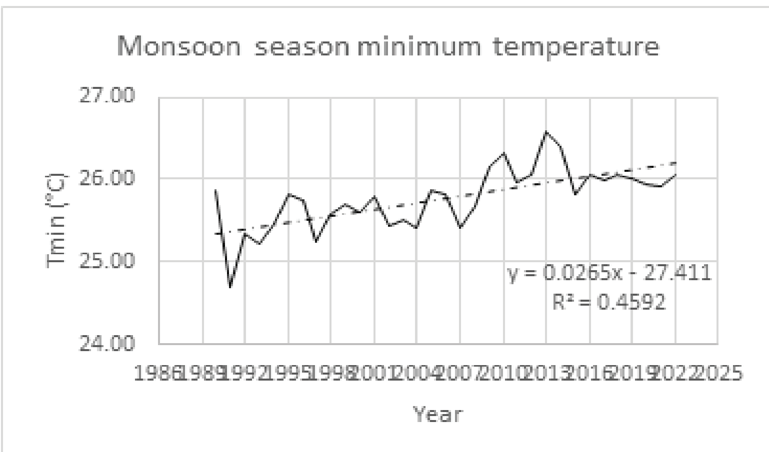

Fig. 10: Monsoon minimum temperature from 1990 to 2022, Parwanipur, Bara, Nepal

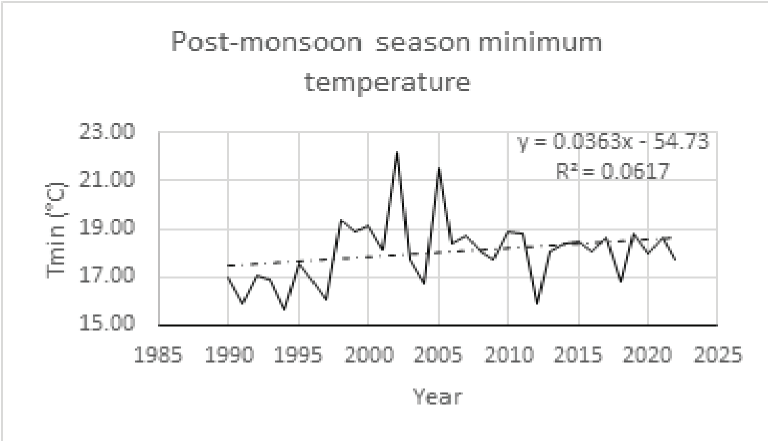

Fig. 11: Post-monsoon minimum temperature from 1990 to 2022, Parwanipur, Bara, Nepal

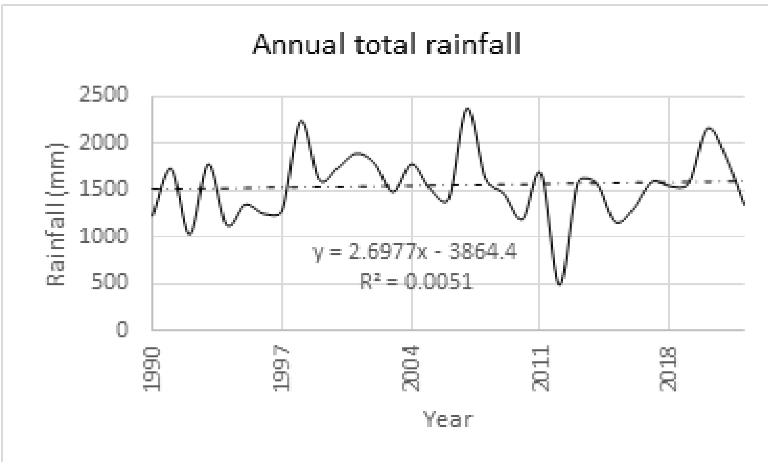

Fig. 12: Annual total rainfall from 1990 to 2022, Parwanipur, Bara, Nepal

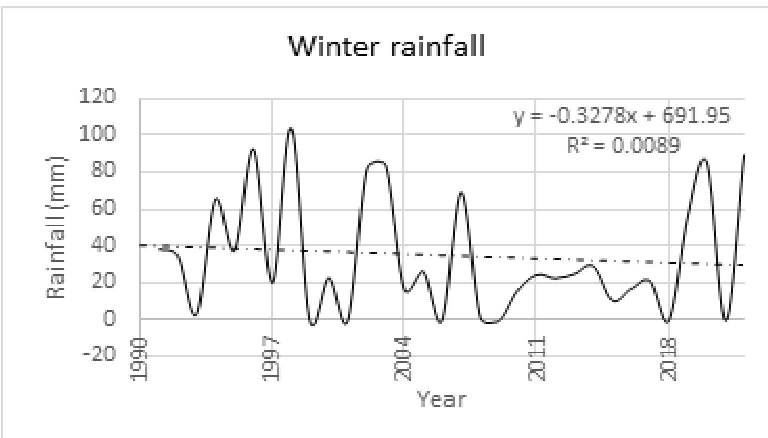

Fig. 13: Winter rainfall from 1990 to 2022, Parwanipur, Bara, Nepal

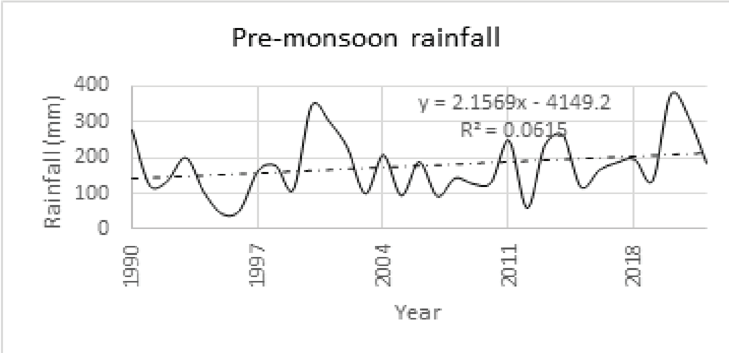

Fig. 14: Pre-monsoon rainfall from 1990 to 2022, Parwanipur, Bara, Nepal

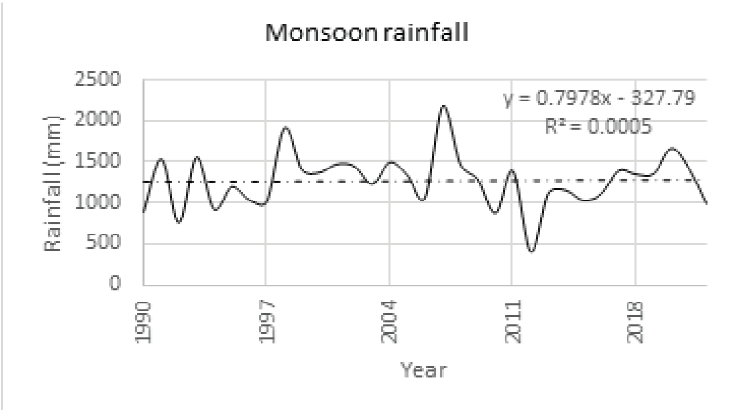

Fig. 15: Monsoon rainfall from 1990 to 2022, Parwanipur, Bara, Nepal

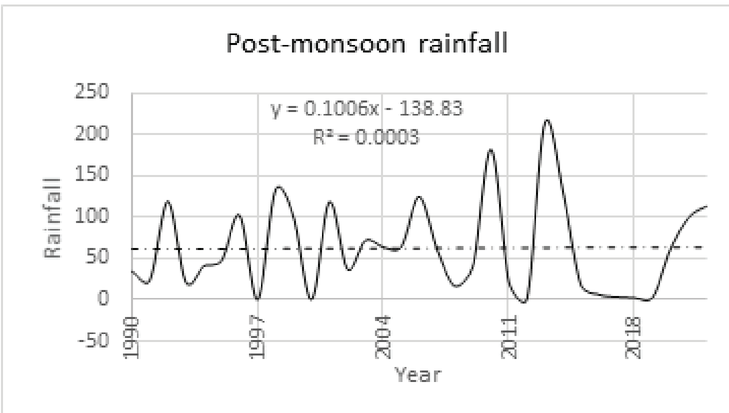

Fig. 16: Post-monsoon rainfall from 1990 to 2022, Parwanipur, Bara, Nepal

Major source of livelihood

Majority of the farmers (64%) responded agriculture and livestock as their major source of livelihood, while 12% respondents have service (Job/labor), 1% have business, 15% have both agriculture and livestock, and service (job/labor), and 8% have both agriculture and livestock and business as a source of livelihood (Fig. 17).

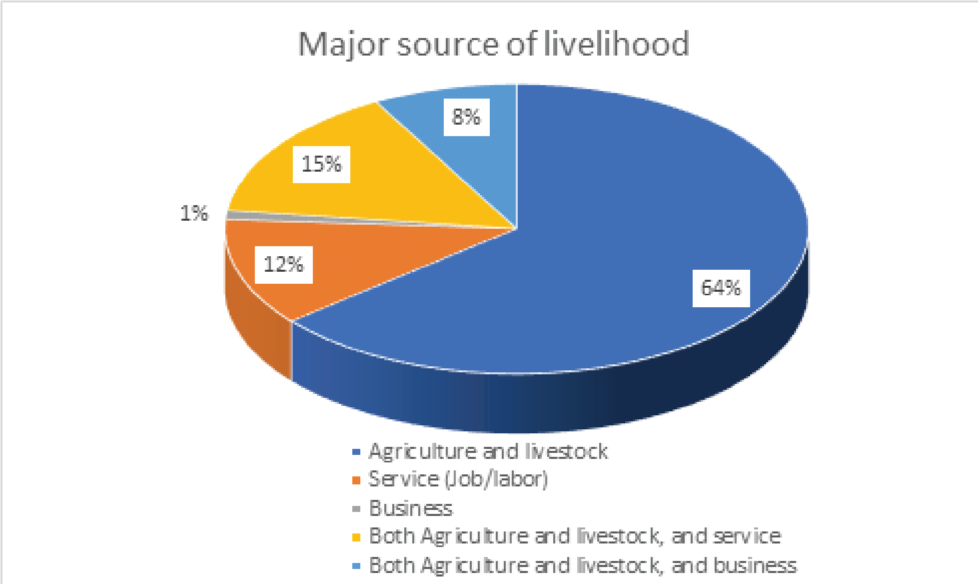

Fig. 17: Major source of livelihood of respondent farmers from Bara district

Participation in training

Seventeen farmers (17%) were participated in trainings based on IPM and cereal crop production.

Status of rice-wheat cropping system

All the farmers have adopted rice-wheat cropping system and large area are under rice cultivation as compared to wheat. According to respondents, area under cultivation of rice and wheat were ranged from 4 to 100 kattha of land while production of rice was ranged from 75 to 200 kg/kattha while it was ranged from 40 to 120 kg/kattha in case of wheat.

Climate change information

In case of climate and weather information, farmers were asked about the climate change that they know or hear and 51% responded to do not know, 28% responded to know a little bit only, 13% responded to clearly know, and 8% responded know more clearly (Fig. 18).

Changes in temperature due to climate change

Moreover, about the perception of farmers on weather variability compared to 10 years back, farmers were asked about changes in summer and winter temperature, number of hotter days, number of rainy days, amount of rainfall and humidity. All the farmers (100%) responded as summer temperature was increased due to climate change. 18% of the farmer responded as winter temperature as same as before 10 years back while 68% responded to increased winter temperature, and 14% responded to decreased winter temperature as compared to 10 years back.

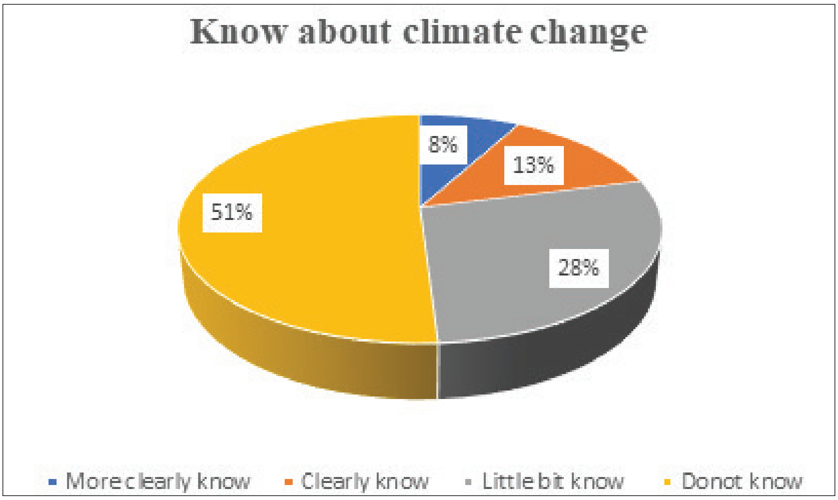

Fig. 18: Perception of participating farmers about climate change from Bara district

In case of hotter days, only 1% responded as same as compared to 10 years back, while 94% responded as increased and 5% responded as decreased. According to rainy days, 4% responded to increased rainy days while 96% responded to decreased rainy days as compared to 10 years back. Likewise, 4% responded increased rainfall, while 96% responded decreased rainfall as compared to 10 years back. Similarly, 61% responded same humidity, 29% responded increased humidity, and 10% responded decreased humidity as compared to 10 years back. In case of perception about extreme weather events, 1% responded same drought or dry spell, 96% responded increased drought or dry spell, and 3% responded decreased drought or dry spell as compared to 10 years back.

Increased monsoon rainfall was responded by 2% responded while 98% responded as decreased monsoon rainfall. Likewise, 1% responded to same winter rainfall while 3% responded to increased winter rainfall and 96% responded to decreased winter rainfall. 9% responded to same unpredictable rainfall, while 79% responded to increased unpredictable rainfall and 12% responded to decreased unpredictable rainfall. In case of hailstorm, 25% responded to same hailstorm as before 10 years while 18% responded to increased and 57% to decreased hailstorm. Same floods intensity was responded by 11% while 52% responded to increased flood intensity and 37% responded to decreased flood intensity. Soil fertility as same as before 10 years responded by 5% of respondent while 1% responded to increased soil fertility and 94% responded to decreased soil fertility. Similarly, 4% responded to same water table while 96% responded to decreased water table.

Rice-wheat cropping system is very important cropping system in Terai region of Nepal. Experience of respondent on climate change impacts on rice-wheat cropping system was also explored. 85% respondent realized there is severe impacts of climate change on rice-wheat cropping system as compared to 10 years before and this was realized by decreased rice yield decreased grain quality, untimely rainfall during harvesting stage, increased drought, sterility problem in seed, increased infestation of insects, pest, and disease, delayed planting, weeds problem, decreased panicle size etc. Majority of the respondent realized that the sugarcane and lentil areas are reduced as compared to ten years before. Similarly, majority of respondent realized onset of monsoon on Jestha month before ten years back but nowadays it was on the month of Asar first or second week and the reason for this late onset of monsoon was due to climate change. Similarly, withdrawal date of monsoon was Asoj last week but nowadays it was in Asoj first week.

3.3 Monitor and estimate of carbon emission from three different cropping system Aadopted in NAgRC, Khumaltar

Carbon emission refers to the release of carbon dioxide (CO_2) and other greenhouse gases into the atmosphere. These gases trap heat from the sun, causing the Earth's temperature to rise and leading to climate change. The primary driver of global climate change is carbon dioxide emissions. As the second largest carbon flux in terrestrial ecosystems, the soil CO_2 flux is closely related to the atmospheric CO_2 concentration. Soil CO_2 flux is the amount of carbon dioxide (CO_2) that is released from the soil into the atmosphere. It is a measure of the rate of CO_2 efflux from the soil surface . CO_2 flux from agricultural soil mainly depends on microbial activities on organic matter and a number of abiotic and biotic factors can also affect it. It generally increases with rise in temperature. Low level of soil moisture limits microbial and root respiration. Higher emission of CO_2 from soil depletes the organic matter content and thus reduces the soil productivity as well as fertility. So, it is necessary to monitor CO_2 emission rates in different cropping pattern to formulate the plan to reduce overall agricultural emission.

The measurement of soil CO_2 flux is important for understanding the carbon cycle and its impact on the environment. Soil CO_2 efflux can be determined by measuring the CO_2 concentration in the air above the soil surface using a chamber. The amount of CO_2 released from the soil is then calculated based on the change in CO_2 concentration over time. The measurement of soil CO_2 flux is used in various fields, including agriculture, forestry, and climate change research. However, it is generally believed that CO_2 emission from the soil and CO_2 fixation by the plant during photosynthesis process is a self-sustaining system and there is balance between carbon released from soil and fixed by the plant through photosynthesis.

The study was carried out at the National Agronomy Research Centre, Khumaltar to estimate CO_2 -C emissions from maize fields with different nitrogen doses (120, 150, 190, and 210 kg/ha) in 2079/80. Soil temperature, pH and moisture were recorded in the study. The collection of gas samples was done by the Japanese closed chamber technique and finally subjected to measurement with the help of a CO_2 monitor. Soil moisture and pH were taken by a combined soil moisture and pH meter. The temperature of the soil was measured at a depth of 8 cm. The gas samples were collected in an interval of one month each.

The study revealed that pH of the soil ranged from 6.2 to 6.5 and the soil moisture index ranged from 7.5 to 7.8. Similarly, the air temperature ranged from 19.6 to 20.6°C during the gas collection process. The CO_2-C flux was recorded at the highest of 118.4 mg/ha/hr from the field with 210 kg/ha of nitrogen applied through urea. The lowest 56.2 mg/ha/hr was found with the application of 120 kg/ha of nitrogen in maize field. The average emission was found to be 84.4 mg/ha/hr (Table 3).

Table 3. CO_2-C emission from maize field with different doses of nitrogen at Khumaltar, Lalitpur in 2079/80 (2022/23)

S. N.	Nitrogen dose (kg/ha)	Air Temp. (°C)	C-flux mg/ha/hr	Soil Temp. (°C)	Soil pH	Moisture index
1	120	20.2	56.2	18.3	6.2	7.6
2	150	21.1	73.6	17.6	6.5	7.5
3	190	19.6	89.5	18.4	6.3	7.8
4	210	20.6	118.4	17.9	6.5	7.5
Mean		20.4	84.4	18.1	6.5	7.5

3.4 Estimation of CO_2 sequestration by Mango and Litchi fruit trees in Rautahat district

Plant biomass is the major sink of atmospheric carbon dioxide as trees stores it for a long period (Brahma *et al*, 2021). Therefore, plantation plays crucial role for removing CO_2 from atmosphere and has important role in mitigating climate change. Moreover, fruit orchards are not only the source of fruits but also the sink of atmospheric carbon dioxide (Shrestha and Malla 2016). According to the Kyoto Protocol from 1997, every nation on earth is required to help reduce greenhouse gas emissions by either increasing carbon sequestration or reducing emissions. The process of taking carbon dioxide from the atmosphere and storing it in soil, water, or plant biomass is known as carbon sequestration. As Nepal has also contributed to carbon stocking, its national carbon stock has been estimated to be 246 to 393 Mt carbon (Gibbs *et al.,* 2007). Though the forestry sector has done a quite good job in quantifying the carbon sequestration by forest trees, the process itself is in a very primitive stage in the agriculture sector.

Rautahat district was taken to estimate the carbon storing capacity of Mango (*Mangifera indica*) and Litchi (*Litchi chinensis*) trees growing at least 0.5 ha of land. Rautahat district, a part of Madhesh Province, is one of the seventy-seven districts of Nepal, covers an area of 1,126 km^2. The district has tropical climate and altitude ranged from 300 to 1000 masl. The district was taken as a sample so that carbon sequestration of the country through these fruits can estimated. Mango productivity of the district (13.07 mt/ha) was higher compared to national average (12.30 mt/ha) while Litchi productivity of the district (5 mt/ha) was lower compared to national average (7.41 Mt/ha) (MOALD, 2023).

The age of the sample trees ranged from 18 to 30 years for Mango and 12 to 30 years for litchi. The total 271 trees were sampled from different farms; among them 145 were Mango trees and 126 were Litchi trees. To calculate the carbon sequestration, the diameter at breast height (DBH) of the plant was measured at 1.3 m above ground level and the plant height was calculated using an angle measured by clinometers. The DBH for the tree is found by taking the square root of the sum of all squared branches at breast height explained in Nature Conservation Practice Note No. 02 (Rev. Jun 2006). The above and below-ground tree biomass and carbon sequestered by Litchi trees within one-hectare of land was calculated following the procedure described in Timilsina et al (2019). The below-ground biomass was determined multiplying above ground by 0.26 as a factor as proposed by Cairns et al (1997). Wood density values were compiled from Zanne et al (2009) to calculate biomass of the plant. The carbon stored in angiosperms were calculated multiplying total biomass by 0.521 as a factor as proposed by SERC (2015). The canopy size, height, age of the tree, and girth diameter are the major determinants of sequestered carbon as tree biomass.

The carbon sequestration (tonnes/tree) was estimated based on diameter and the height of the trees (Table 4 and Table 5). Carbon sequestration data was collected from the mango trees (varieties; Bombay Green, Maldaha and Amrapali) and Litchi trees (Shahi). Carbons sequestration per tree is positively correlated to age (height and diameter of the plants) of the plants.

Table 4: Carbon Sequestration by Mango trees in Rautahat district

S. N.	Owner's name and location	No. of samples	Tree age (year)	Diameter at breast height (M)	Tree height (M)	Carbon sequestrated (t/tree)
1	Ram Adhar Yadav (Gadimai-5)	50	30	1.19	10.70	0.61
2	Madhabnarayan-5	35	25	1.27	12.23	0.70
3	Basistha Ray Yadav (Garuda-8)	25	12	0.88	8.17	0.38
4	Rajesh Chaudhari (Durga Bhagwoti -3)	60	18	0.43	6.71	0.05

Source: Field data, 2023

The highest carbon sequestration (0.70 tonnes/tree) was observed in the 25 years Bombay mango trees grown at Madhabnarayan-5 Rautahat and lowest carbon sequestration (0.05 tonnes/tree) was observed in the 18 years Amrapali mango trees grown in the field of Rajesh Chaudhari at Durgabhagwoti-3, Rautahat. Similarly, 12 years mango trees grown at Garuda-8 sequestrated carbon 0.38 tonnes/tree. Likewise, 30 years mango trees of Ram Adhar Yadav at Gadhimai-5 were sequestrated 0.61 tonnes/tree.

Table 5: Carbon Sequestration by Litchi trees in Rautahat district

S. N.	Owner's name and Location	No. of samples	Tree age (year)	Diameter at breast height (M)	Tree height (M)	Carbon sequestrated (t/tree)
1	Basistha Ray Yadav (Garuda-8)	26	12	0.61	6.15	0.13
2	Madhabnarayan-5	45	30	1.13	9.44	0.63
3	Rajesh Chaudhari (Durga Bhagwoti-3)	30	18	0.62	5.51	0.12

Source: Field data, 2023

The highest carbon sequestration (0.63 tonnes/tree) was observed in the 30 years Shahi litchi trees grown at Madhabnarayan-5 Rautahat and lowest carbon sequestration (0.12 tonnes/tree) was observed in the 18 years Shahi litchi trees grown in the field of Rajesh Chaudhari at Durga Bhagwoti-3, Rautahat. Similarly, 0.13 tonnes/tree carbon sequestration was observed in 12 years Shahi litchi trees grown in the field of Basistha Ray Yadav at Garuda-8, Rautahat.

3.5 Survey on pasture grazing area of Solukhumbu district

Solukhumbu District is a district in the province koshi of eastern Nepal. It is known for its stunning mountainous landscapes, including a part of the Himalayas. Solukhumbu is located in the northeastern part of Nepal and is known for its diverse topography, ranging from lowland areas to high mountainous regions. It is home to some of the world's highest peaks, including Mount Everest, which is a major attraction for trekkers and mountaineers. The district is inhabited by diverse ethnic groups, and the Sherpa community is prominent in the region. Sherpas are known for their association with mountain climbing and trekking activities. Agriculture is a significant part of the local economy, with crops like potatoes, barley, and wheat being cultivated. Tourism, especially trekking and mountaineering-related activities, also contributes substantially to the economy. The climate in Solukhumbu varies based on altitude. The lowland areas have a subtropical climate, while the higher elevations experience colder temperatures.

Climate change in pastoral system

Climate change can have diverse impacts on ecosystems, including pastures. Some of the potential impacts on pastures in a region like Solukhumbu District may include:

Changes in temperature and precipitation patterns: Climate change can alter temperature and precipitation patterns, affecting the growth and productivity of pasture plants. Changes in these patterns may lead to shifts in the types of grasses and other vegetation that thrive in the region.

Water availability: Changes in precipitation patterns can influence water availability for pastures. Droughts or shifts in the timing and intensity of rainfall can affect the quality and quantity of forage available for livestock.

Extreme weather events: Increased frequency and intensity of extreme weather events, such as storms, floods, or prolonged droughts, can damage pasture ecosystems. This can lead to soil erosion, loss of vegetation cover, and disruption of grazing patterns.

Pests and diseases: Changes in climate conditions can influence the prevalence and distribution of pests and diseases. This may affect the health of pasture plants and livestock, leading to reduced productivity.

Altered grazing patterns: Climate change can impact the timing and availability of pasture resources. This may necessitate changes in traditional grazing patterns for livestock, potentially leading to overgrazing in some areas and underutilization in others.

Mountain ecosystem vulnerability: Solukhumbu district is situated in the Himalayan region, which is particularly vulnerable to climate change. The impacts on glaciers, snow melt patterns, and water availability can have cascading effects on the entire ecosystem, including pastures.

To obtain the most accurate and up-to-date information on the specific impacts of climate change on pastures in Solukhumbu district, it is advisable to refer to local research studies, government reports, and the expertise of local agricultural and environmental authorities. Additionally, community-based knowledge and observations from residents can provide valuable insights into the changes occurring in the region.

The research was conducted on three sites of solukhombu districts. These sites were purposively selected because of farmers involved in pasture and fodder cultivation along with their interest in animal husbandary. Total of 23 farmers, 12 from Dudhkunda and 6 from Takasindhun and 5 from Nele were included in the sample. The sample selection was done by simple random sampling technique having minimum 3 ropani of land under pasture land. Primary data were collected through household survey by using semi-structured questionnaires. Secondary data collection was done through the desk study of grey literatures and various authentic publications.

Demographic features

Demographic features include household and farm characteristics like sex, education, income, land holding of the respondents. These characteristics are discussed briefly here.

Sex

The proportion of male respondents is higher in total. Male respondents constitute 73.91 percent whereas female were only 26.09 percent (Table 6).

Table 6: Characteristics of the survey respondents from Solukhumbu district

Respondents	Number	Percentage
Male	17	73.91
Female	6	26.09
Total	23	100.00

Source: Field survey, 2023

Education of respondents

Altogether 13.1 percent of the respondents have university level of education, 39.1 percent have higher secondary level degree, 26.1 percent respondents were literate and remaining 21.7 percent have illiterate background. Majority of the farmers were literate in solukhombu district (Table 7).

Table 7: Education status of sample population from Solukhumbu district

	Illiterate	Literate	High school	University degree	Sub-total
Number	5	6	9	3	23
Percentage	21.7	26.1	39.1	13.1	100

Source: Field survey, 2023

Land holding and income

Average land holding of the sample farmers in three sites of solukhumbu was estimated 17 ropani. Average annual household income from agriculture production is estimated NRs 48.3 thousand and from livestock is estimated at NRs. 40.7 thoudsand in solukhombu district at the sampled sites.

Climate change information

The information about climate and climate change in the surveyed area was less with about 17.4 % of the sampled population got the information, while 82.6 % of people did not get information on climate and climate change.

Changes in temperature due to climate change

The effect of climate change in winter and summer were analysed and it was found that the winter temperature was at similar conditions (56.5%), increased (34.8%) and decreased (8.7%) (Fig. 19).

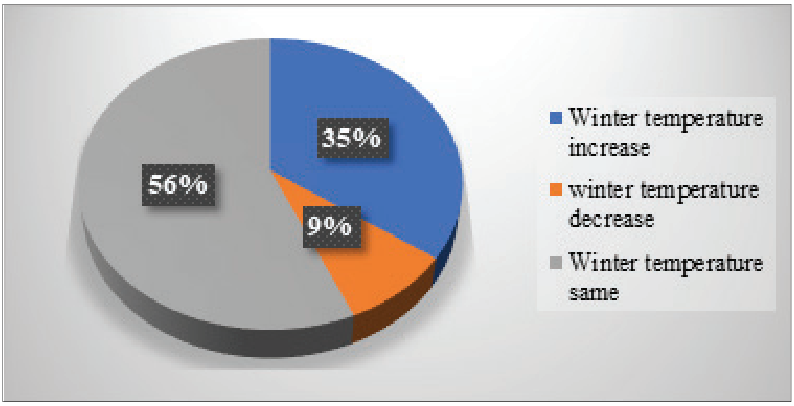

Fig. 19: Winter temperature trend due to climate change at Solukhumbu district

While in summer the respondent said that the temperature was similar conditions (60.9%), while few respondents said that the temperature was increasing (39.1%) due to climate change effect (Fig. 20). These shows that even the farmers have felt the changes in temperature in summer and winter as compared to few years back. This can be compared with the melt of snowfall, where farmers said there was increasing (69.7%) trend of snow melt, while few farmers did not find any changes (31.3%).

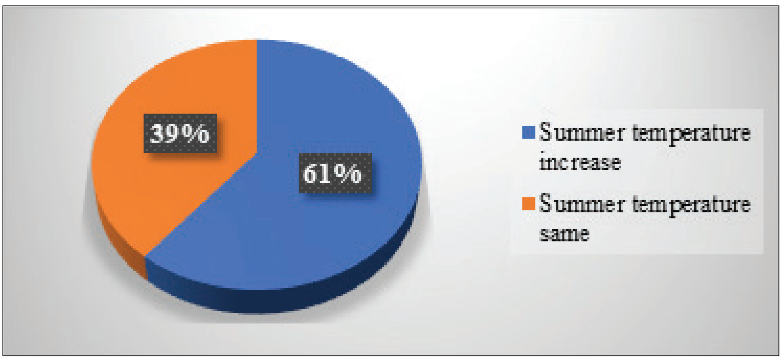

Fig. 20: Summer temperature trend due to climate change at Solukhumbu district

Feed management for livestock

The solukhombu area is famous for livestock production and has a large grazing area where animals can meet their feeding habits. It was observed that most of the farmers feed animals in grazing land, but few farmers also do stall feeding for the livestock production. From the surveyed are it was found farmers feed their animals in both ways i.e grazing and stall feeding (65.2%) but few farmers feed their animals mostly on grazing land (34.8%).

Grazing land status in surveyed areas

Grazing land for livestock plays a crucial role in animal production, providing the necessary space and resources for animals to feed on natural vegetation.

Sustainable and well-managed grazing land is essential for both the health of the livestock and the long-term productivity of the land. Continuous monitoring and adaptive management practices are key components of successful grazing land management. Farmers of the surveyed area faced a problem of decreasing grazing land (52.2%), few farmers were able to increase their grazing land (21.7%) and rest had similar lands for grazing (26.1%).

Conclusion and suggestions

Climate change poses significant challenges to pasture and grazing land management, impacting the availability and quality of forage for livestock. The increasing frequency of extreme weather events, changes in precipitation patterns, and rising temperatures can have profound effects on pasture ecosystems. It's crucial to acknowledge the importance of adapting grazing practices to mitigate the impacts of climate change.

3.6 Analysis of weather patterns in the study area

This is mentioned in the activity of climatic patterns analysis of the Bara district.

3.7 Generation of weather forecast based weekly agro advisory bulletin (AAB)

A total of 52 episodes of the agro-met advisory bulletin have been prepared by an expert team in collaboration with the Department of Hydrology and Meteorology (DHM). The bulletin continued to encompass all 77 districts of Nepal. The seven-day weather forecast was received for Terai, the Hills, and the Mountains in the respective provinces. The problems faced by the farmers were collected from Kisaan Call Centre (KCC) service of the NARC as well as AITC and were provided to the expert team regularly. The expert team used crop and livestock status as well as weather forecast to prepare agro-met advisories which have been disseminated through Google group, television, mobile SMS, web service, email, facebook group, etc.

3.8 Roving seminar for farmers

This activity was not accomplished due to budget cut down by the government of Nepal.

3.9 Stakeholders interaction workshop on importance of AAB

This activity was not accomplished due to budget cut down by the government of Nepal.

3.10 Sharing adaptation strategies on climate resilient technologies to the farmers of NARC technology village

This activity was not accomplished due to budget cut down by the government of Nepal.

3.11 Performance study of tomato under elevated temperature

Due to genetic make-up, crop species and varieties response differently with weather and rising temperature. Due to the higher temperature, soil mineralization process alters and the properties of soil will be affected. Therefore, there is need to understand crop and crop varieties, those perform better and the time of crop establishment under rising temperature. This will help the plant breeder and agricultural scientist to plan breeding program and crop management practices for the future. In case of tomato (*Lycopersicon esculentum* MILL.), it is one of the widely grown vegetables in Nepal. With increasing temperature due to change in climate over the year, tomato production might have affected. The higher temperature stress could cause flower abortion, impact on the fruit quality reduces yield (Hernandez et al 2015). Higher temperature also cause change in plant height, leaf area, dry weight of leaves, stem and roots, number of clusters, number of flowers as well as the number of pollen grains per microscopic field. Moreover, different genotypes might have different capacity to response under increased temperature (Abdelmageed 2003). The other factors like relative humidity are linked with the impact of the higher temperature on tomato (Zheng et al 2020). The study of temperature effect on crops is mostly done either in growth chamber or in phytotron under controlled condition. Such facility is not available in Nepal. However, Open Top Chambers are available in NARC where such study can be performed.

Thus, this experiment was done to study the performance of four tomato varieties under different climatic environment i.e. open top chamber (OTC) and open field condition in Mid-hill condition of Khumaltar, Lalitpur. The experiment was conducted in split plot design in which main plot consisted of production environment i.e. open top chamber and open field condition while in sub-plot consisted of four tomato varieties viz. HRDTM, AVTO 0922, AVTO 1422 and AVTO 1705, and replicated thrice. The plot size was 1 x 1 m^2 and spacing was 50 x 50 cm^2. Date of transplanting was 2080-01-28. From the experiment it was observed that average number of fruits per plant was higher in OTC (67) than open field condition (21) (Table 8). Similarly, among the varieties, AVTO 0922 recorded the highest total fruits yield per plant (2900 gm).

Table 8: Response of tomato genotypes under OTC and open field conditions at Khumaltar, Lalitpur

Treatment	No. of fruits per plant	Total fruits yield (gm)/plant
OTC	67	3879.16
Open Field	21	982.50
HRDTM	43	2298.33
AVTO 0922	52	2900
AVTO 1422	33	1891.66
AVTO 1705	48	2633.33

3.12 Verification of potato late blight forecasting model in mid-hill and Terai condition

Weather is one of major factors to influence incidence of disease and insect in various crops. The appropriate forecasting of diseases and pest could minimize the anticipated losses from their occurrence. Late blight (*Phytophthora infestans*) of potato is the major disease that leads to complete loss of potato production. This disease is economically important disease-causing substantial yield loss each year in Nepal (Sharma et al 2009) which is highly dependent on the weather parameter prevailing during crop growing period. Late blight develops when humidity is high, and a temperature is about 20°C (Crosier 1934). The loss has been recorded more than 75% in high hills and up to 50-90% in Terai region (Shrestha 2000).

A pest forecasting model expected to develop will help to predict out-break or changes in intensity of pests based on information about weather, crop, and pests. Forecasting helps to notify the favorable or unfavorable weather condition for potato blight and fruit borer, thereby to adapt the control measures in appropriate time. Forecasting model assists the growers for spray schedule and reduces the costs involved by eliminating the unnecessary sprays and labour cost without increasing the risk of losing the crop. Moreover, forecasting is an ecologically and economically sound approach like cultural, biological control methods which plays an important role in the management of diseases and insect.

The forecasting model for potato late blight experiment was conducted at NAERC, Khumaltar, NMRP, Rampur, NWRP, Bhairhawa and DoAR, Nepalgunj using Indo-blight Cast (IBC) late blight forecasting model. The experiment was conducted in split plot design. In main plot, there were three treatments viz. (i) No spray, (ii) Recommended spray i.e. 1st spray Mancozeb at 35 days after planting (DAP), 2nd spray Dimethomorph at 45 DAP, 3rd spray Sectin at 55 DAP, and 4th Spray Dimethomorph at 65 DAP, and (iii) System guided spray (model based). In sub-plots, there were 4 potato varieties viz. Kufrijyoti, Janakdev, Desire, and Khumal Ujjal. For the application of pesticides, a standard protocol developed by National Potato Research Program, Khumaltar was followed.

The individual plot size was 7.2 m^2 (3m x 2.4m) and planting distance was 60 cm row to row, 25 cm plant to plant, hence, there was 4 rows each having 12 plants. The distance between two plots was 60cm and block to block distance was 1 meter. Fertilizer dose applied was FYM @ 3 ton/ha, and NPK @ 70:50:40 kg/ha. Thus, FYM applied @ 14.4 kg/plot, DAP @ 156 gm/plot, MOP @ 72 gm/plot and Urea @ 35 gm/plot as basal dose while Urea @ 60 gm/plot was top dressed at 40 days after seeding (DAS). Similarly, first earthing up was done at 40 DAS while second was done at 60 DAS. Irrigation was provided after these two earthing up. Date of potato sowing was 11th Aswin 2079.

Unfortunately, blight did not appear in Khumaltar area during the experimentation. However, biometrical observation i.e. plant height, and yield and yield attributes of potato was recorded and presented in Table. Plant height was significantly influenced by different varieties of potato at different growth stages while there was non-significant effect of spraying system. Significantly higher plant height was observed with variety Desire (27.22 cm) which was also statistically similar with variety Kufri Jyoti (24.79 cm) at 30 DAP. Likewise, similar results were also observed at 45 and 60 DAP. In case of effect of spraying system on plant, there was non-significant effect at all the growth stages of potato i.e. at 30, 45, and 60 DAP.

Potato tubers were categorized into three different sizes viz. 0-25gm, 25-50 gm, and >50 gm and total weight of tubers per plot based on these three categories were recorded (Table 9). Significant effect of varieties on potato tubers having size of 0-25 gm and >50 gm was observed, and higher potato tuber yield was observed from variety Desire (0.81 kg/plot) with 0-25 gm category. Similar results were also observed with >50 gm size category of potato tuber size with variety Desire (5.46 gm/plot) which was also statistically similar with variety Kufri Jyoti and Janakdev. In case of spraying system, non-significant effect was observed on 0-25 and >50 gm category sizes while significant effect was observed on 25-50 gm category size and higher potato yield was observed with symptom-based spray (1.06 kg/plot) which was also statistically similar with no spray (0.90 kg/plot).

Total potato yield (kg/ha) was significantly influenced by different varieties while non-significant effect was observed in case of spraying system. Significantly higher yield of potato was observed with variety Desire (9971 kg/ha) which was also statistically similar with variety Kufri Jyoti (9017 kg/ha) and Janakdev (8773 kg/ha) and lowest yield was with variety Khumal Ujjawal (7110 kg/ha).

Table 9: Plant height, and yield and yield attributes of potato as influenced by varieties and spray system during 2079

Treatments 30	Plant height (cm) (DAP)			Weight of different category of potato tuber size (kg/plot)			Total yield (kg/ha)
	30	45	60	0-25 g	25-50 g	>50 g	
Varieties							
Kufri Jyoti	24.69ab	35.00a	33.80a	0.57b	0.97a	4.94ab	9017.00a
Janakdev	21.80b	29.84b	28.84b	0.60b	0.99a	4.72ab	8773.00ab
Desire	27.22a	35.91a	34.53a	0.81a	0.90a	5.46a	9971.00a
Khumal Ujjawal	15.43c	21.53c	22.42c	0.47b	0.77a	3.86b	7110.00b
SEm ±	1.11	1.73	1.51	0.06	0.10	0.36	631.70
LSD (P=0.05)	3.19	4.98	4.35	0.17	0.31	1.04	1814.00
Sprays							
Symptom based spray	21.96a	30.35a	28.65a	0.67a	1.06a	4.98a	9340.00a
System guided spray	22.81a	28.70a	29.18a	0.54a	0.76b	4.23a	7707.00a
No spray	22.08a	32.67a	31.87a	0.62a	0.90ab	5.03a	9105.00a
SEm ±	0.96	1.50	1.31	0.05	0.09	0.31	547.00
LSD (P=0.05)	2.76	4.31	3.76	0.15	0.27	0.90	1571.00
CV, %	14.99	17.04	15.20	29.84	36.08	23.05	21.74
Grand mean	22.28	30.57	29.90	0.61	0.91	4.75	8717.59

Note: DAP: days after planting; means followed by the common letter (s) within a column are non-significantly different based on DMRT at P = 0.05

3.13 Population dynamics of tomato fruit borer

Tomato productivity in Nepal is around 18.01 t/ha, which is half of global productivity and far less than that of Southern Asia (MoALD 2020). Among many biotic factors that reduce tomato yield, tomato fruit borer *(Helicoverpa armigera*) is one of the major polyphagous pest which feeds on more than 15 crops (Vinutha et al 2013). In Asia, it affects more than 100 economically significant plants and greatly harms tomato crops in terms of both quality and quantity (Muthukumaran and Selvanarayan 2016). This insect is widespread across the country and is considered as the national priority pest in Nepal (Manandhar 1997). This pest is becoming a major threat of winter season tomato for the last few years in Nepal. Tomato is grown as an Autumn-Winter crop in Terai, inner Terai and foot hills of Nepal (Ghimire et al 2017). Monitoring of this pest was carried out in Khumaltar as well as in DoAR, Parwanipur.

The Heli-lure traps was installed one foot (30 cm) above the surrounding vegetables plant height. The adult's moths were attracted to sex pheromone (Heli-lure) traps. The traps were installed at density of 4-5/hectare. Extraction (removal from trap), target screening (sorting of moths that appeared to be Helicoverpa, proper identification) was carried out in every alternate day throughout the year. Similarly, the damage level to the vegetable fruits grown in nearby vicinity like tomato and brinjal was monitored whenever possible. The population dynamics of tomato fruit borer was recorded from Push (2079) to Asadh (2080). Population of pest monitored in 2 days interval.

At Khumaltar and Parwanipur, Herli-lure traps were kept from February to July 2022. Very few numbers of *H. armigera* adults were trapped. There were only one, two and one moths were observed in March, May and June, respectively.

3.14 Consortium for scaling-up climate smart agriculture in South Asia (C-SUCSes)

3.14.1 Inventory of Climate Smart Agriculture (CSA) Technology

An inventory report of Climate Smart Agriculture (CSA) technology developed in Nepal was compiled. The major source of information were the Nepal Agricutlural Research Council (NARC), Agriculture and Forestry University (AFU), Institute of Agricuture and Animal Science (IAAS) and NGOs and INGOs like LIBIRD, CEAPRED, ICIMOD etc. The informations were collected from the proceedings, annual reports, leaflets, booklets and journal articles etc. A list of CSA technologies (51 technologies) documented for different cropping system (rice-rice, rice-wheat, rainfed mixed, and highland mixed).

3.14.2 Participatory research on climate smart agriculture technologies in Nepal

A draft copy of Participatory research on climate smart agriculture technologies in Nepal was submitted to Consortium for scaling-up climate smart agriculture in South Asia (C-SUCSes) project. The main objective of this Participatory Research

(PR) was to carry out validation and viability assessment of CSA technologies (AWD, DSR and drip irrigation) through participatory research with farmers and to enhance farmers' adaptive capacity to the changing climate with the adoption of appropriate CSA technologies. Participatory research is a learning platform for researchers also. Thus, these participatory research in Terai and hill agro-ecosystem will be helpful in the promotion of sustainable agriculture in Nepal.

Validation/viability assessment of CSA technologies through participatory research

1. Alternate wetting and drying (AWD) system of rice cultivation in spring rice

AWD system of rice cultivation was conducted under DSR field during spring season of 2079/80 with one farmer (Mr. Abhay Yadav) at Bijbania, Parsa. The total area of land was 1 ha. Laser land leveller was used to levelling the field and zero-till seed drill was used for seeding. Seed rate used was 45 kg/ha and the rice variety used was Amardinath-1 which is short duration variety of 115 days. In case of fertilizer, DAP was used through zero-till seed drill while urea and potash was broadcasted manually. The next day after seeding, Pendimethalin (pre-emergence herbicide) @ 1000 g a.i. /ha (2500 ml/ha) as well as Bispyribac sodium 10% SC (Nominee Gold) (post-emergence herbicide) @ 25 g a.i./ha (250 ml/ha) 20 days after seeding (DAS) was applied. Sprayer with flat fan nozzle was used for spraying herbicides. The total yield obtained from this AWD spring rice was 6.3 t/ha.

Similarly, AWD system of rice cultivation was also practiced at Harnari and Kathar of Chitwan district and the number of participating farmer were 41 (21 at Harnari and 20 at Kathar) (Table 10), while it was practiced using rice transplanter in spring season. Rice variety used was Chaite-5 and the total area of rice cultivation was 3.32 and 3.2 ha in Harnari and Kathar, respectively. Seedlings were raised in seedling tray and seed rate used was 25 kg/ha. About 15 days old seedlings were used for transplanting. Pretilachlor 50% EC (pre-emergence herbicide) @ 500 g a.i./ha (1000 ml/ha) was applied one day after transplanting. Similarly, Bispyribac sodium 10% SC (Nominee Gold) (post-emergence) @ 25 g a.i./ha (250 ml/ha) was applied 25 days after transplanting.

In AWD, field water tube (pani pipe) having 4 inch in diameter and 30 cm in length was installed in field (3 tubes in 1 Kattha of land). The tube consisted of many perforated holes on all side of 20 cm length which was installed inside the soil while 10 cm length of tube was above the soil surface. Irrigation was applied till the water level in tube was 5 cm above the soil surface. When the water level was dropped to about 15 cm below the surface of the soil, irrigation was applied to re-flood the field to a depth of about 5 cm above the soil surface. It was implemented 2 weeks after transplanting of rice whereas in DSR, it was started when the plants were 10 cm tall.

Table 10. Yield of spring season rice from AWD system of rice cultivation at Harnari and Kathar, Chitwan during 2079/80

SN	Name of farmer	Address	Grain yield (kg/ha)	SN	Name of farmer	Address	Grain yield (kg/ha)
1	Krishna Karki	Harnari	5170	1	Anita Chaudhary	Kathar	5538
2	Keshab Bahadur Adhikari	Harnari	5890	2	Ashima Chaudhary	Kathar	5889
3	Deepa Bogati	Harnari	5760	3	Sumitra Chaudhary	Kathar	4979
4	Ambika Bogati	Harnari	5120	4	Dilramiya Devi	Kathar	5115
5	Deep Narayan Raut	Harnari	4760	5	Ranjana Chaudhary	Kathar	5218
6	Sharan Bahadur Bogati	Harnari	4240	6	Sita Pathak	Kathar	5331
7	Ram Lal Raut	Harnari	5050	7	Asmita Chaudhary	Kathar	3573
8	Suraj Bhusal	Harnari	5220	8	Subadi Chaudhary	Kathar	5925
9	Nim Nath Pokhrel	Harnari	4110	9	Shovani Chaudhary	Kathar	5386
10	Shri Ram Raut	Harnari	4390	10	Kamala Bhandari	Kathar	4979
11	Ram Bahadur Neupane	Harnari	4760	11	Debaki Chaudhary	Kathar	5472
12	Sumitra Thapa	Harnari	5010	12	Fulmati Chaudhary	Kathar	5114
13	Saraswati Adhikari	Harnari	4660	13	Binita Chaudhary	Kathar	6628
14	Dil Maya Neupane	Harnari	4120	14	Pusp Chaudhary	Kathar	5337
15	Dil Bahadur Neupane	Harnari	3990	15	Sabita Chaudhary	Kathar	4992
16	Laxmi Parajuli	Harnari	5390	16	Ramhari Pandey	Kathar	4471
17	Ram Bahadur Adhikari	Harnari	5290	17	Dipa Chaudhary	Kathar	4505
18	Man Kumar Neupane	Harnari	5110	18	Sabita Chaudhary	Kathar	4929
19	Hari Bahadur Bogati	Harnari	5090	19	Sulochana Chaudhary	Kathar	4846
20	Laxmi Sapkota	Harnari	5000	20	Daya Chaudhary	Kathar	4665
21	Tika Kumari Neupane	Harnari	4920				

2. Zero tillage (ZT) wheat

Zero tillage wheat was practiced in 54 farmers field of Bijbania, Parsa. The variety used was NL 971 and the total area was 18.44 ha. Seeding was accomplished using zero-till seed drill. Before seeding, laser land leveller was used for levelling the land. In case of fertilizer, DAP was used through zero-till seed drill while urea and potash was broadcasted manually. For weed management, Metribuzin (70 WP) , a post-emergence herbicide, was sprayed mixing 250 gram herbicide in 500 liter of water for 1 hectare of land and it was sprayed 30 days after seeding of wheat. Crop cut was done from 20 farmers field and yield data was recorded (Table 11).

Table 11. Yield of Zero Tillage (ZT) wheat at Bijbania, Parsa during 2079/80

S.N.	Name of farmer	Grain yield (kg/ha)	SN	Name of farmer	Grain yield (kg/ha)
1	Bhairav Lal Sah	3168	11	Nawal Yadav	5740
2	Abhay Yadav	5284	12	Bhulan Raut	5231
3	Jay Kishor Yadav	4012	13	Sahadul Raut	3794
4	Binay Yadav	1908	14	Rajendra Gaddi	4805
5	Hira Raut	2172	15	Hiraman Gaddi	3924
6	Parbati Devi	3482	16	Purna Dharm Sah	4144
7	Moti Kushwaha	3890	17	Rajesh Gaddi	3009
8	Mukesh Sah	3204	18	Rashula Jan	4304
9	Jay Narayan	2893	19	Mobarak	3202
10	Raju Raut	2331	20	Prem Prasad	3483

3. Direct Seeded Rice (DSR)

Participatory research on DSR technology was conducted at Bijbania, Parsa district during the rainy season of 2079. Six farmers were involved and the variety used was Bahuguni Dhan-2 (Table 12). They were supported with seed, fertilizer, herbicides and rental cost of machines. The total land under DSR were 45 kattha.

Table 12. Yield of Direct Seeded Rice (DSR) at Bijbania, Parsa during 2079

S.N.	Name of farmer	Grain yield (kg/ha)
1	Abhay Yadav	5100
2	Pun Ram Sah	4062
3	Naresh Yadav	4148
4	Sharif Gaddi	4582
5	Binay Yadav	4722
6	Jay Kishor Yadav	4888

DSR is being practiced in 29 farmers field of Bijbania, Jamuniya, Khalucadi, Belwa and Parsagadhi of Parsa district during the rainy season of 2080 (Table 13) and the total area is 8.54 ha. Laser land leveler was used in 11 farmers field (3.93 ha land). Zero-till seed drill was used for seeding. Seed rate used was 45 kg/ha and the rice variety used was Bahuguni-2. In case of fertilizer, DAP was used through zero-till seed drill while urea and potash was broadcasted manually. The next day after seeding, Pendimethalin (pre-emergence herbicide) @ 1000 g a.i. /ha (2500 ml/ha) as well as Bispyribac sodium 10% SC (Nominee Gold) (post-emergence) @ 25 g a.i./ha (250 ml/ha) 20 DAS was applied. Crop yield was recorded based on crop cutting data from 6 farmers field. All the activities of Parsa district were implemented by Agriculture Implement Research Center, NARC, Ranighat, Birgunj, Parsa.

Table 13. List of farmers adopting direct seeded rice (DSR) at Parsa during 2080

S.N	Name of farmer	Address	Area (ha)	SN	Name of farmer	Address	Area (ha)
1	Jaykishor Pd. Yadav	Bijwaniya	1.69	16	Jaynarayan	Bijwaniya	0.17
2	Purna Dharm Sah	Bijwaniya	0.17	17	Prem Prasad	Bijwaniya	0.17
3	Hira Raut	Bijwaniya	0.20	18	Moti Kushwaha	Jamuniya	0.17
4	Abhay Yadav	Bijwaniya	0.30	19	Jaynarayan	Jamuniya	0.17
5	Kapil Dev Ram	Bijwaniya	0.17	20	Nagina yadav	Jamuniya	0.24
6	Motor Ram	Bijwaniya	0.17	21	Mojaahir Miya	Khalucadi	0.34
7	Bhairav Lal Sah	Bijwaniya	0.17	22	Loha Singh	Khalucadi	0.34
8	Binay Yadav	Bijwaniya	0.17	23	Ram Sewak	Jamuniya	0.14
9	Raju Raut	Bijwaniya	0.17	24	Nagendar	Jamuniya	0.17
10	Bhikari Raut	Bijwaniya	0.17	25	Anurud Chaudhary	Belwa	1.00
11	Nawal Yadav	Bijwaniya	0.17	26	Yubraj Thapa	Parsagadi-03	0.68
12	Rajesh Gadi	Bijwaniya	0.17	27	Krishna Paudeyal	Parsagadi-03	0.34
13	Rashulajan	Bijwaniya	0.17	28	Rita Thapa	Parsagadi-03	0.41
14	Mobarak	Bijwaniya	0.17	29	Bhim Bdr. Thapa	Parsagadi-03	0.68
15	Moti Kushwaha	Bijwaniya	0.17				

4. Drip irrigation

Drip irrigation system of water smart CSA technology was practiced under plastic house of 8 farmers of Dhunibeshi-9, Jugedi of Dhading district (Table 14). Similarly, it was practiced in 11 and 20 farmers of Thakurichaap, Kavre district and Baradi, Tanahu, district, respectively (Table 15 and 16). The cropping system of these sites were high-land mix. It is the cost-effective method for making the best use of limited available water.

Table 14: List of farmers adopting drip irrigation at Dhunibeshi-9, Jugedi, Dhading district during 2079

S.N.	Name of the Farmer	Locality
1.	Ramesh Rai	Jugedi, Dhading
2.	Rama Rai	Jugedi, Dhading
3.	Jaymita Rai	Jugedi, Dhading
4.	Shova Rai	Jugedi, Dhading
5.	Binita Rai	Jugedi, Dhading
6.	Bhagwati Rai	Jugedi, Dhading
7.	Samjhana Rai	Jugedi, Dhading
8.	Chameli Rai	Jugedi, Dhading

A water tank is installed on above the level of field and lateral pipes were laid out. Then planting holes were dug along the lateral pipes which were spaced to overlap with the drip holes. These holes are set at every 60 cm along the pipes. FYM and chemical fertilizers were placed in pits and mixed well with the soil and seedlings of tomato were planted in each hole. Irrigation was applied during morning or evening. For the implementation of these CSA technologies, farmers were provided with drip irrigation sets, seed, fertilizers and pesticides from the project.

Table 15. List of farmers adopting drip irrigation at Thakurichaap, Kavre during 2080

SN	Name of the Farmer	Locality	SN	Name of the Farmer	Locality
1.	Debaki Malla	Thakurichaap, Kavre	7.	Deb Raj Shah	Thakurichaap, Kavre
2.	Sandhya Shahi	Thakurichaap, Kavre	8.	Gun Kumari Shah	Thakurichaap, Kavre
3	Deepa Malla	Thakurichaap, Kavre	9.	Renku Shrestha	Thakurichaap, Kavre
4.	Shanti Malla	Thakurichaap, Kavre	10	Shova KC	Thakurichaap, Kavre
5.	Ram Kr. Malla	Thakurichaap, Kavre	11	Reeta Malla	Thakurichaap, Kavre
6.	Narayan Malla	Thakurichaap, Kavre			

Table 16. List of farmers adopting drip irrigation at Tanahu, district during 2080

SN	Name of the Farmer	Locality	SN	Name of the Farmer	Locality
1.	Hemendra KC	Dhaap	11.	Laxmi Gauli	Dihi
2.	Diwas Ghimire	Dhaap	12.	Sabita Pokhrel	Dihi
3	Ram Bdr. Ghimire	Dhaap	13.	Radhika Mishra	Baradi
4.	Bir Bahadur Khanal	Samastipur	14.	Ganga Mishra (Bagale)	Dumri Danda
5.	Pabitra Chauhan	Dhaap	15.	Bishnu Prasad Bagle	Dihi
6.	Kabita Mishra	Dihi	16.	Laxmi Bagle	Dihi
7.	Kopila Amgain	Dihi	17.	Sharala Pokhrel	Dihi
8.	Sakuntala Bagle	Dihi	18.	Sandhya Pokhrel	Baradi
9.	Sharmila Bagle	Dihi	19.	Samsher Pariyar	Dumri Danda
10.	Laxmi Sapkota	Dihi	20.	Bimala Gauli	Baradi

5. Intercropping of maize with soybean

Maize based intercropping is popular in mid hills of Nepal. Soybean is ideal crop for intercropping due to its comparative tolerance for shade and drought. Maize intercropping with soybean was practiced in 15 farmers field of Thakurichaap, Kavre district and the total area was 0.8 ha (Table 17). There was 3 types of treatment combinations. In first treatment, 1 line of maize and 1 line of soybean and row to row distance between maize was 90 cm; in second treatment 2 rows of soybean and one row of maize and row to row distance between maize was 150 cm; and in third treatment (farmers practice), 1 row maize and one row soybean and the distance between maize and soybean was 40 cm.

Table 17. List of farmers involved in intercropping of maize with soybean at the participatory research site of Thakurichaap, Kavre during 2080

SN	Name of the Farmer	Locality	SN	Name of the Farmer	Locality
1.	Narayan Malla	Thakurichaap	9	Shanti Malla	Thakurichaap
2.	Ganesh Shahi	Thakurichaap	10	Dev Raj Shah	Thakurichaap
3	Sudan Malla	Thakurichaap	11	Gun Kumari Shah	Thakurichaap
4.	Daan Beer Shah	Thakurichaap	12	Shanti Thakuri	Thakurichaap
5.	Dhan Bahadur Malla	Thakurichaap	13	Ambika Malla	Thakurichaap
6.	Renku Shrestha Shahi	Thakurichaap	14	Deepa Malla	Thakurichaap
7	Sandhya Shahi	Thakurichaap	15	Narayan Malla	Thakurichaap
8	Ram Kumar Malla	Thakurichaap			

3.14.3 Farmers training on CSA Technology

1. Thakurichaap, Kavre

A one-day farmers training was conducted at Participatory Research site Thakurichaap, Kavre. The title of the training was “Farmers Participatory Training on Climate Smart Agriculture Technologies”. The training was conducted on 25th Asar 2080 and the total number of participants was 19.

2. Baradi, Tanahu

A one-day farmers training was conducted at Participatory Research site Baradi, Tanahu. The title of the training was “Farmers Participatory Training on Climate Smart Agriculture Technologies”. The training was conducted on 28th Asar 2080 and the total number of participants was 20 (Table 18).

Table 18. List of farmers involved in training entitled “Farmers’ Participatory Training on Climate Smart Agriculture Technologies” at Thakurichaap, Kavre and Baradi, Tanahu during 2080

SN	Name of the Farmer	Place	SN	Name of the Farmer	Place
1.	Uday Bahadur Ranabhat	Thakurichaap	1	Ram Bahadur Ghimire	Baradi
2.	Khum Nath Dhungel	Thakurichaap	2	Bir Bahadur Khanal	Baradi
3.	Raj Bikram Malla	Thakurichaap	3	Shamsher Pariyar	Baradi
4.	Krishna Bahadur KC	Thakurichaap	4	Diwas Ghimire	Baradi
5.	Shova KC	Thakurichaap	5	Bishnu Bagle	Baradi
6.	Laxmi Sintan	Thakurichaap	6	Ganga Bagale	Baradi
7.	Narayan Malla	Thakurichaap	7	Radhika Mishra	Baradi
8.	Rita Malla	Thakurichaap	8	Sabita Pokhrel	Baradi
9.	Makhan Ranabhat	Thakurichaap	9	Laxmi Gauli	Baradi
10.	Parbati Basnet	Thakurichaap	10	Laxmi Sapkota	Baradi
11.	Laxmi Tamang	Thakurichaap	11	Sharmila Bagle	Baradi
12.	Ganesh Shahi	Thakurichaap	12	Laxmi Bagle	Baradi
13.	Sudan Malla	Thakurichaap	13	Kabita Mishra	Baradi
14.	Daan Bikram Shah	Thakurichaap	14	Kopila Amgain	Baradi
15.	Dhaan Bahadur Malla	Thakurichaap	15	Sakuntala Bagle	Baradi
16.	Kabi Raj Malla	Thakurichaap	16	Pabitra Chuman	Baradi
17.	Renku Shrestha Shahi	Thakurichaap	17	Sandhya Acharya	Baradi
18.	Raj Kumari Shahi	Thakurichaap	18	Saral Pokhrel	Baradi
19.	Sita Malla	Thakurichaap	19	Dhurba Babu Gauli	Baradi
			20	Bimala Gauli	Baradi

3. Parsagadhi-3, Auraiya, Parsa

A one-day farmers training was conducted at Participatory Research site Parsagadhi-3, Auraiya, Parsa. The title of the training was "Technology transfer training to participating farmers about CSA technologies and scaling-up of DSR and zero-tillage technology through capacity building of youth farmers". The training was conducted on 4th Asar 2080 and the total number of participant was 33 (Table 19).

Table 19. List of farmers involved in technology transfer training to participating farmers about CSA technologies at Parsagadhi-3, Auraiya, Parsa during 2080

SN	Name of the Farmer	Locality	SN	Name of the Farmer	Locality
1	Arjun Nepal	Parshagadi-03	18	Dhrub Basnet	Parshagadi-03
2	Narayan Prasad Paudel	Parshagadi-03	19	Krishna Paudeyal	Parshagadi-03
3	Yam Maya Thapa	Parshagadi-03	20	Jibnaga Dhakal	Parshagadi-03
4	Rita Thapa	Parshagadi-03	21	Bal Krishna Aaryal	Parshagadi-03
5	Juna Thapa	Parshagadi-03	22	Prem Bastakoti	Parshagadi-03
6	Bhima Thapa	Parshagadi-03	23	Yubraj Thapa	Parshagadi-03
7	Hiramati Thapa	Parshagadi-03	24	Bishnu Prasad Dahal	Parshagadi-03
8	Devkumari Thapa	Parshagadi-03	25	Hem Pd. Neupane	Parshagadi-03
9	Gauri Thapa	Parshagadi-03	26	Bikki Thapa	Parshagadi-03
10	Bhuma Adhikari	Parshagadi-03	27	Lalita Devi	Parshagadi-03
11	Asha Bogati	Parshagadi-03	28	Kumari Thapa	Parshagadi-03
12	Rupa Thapa	Parshagadi-03	29	Ashok Burlakoti	Parshagadi-03
13	Runa Dogi	Parshagadi-03	30	Sarsawati Thapa	Parshagadi-03
14	Mina Thapa	Parshagadi-03	31	Laxmi Koirala	Parshagadi-03
15	Aashika Thapa	Parshagadi-03	32	Ram prasad Subedi	Parshagadi-03
16	Bhim Bdr. Thapa	Parshagadi-03	33	Ruja Thapa	Parshagadi-03
17	Dira Bahadur thapa	Parshagadi-03			

4. TECHNOLOGY TRANSFER AND SERVICES

Services

Information regarding climate change and climate smart agriculture technologies, was provided to various concern stakeholders.

Publications

Annual report of the fiscal year 2078/79 was published and distributed to several institutions. (Annex 5).

Information through media

Various interviews related to climate change and its impact on Nepalese agriculture were broadcasted/published on various media. E-copies of the weekly agro-meteorological advisory bulletin were published and distributed to the concerned stakeholders through mails and other media.

5. VISITS

The Center was visited by students from Tribhuvan University, Agriculture and Forestry University, CTEVT and personnel's from NGOs, INGOs, GOs regarding meteorological and climate change information.

6. OTHER ACTIVITIES

Participation in different training and workshop by different personals from the centre is given in Annex 6.

7. BUDGET AND EXPENDITURE

The total annual budget and expenditure of the centre for regular projects are provided in detail in from Annex 8. The budget and expenditure of special project (C-SUCSeS) is given in Annex 9. Revenue generated from various activities and arrear (beruju) status of the centre is provided in Annex 10 and Annex 11, respectively.

8. KEY PROBLEMS

- Insufficient technical human resources to represent different disciplines.

9. WAY FORWARD

- Expansion of climate change related research activities to other research stations.
- Establishment of Environment Unit in each Agricultural Research Directorate and commodity program of NARC.
- Strengthening human resource and laboratory facilities to conduct climate change related research work in NARC system.
- Coordination with different organizations to provide agro-met advisory based on weather forecasting for agriculture use.

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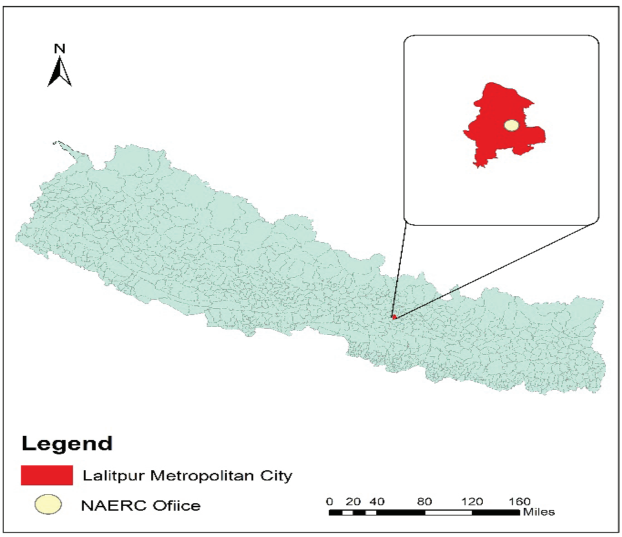
11. ANNEXES

Annex 1: Monthly meteorological data of Khumaltar, Lalitpur during 2079/80 (2022/23)

Month/Year	Mean Temperature (^{0}C)		Total rainfall (mm)	Rainy days
	Maximum	Minimum		
July 2022	25.4	20.0	263.6	23
August 2022	25.4	19.0	192.9	18
September 2022	28.1	19.8	121.1	16
October 2022	26.0	14.2	107.7	8
November 2022	23.5	8.3	0.0	0.0
December 2022	16.6	4.4	0.0	0.0
January 2023	19.7	3.1	0.0	0.0
February 2023	22.2	6.6	9.4	1
March 2023	23.0	9.6	58.9	8
April 2023	25.6	11.6	40.8	7
May 2023	27.0	14.3	109.8	16
June 2023	29.9	19.7	203.9	17
Mean/Total	**24.09**	**10.80**	**1108.1**	**114**

Annex 2: Location of office in NAHRC facility, Khumaltar



Annex 3: Human Resources in NAERC during 2079/80

S.N.	Name	Designation	Qualification	Specialization	Remarks
1	Dr. Tika Ram Chapagain	Chief and Senior Scientist (S-4)	PhD	Horticulture	Till 2079/12/14
2	Mr. Amar Bahadur Pun Magar	Chief and Senior Scientist (S-4)	M.Sc. Ag	Horticulture	Since 2080/01/03
3	Mr. Bishnu Prasad Paudel	Senior Scientist (S-3)	M.Sc. Ag	Soil Science	
4	Dr. Pradeep Shah	Scientist (S-2)	PhD	Agronomy	
5	Mr. Alok Sharma	Technical Officer (T-6)	M.Sc. Ag	Pasture and Agroforestry	
6	Mr. Rameshwar Rimal	Technical Officer (T-6)	M. Sc. Meteorology	Meteorology	
7	Mr. Ram Kumar Rai	Admin. Officer (A-6)	M.A.	Administration	
8	Ms. Chandra Kala Silwal	Admin. Officer (A-6)	B.A.	Administration	Since 2080/03/27
9	Mr. Krishna Prasad Pokhrel	Account Officer (A-6)	B. Com.	Account	
10	Mr. Hem Lal Bhandari	Technician (T-5)	M.Sc. Ag	Agri. economics	
11	Mr. Raj Kumar Chalise	L. V. Driver (Level V)	Literate		
12	Mrs. Reena Maharjan	Technician (T-1, Level II)	Literate		

Annex 4: Summary of progress of NARC research projects and activities in 2079/80 (2022/23)

Project code no.	Name of project/activity	Project/ Activity Leader	End Year	Major progress/achievements
1	Farm management and Research Support Project	Tika Ram Chapagain		
Activity 1	Farm security and maintenance	Tika Ram Chapagain		Farm security well maintained
Activity 2	Research support	Tika Ram Chapagain		All research supports made available as per requirements
Activity 3	Annual Report and other publication	Tika Ram Chapagain		100 units of annual report was published
224	Assessing vulnerability of Climate Variability/ Change in Agriculture	Tika Ram Chapagain		
Activity 1	Collection, Processing and dissemination of met data of various location of Nepal	Rameshwar Rimal		Data collected.
Activity 2	Weather pattern analysis under rice-wheat cropping system in Bara district	Pradeep Shah		Overall climate patterns of weather variables like temperature, rainfall and relative humidity of past 30 years of Bara district was analyzed and a household survey was conducted using semi-structured questionnaire consisting of 100 farmers i.e. 31 from Jeetpur Simara Sub-metropolitan city, ward no. 11; 35 from Feta ward no.1; and 34 from Karaiyamai Rural Municipality, ward no. 5.
Activity 4	Estimation of CO_2 sequestration by Mango and Litchi fruit trees in Rautahat district	Bishnu Paudel, Hemlal Bhandari		Carbon sequestration capacity of mango and litchi tree was measured from the different farms of Rautahat districts of Nepal. A total of 145 of mango and 126 of litchi trees were sampled from different farms. The carbon sequestration by litchi trees (ton/tree) was found based on diameter and the age of the trees.
Activity 5	Survey on pasture grazing area of Solukhumbu district	Alok Sharma		Effect of climate change on pasture grazing area of Solukhumbu district was analyzed through household survey using semi-structured questionnaire consisting of 23 farmers i.e. 12 from Dudhkunda, 6 from Takasindhun and 5 from Nele.

Project code no.	Name of project/activity	Project/ Activity Leader	End Year	Major progress/achievements
Activity 6	Performance study of tomato under elevated temperature	Pradeep Shah, Hemlal Bhandari		Four tomato genotypes (HRDTOM, AVTO 1705, AVTO 0922, and AVTO 1422) were evaluated in open top chamber (OTC) and open field condition.
228	Generation of weather forecast based agro-advisory	Rameshwar Rimal	2080	
Activity 1	Generation of weather forecast based weekly Agro Advisory Bulletin (AAB)	Rameshwar Rimal	2080	In total, 52 episodes of the weekly agro-met advisory bulletins were prepared and disseminated by the centre.
Activity 2	Roaving Seminar for farmers	R Rimal, expert members	2080	This activity was not accomplished due to budget cut down by the government of Nepal.
Activity 3	Stakeholders interaction workshop on importance of AAB	R Rimal, NAERC staffs	2080	This activity was not accomplished due to budget cut down by the government of Nepal.
Activity 4	Sharing adaptation strategies on climate resilient technologies to the farmers of NARC technology village	Rameshwar Rimal	2080	This activity was not accomplished due to budget cut down by the government of Nepal.
713	Development of Forecasting Model for Potato Leaf Blight and Fruit Borer in Nepal	TR Chapagain	2082	
Activity 1	Explore prevalence of late blight of potato and fruit borer in nearby vicinity	Pradeep Shah, Hemlal Bhandari		In Khumaltar, very few fruit borer adults were recorded. In summer season potato, no prevalence of late blight recorded.
Activity 2	Scoring disease incidence of potato late blight	Pradeep Shah, Hem Lal Bhandari		No late blight appeared in late season potato
Activity 3	Establishment of heli-lure trap and data collection	Pradeep Shah, Rameshwar Rimal		The population dynamics of tomato fruit borer monitored from Push (2079) to Asadh (2080) using helilure pheromone traps showed the lowest population of pest (1 or 2 moths/month) in Khumaltar and Parwanipur, Bara of Nepal.
Activity 4	Collection of weather parameters	Rameshwar Rimal		Information collected.

Annex 5: Publications in 2079/80 (2022/23)

S. N.	Title of publication	Type	Language	Author	No. of copies
1.	Annual Report 2078/79 (2021/22). National Agricultural Environment Research Centre, Khumaltar, Lalitpur, Nepal	Report	English	National Agricultural Environment Research Centre, Khumaltar	100

Annex 6: Training/workshop/seminar attended by staff in 2079/80 (2022/23)

S. N.	Name of staff	Position	Name of Training/ seminar/workshop	Duration	Place/Country	Organizer
1	Rameshwar Rimal	Technical officer (T6)	Advanced Course on Climate Resilient Agriculture (CRA)	13 Mangsir-4 Poush, 2079	Ludhiana and Jabalpur, India	BISA
2	Hemlal Bhandari	JT T5	Advanced Course on Climate Resilient Agriculture (CRA)	13 Mangsir-4 Poush, 2079	Ludhiana and Jabalpur, India	BISA
3	Tika Ram Chapagain	Chief	Inception Workshop of ACASA project	11-15 Baisakh, 2080	Delhi, India	BISA/ CIMMYT
4	Amar Bdr. Pun Magar	Chief	Inception Workshop of ACASA project	11-15 Baisakh, 2080	Delhi, India	BISA/ CIMMYT
5	Pradeep Shah	Scientist (S2)	Inception Workshop of ACASA project	11-15 Baisakh, 2080	Delhi, India	BISA/ CIMMYT
6	Rameshwar Rimal	Technical officer (T6)	Inception Workshop of ACASA project	11-15 Baisakh, 2080	Delhi, India	BISA/ CIMMYT
7	Hemlal Bhandari	Technical assistant (T5)	Inception Workshop of ACASA project	11-15 Baisakh, 2080	Delhi, India	BISA/ CIMMYT
8	Tika Ram Chapagain	Chief			Sikkim, India	ICIMOD

Annex 7: Regular Annual Budget and Expenditure Record of F.Y. 2079/80 (2022/23)

Rs. in '000

B. Code	Budget Heads	Approved Annual Budget	Released Budget	Expenses	Balance
Budget Sub-Heading No.: 312411014 Capital Expenses					
31122	Machinery and Equipments	400.00	298.32	298.32	101.68
31161	Structural Improvement Expenses of the Constructed Building	400.00	375.63	375.63	24.37
	Total	**800.00**	**673.95**	**673.95**	**126.05**
Budget Sub-Heading No.: 312411013 Recurrent Expenses					
21111	Staff Salary	8012.00	7685.89	7685.89	326.11
21121	Uniform Expenses	110.00	90.00	90.00	20.00
21132	Dearness allowances	264.00	246.00	246.00	18.00
21124	Staff Meeting allowances	1560.00	1204.70	1204.70	355.30
21213	Contribution-based Insurance Fund Expenses	51.40	49.20	49.20	2.20
22111	Electricity and Water Supply Expenses	72.00	70.35	70.35	1.65
22112	Communication Expenses	120.00	82.00	82.00	38.00
22212	Fuel (Office Uses)	618.00	554.85	554.85	63.15
22213	Vehicle Repair and Maintenance	320.00	278.48	278.48	41.52
22214	Insurance and Renewal Expenses	89.00	87.90	87.90	1.10
22221	Repair and Maintenance of Machinery and Equipment	159.00	127.00	127.00	32.00
22231	Repair and Maintenance Expenses of the Constructed Public Assets	0.00	0.00	0.00	0.00
22291	Operation and Maintenance of Other Assets	119.00	93.92	93.92	25.08
22311	Stationary and Office Expenses	324.00	275.43	275.43	48.57
22313	Books and Materials Expenses	32.00	12.80	12.80	19.20
22314	Fuel for Other Use	21.00	19.00	19.00	2.00
22315	Newspaper, Printing and Notice Publication Expenses	1749.00	50.00	50.00	1699.00
22413	Contract Service	327.00	230.29	230.29	96.71
22512	Skill Development, Public Awareness Training and Workshop Expenses	609.00	0.00	0.00	609.00
22521	Farm Supplies and Service Cost	1517.00	1053.54	1053.54	463.46
22522	Program Expenses	300.00	95.62	95.62	204.38
22611	Monitoring Evaluation Expenses	280.00	154.18	154.18	125.82
22612	Travel Expenses	1225.00	843.48	843.48	381.52
22711	Miscellaneous Expenses	236.00	205.85	205.85	30.15
28143	Vehicle and Mechinary Equipment Rent	140.00	115.03	115.03	24.97
	Total	**18254.40**	**13625.51**	**13625.51**	**4628.89**
	Grand Total	**19054.40**	**14299.46**	**14299.46**	**4754.94**

Annex 8: SAARC/C-SUCSeS Project Annual Budget and Expenditure Record, F.Y. 2079/80 (2022/23)

Rs. in '000

B. Code	Budget Heads	Approved Annual Budget	Released Budget	Expenses	Balance
21135	Staff Incentive	545.75	543.93	543.93	1.82
22112	Communication Expenses	25.00	18.07	18.07	6.93
22212	Fuel (Office uses)	310.00	270.10	270.10	39.90
22221	Repair and Maintenance of Machinery and Equipment	50.00	46.97	46.97	3.03
22311	Stationary and Office Expenses	45.00	45.00	45.00	0.00
22315	Newspaper, Printing and Notice Publication Expenses	128.00	0.00	0.00	128.00
22512	Skill Development, Public Awareness Training and Workshop Expenses	410.00	344.17	344.17	65.83
22521	Farm Supplies (Wages)	75.00	65.95	65.95	9.05
22521	Farm Supplies (Farm supplies)	714.04	657.96	657.96	56.08
22611	Monitoring Evaluation Expenses	50.00	43.39	43.39	6.61
22612	Travel Expenses	400.00	376.77	376.77	23.23
22711	Miscellaneous Expenses	70.00	60.20	60.20	9.80
28143	Vehicle and Mechinary Equip. Rent	50.00	9.70	9.70	40.30
31122	Machinery and Equipments	250.00	0.00	0.00	250.00
	Total	**3122.79**	**2482.18**	**2482.18**	**640.61**

Annex 9: Revenue Status of F.Y. 2079/80 (2022/23)

Source	Total (Rs.)	Remarks
Crop and Horticulture Research	0.00	0.00
Administrative income	15,249.63	15,249.63
Total	15,249.63	15,249.63

Annex 10: Status of Arrears (Beruju) during FY 2078/79 (2021/22)

Description	Total Arrears	Arrears Cleared	Arrears Leftover
F.Y. 2060/61 to 2076/77	4,300.00		4,300.00
F.Y. 2077/78	72,500.00		72,500.00
Total	**76,800.00**		**76,800.00**

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