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Agricultural Environment Research Division

Khumaltar, Lalitpur, Nepal

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Agricultural Environment Research Division (AERD)
Nepal Agricultural Research Council (NARC)
Khumaltar, Lalitpur
Tel: 977-1-5535981
Email: env@narc.gov.np, env.narc@gmail.com
URL: http://www.narc-env.gov.np, http://www.narc.gov.np

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FOREWORD

An Assessment of agriculture related environmental issues like global warming, climate change, their consequences on agricultural sector and mitigation of the consequences should be prime needs of the country. Agricultural Environment Research Division (AERD) working under Nepal Agricultural Research Council (NARC) has initiated diverse works on such issues independently or in collaboration with different organizations and stakeholders. Efforts are being made to develop a hub for the climatic database of different locations of Nepal to study their seasonal and annual trend. AERD has started studying the temporal and spatial adaptive capacity of different varieties of various crops under the elevated temperature conditions to find out adaptive measures against the effects of climate change. Estimating GHGs from different agricultural sectors, management practices and locations are also some of the working areas of this division.

This annual report presents the detail activities and upshots of the research activities conducted in the FY 2073/74 by the division. It is expected that this annual report will serve as a useful resource to agricultural researchers, extension personnel, students and national policy makers.

I am very much thankful to Mr. SK Rai, Mr. G Malla, Mr. Bishnu P. Paudel, Mr. R Rimal, Mr. A Sharma, Mr. HP Devkota and Mr. HL Bhandari for their precious contributions to carry out all the activities of the Division. My special thanks to Mr. Bishnu P. Paudel for preparation of the manuscript of this report. Also, I would like to appreciate the hard work of Mrs. Y Kunwar, Mr. P Sah and Mr. RK Chalise for their logistics and other supports. Nepal Agricultural Research Council (NARC) holds recognition for its financial support. I would sincerely appreciate the constructive comments and suggestions for the improvement of the report in days ahead.

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Deepak Bhandari, Ph.D.
Principal Scientist and Chief
Agricultural Environment Research Division (AERD)
Khumaltar, Lalitpur, Nepal

LIST OF ABBREVIATIONS

°C	Degree Centigrade
°F	Degree Fahrenheit
AGB	Above Ground Biomass
AERD	Agricultural Environment Research Division
ARS	Agriculture Research Station
Av.	Average
AWS	Automatic Weather Station
BGB	Below Ground Biomass
BP	Branches per Plant
BY	Bio-mass Yield
CC	Climate Change
CDR	Central Development Region
CO_2	Carbon di-oxide
CO_2- C	Carbon in CO_2 form
Cms	Centimetres
DF	Days to Flowering
DHM	Department of Hydrology and Meteorology
DM	Days to Maturity
F.Y.	Fiscal Year
FM	Flat with Mulch
FNM	Flat with No mulch
GHGs	Greenhouse Gases
GS	Grains per Spike
GY	Grain Yield
ha	hectare
Hr	Hour
HP	Hills per Plot
IPCC	Intergovernmental Panel on Climate Change
Kg	Kilogram
kg/ha/yr	kilogram per hectare per year
m^2	Square meter
Mg	Milligram
Mm	Millimetre
MoAD	Ministry of Agricultural Development
MoE	Ministry of Environment
MT	Minimum Tillage
$N:P_2O_5:K_2O$	Nitrogen, Phosphorous, Potash
NARC	Nepal Agricultural Research Council
OTC	Open Top Chamber
PLH	Plant Height

RARS	Regional Agricultural Research Station
SP	Seeds per Pod
t/ha	ton per hectare
t/ha/yr	ton per hectare per year
Temp.	Temperature
TGW	Test Grain Weight
TH	Tillers per Hill
Tmax	Maximum temperature
Tmin	Minimum temperature
TR	Tillers per Row
Wt	Weight

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सारांश

कृषि वातावरण अनुसन्धान महाशाखाबाट वातावरण मैत्री विभिन्न अनुसन्धान र मौसम परिवर्तनका कारण बालीमा पर्न सक्ने जोखिम सम्बन्धी अध्ययन हुदै आइरहेको छ । साथै अन्य सीपमूलक कार्यक्रम, क्रप मोडेलिंग, कार्वन स्थिरिकरण र कार्वन उत्सर्जन सम्बन्धी अध्ययन तथा अनुसन्धानात्मक कार्यक्रम संचालन भइरहेको छ । जलवायु परिवर्तन र यसले कृषि प्रणालीमा पार्ने असर सम्बन्धी जानकारीलाई उच्चतम प्राथमिकतामा राखी नया नया अनुसन्धान केन्द्रहरुमा स्वचालित मौसम मापन प्रणाली स्थापना गर्दै आएको छ ।

आ.व. २०७३/७४ देखि जलवायु समुत्थान निर्माण आयोजना (पि.पि.सि.आर.) अन्तर्गत २५ जिल्लामा कृषि मौसम सल्लाह सेवा बुलेटिन मार्फत कृषकहरुलाई सेवा पुर्याई रहेको छ । यस बाहेक यस महाशाखाले विभिन्न राष्ट्रिय अन्तराष्ट्रिय संघ संस्था, अनुसन्धान केन्द्र र कृषि अनुसन्धानमा संलग्न विद्यार्थीहरुलाई कृषि तथा मौसम सम्बन्धी संकलित तथ्याङ्कहरु उपलब्ध गराउदै आएको छ । यस महाशाखाबाट संचालन गरिएका अनुसन्धानात्मक अध्ययनहरुबाट आ.व. २०७३/७४ मा निम्न अनुसारका अनुसन्धान परिणामहरु प्राप्त भएका छन् ।

- बढ्दो तापक्रमको अवस्थामा ओपन टप चेम्बर (OTC) मा धानको जातहरुको परिक्षण गर्दा खुमल-८ को उत्पादन खुला फिल्डमा भन्दा कम पाइयो भने NR 1005, BB27 र खुमल १० को उत्पादन चेम्बरमा (बढ्दो तापक्रममा) खुल्ला फिल्डमा भन्दा बढी पाईयो ।
- डाँफे, डब्लु.के.१२०४, स्वर्गद्वारी र धौलागिरी गहुँका जातहरुको उत्पादन फिल्डमा भन्दा चेम्बरमा (बढ्दो तापक्रममा) कम पाइयो ।
- विभिन्न बालीमा गरिएको CO_2-C उत्सर्जन सम्बन्धी अध्ययनमा सबैभन्दा बढी खुसानीमा ३२२ मिग्रा/वर्ग मी./घण्टा र सबैभन्दा कम १०१ मि.ग्रा./वर्ग मी./घण्टा गहुँमा पाइयो ।
- गहुँमा छापो प्रयोग गर्दा (८४.५ मि.ग्रा/वर्ग मी./घण्टा) भन्दा छापो प्रयोग नगर्दा बढि ११७ मि.ग्रा/वर्ग मी./घण्टा CO_2-C उत्सर्जन गरेको पाईयो ।
- फलफूलका बिरुवामा कार्बन स्थिरिकरणको अध्ययनमा सुन्तला जातका बिरुवाले कम समयमा बढि स्थिरिकरण गरेको पाइयो भने फलफूलमा स्थिरिकरणको मात्रा बिरुवाको उमेर र बोटको उचाईमा निर्भर रहेको पाइयो ।
- कपिलवस्तु र रसुवा जिल्लामा गरिएको जलवायु परिवर्तन र त्यसको कृषिमा परेको असर सम्बन्धी सर्वेक्षणमा उक्त परिवर्तनका कारण रोग, कीरा र झारको प्रकोप पहिले भन्दा बढि भएको पाइयो भने गर्मीयाममा अधिकतम तापक्रम पहिले भन्दा बढेको र जाडो याममा न्यूनतम तापक्रम पहिले भन्दा घटेको पाइयो ।

EXECUTIVE SUMMARY

Agricultural Environment Research Division has been contributing and sharing the environment friendly agricultural technologies and knowledge developed through the crop vulnerability studies and other researches. It includes the sharing of knowledge on skilful programs like crop modelling, carbon sequestration and GHGs emission estimation studies. Realizing the importance of climate information to agricultural researchers, the division has continuously emphasized on the establishment of automatic weather stations in different research stations. The division has been providing advisory services on changing climate scenario and its effect on agricultural crops to many of its clients including researchers and organizations. Recently the division has started weekly agro-met based advisory services through bulletins for the farmers of twenty five districts under PPCR project to minimize the weather induced crop vulnerabilities. Continuous research works are also in action on developing environment friendly agricultural technologies and mitigation options to reduce the crops vulnerabilities under the division. Apart from above mentioned services, the division is also making weather data available of various organizations, research stations and to the students involved in agricultural researches. Following are some of the findings of researches conducted by the division last year:

- Among four rice varieties (NR1105,BB27, Khumal-10, Khumal-8 and 08 fan-10), Khumal-8 showed clear pattern of decreased and Khumal-10 and NR1105,BB27 had increased average grain yield under elevated temperature under differential height open top plastic chamber than open filed condition.
- Similarly, four wheat varieties (Danphe, WK 1204, Swargadwari and Dhaulagiri) grown in open top plastic chamber resulted lower grain yield under elevated temperature having differential height except Daphne in chamber with 4' height plastic chamber than open field condition.
- The CO_2-C flux was recorded the highest of 322.0 mg/ha/hr on vegetable crop (Chilly) and the lowest of 101 mg/ha/hr in wheat at Ranighat,
- CO2-C emission was lower (84.5 mg/m^2/hr) in mulch as compared to no mulch (117 mg/m^2/hr) in wheat.
- Fourteen years aged orange tree was found to sequestrate 0.34 ton/carbon per year per tree. Similarly, individual Avocado tree (14 years age) was estimated to capture 0.04 ton/carbon per year.
- Kapilvastu and Rasuwa district's Farmers felt that short summer and cooler winter with increased incidence of disease, insect and weeds due to climate change.

1. WORKING CONTEXT

Nepal is an agriculture based country with two third of population involved in this sector. In addition, the increasing population and food demand makes the sector of prime importance in order to become a food secured country. Moreover, global warming, spatial, temporal and weather anomalies are becoming alarming in whole agricultural system and productivity. The database on agro-meteorological record from various stations is helpful for cause and effect studies and for explanation and prediction of production performance in a given set of environment. The agro-meteorological databases can also be helpful in crop modelling. The crop yield is the output of crop genetic make-up, environment and management factors. Study on crop performance under elevated temperature conducted in open top chamber will be helpful for agricultural scientists for planning breeding programs and crop management practices. The contribution of agriculture sector in Greenhouse Gases (GHGs) emission is of great concern and is significantly contributing in the climate change.

Agriculture has also an important role in emission of CO_2 by agricultural practices. Similarly, horticultural fruit crops help sequestrating the CO_2 in the form of trees and organic matters in soil. In this context, the division is currently monitoring CO_2 emission from crops and pasture land under different management practices in different parts of the country. The division is also trying to make inventory of carbon sequestration by different types of fruit trees. With the strategy of working in collaboration, the division is currently working together with national and international organizations in different aspects of researchable issues related to climate change.

2. INTRODUCTION

The Agricultural Environment Unit was established in the F.Y. 2000 AD in Khumaltar, Lalitpur under the Directorate of Planning and Coordination, Nepal Agricultural Research Council (NARC). It aims to contribute in protection of the environment with secured and increased agricultural productivity for livelihood enhancement and strengthen the agro-meteorological stations in NARC research stations. Later, it has been upgraded to Agricultural Environment Research Division (AERD) in the Fiscal Year 2013 AD.

2.1 Goal

- To sustain the production and productivity of agricultural system without deteriorating production factors in context of climate change.

2.2 Objectives

- Raise awareness and seek solutions for agriculture related environmental issues ensuring a sustainable agricultural development.
- Assess impact of climate change on agriculture and develop adaptation options for reducing vulnerabilities.
- Study agricultural researches and development on system perspective using modern tools like GIS, remote sensing, crop models etc.
- Support commodity programs, divisions and research stations to develop climate resilient technologies.
- Assist NARC in preparing policy guidelines on environment friendly agriculture and climate change issues.

2.3 Strategies

- Identification and prioritization of environment related problems in agriculture.
- Develop system perspective agricultural technologies through decision support tools.
- Support NARC research stations to generate climate resilient agricultural technologies.
- Strengthen the agro-meteorological stations in NARC research stations.
- Strengthen collaboration with national and international institutions.
- Enhance capacity of different stakeholders in understanding climate change and its impact on agriculture.

2.4 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).
- Yield characterization and forecasting.
- GHGs emission under different agricultural soil and system.
- Carbon sequestration in agricultural, plantation and horticultural crops.

2.5 Infrastructure and facilities

- **Automatic weather station (11):** Daily agro-meteorological data recording (Temperature, rainfall, solar radiation, relative humidity, soil temperature etc.)
- **Open Top Chamber:** 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**

2.6 Organization structure and human resources

The structure of this division is given in Fig 1 and detail of human resources in 2073/74 has been presented in Annex 1.

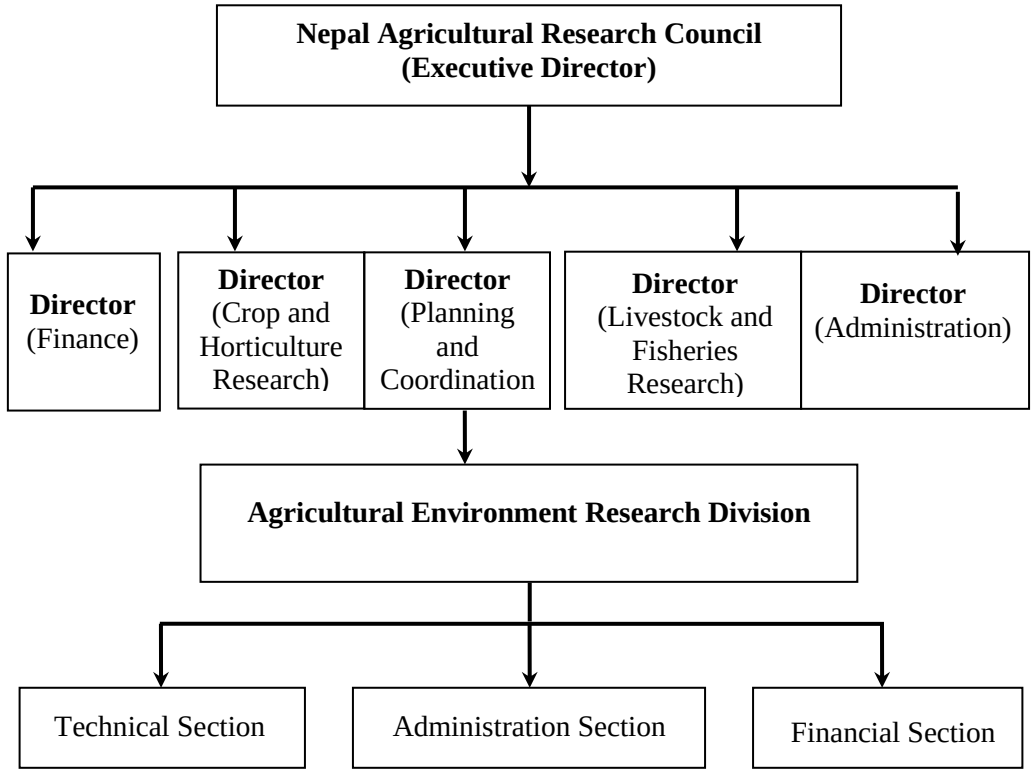

Figure 1: Organizational structure of Agricultural Environment Research Division

3. RESEARCH HIGHLIGHTS

3.1 Study on rice and wheat under changing climate parameters

Air temperature is important to agriculture because it influences plant growth and crop productivity. It affects on different parameters of soil including soil mineralization rate, soil moisture. It also has effects on whole crop phenology like maturity, heading. Farmers use air temperature and weather information to decide when to irrigate crop and to determine incidence of insect pests and plant diseases. Thus, study on effects of temperature on major crops is necessary for knowing adaptability or vulnerability of new crop varieties. The main objective of the study is to select and conserve appropriate rice variety under elevated temperature condition.

Plants have specific requirement of temperature range at which their best growth occurs. When the temperature reaches the upper end of the spectrum, generally there is change in physiological behaviour and photosynthesis declines. Optimal temperature requirement of crops are different from nature of crops, and even different within species. Rice crop can adapt up to maximum temperature of 45^0 C although its average air temperature required for growth is considered 22-30^0 C.

The main objective of study is to find out the rice and wheat crop adaptability in different temperature. Thus, an experiment was carried out in a split plot design in three different type or size of plastic chamber under irrigated condition to know the adaptability and behaviour of rice varieties in 2073/74 at Khumaltar. Four conditions of study [three different height (Table 2) plastic chamber and field] as main plot (factor A) and four varieties as sub-plots (factor B) were carried out.

Rice at Khumaltar

Thirty days old rice seedling of varieties Khumal-10, NR 1105, B-B 27, Khumal-8 and 08 fan-10 were transplanted in 3 open top plastic chamber (OTPC) and field in July 01, 2016 at 20 x 20 cm spacing. Agronomic parameters taken were presented in Table 1. Fertilizers were applied @ 100:30:30 kg/ha N:P_2O_5:K_2O in rice. Nitrogen was applied in two split doses,

half as basal dose and rest at 29 days after transplanting. The phenological parameters and yield were recorded.

Table 1: Agronomical parameters of rice at Khumaltar in 2073/74 (2016/17)

Treatment	TH	PH	50% HD	MD	PL (cm)	FBM t/ha	GY (t/ha)
Chamber 4'							
Khumal-10	10.67	144.20	99	124	24.87	11.67	5.59
NR1105,BB 27	11.00	134.33	94	121	24.20	12.33	**5.86**
Khumal-8	12.33	122.67	103	131	28.13	9.81	**5.05**
08 fan-10	11.33	103.00	94	130	24.27	9.99	3.26
Chamber 5'4"							
Khumal-10	10.00	145.00	96	126	25.27	13.15	5.64
NR1105,BB 27	10.67	130.67	95	125	25.47	12.20	**6.03**
Khumal-8	10.67	126.33	101	129	27.40	9.93	5.87
08 fan-10	11.67	104.67	96	128	24.40	10.77	**3.12**
Chamber 6'9"							
Khumal-10	10.00	147.67	96	122	24.73	12.78	**6.05**
NR1105,BB 27	10.33	136.00	94	121	24.07	12.22	4.93
Khumal-8	11.67	122.00	100	126	29.27	9.64	4.80
08 fan-10	10.00	104.67	95	121	24.53	10.91	**2.77**
Field							
Khumal-10	9.00	143.33	98	128	25.60	10.10	5.35
NR1105,BB 27	10.33	134.00	96	127	24.53	10.20	4.99
Khumal-8	11.67	124.67	104	133	27.53	10.29	**6.39**
08 fan-10	10.00	102.00	95	128	25.47	8.04	**2.80**

TH=Tillers/hill, PH=Plant ht, HD=Heading days, MD=Maturity Days, PL=Panicle length, FBM=Fresh biomass, TGW= Thousand grain wt, GY= Grain yield

Table 2: Average temperature of chamber and field for rice growing period 2073/74 (2016/17)

SN	Treatment	T Max. ^{0}C	T Min ^{0}C
1	Chamber 4'	38.7	17.6
2	Chamber 5'4"	39.2	18.7
3	Chamber 6'9"	42.1	19.7
4	Open field	34.4	17

Average maximum temperature was found 4.3^0 C, 4.8^0 C and 7.7^0 C higher in 4, 5.4 and 6.9' height open top plastic chamber respectively than field condition. However, increase in minimum temperature (Tmin) was found nominal (0.6^0 C, 1.7 ^{0}C and 2.7 ^{0}C respectively) in three chambers compared to field condition. The average seasonal

increase in temperature were 2.5, 3.3 and 5.2^0 C in three chambers (4', 5'4" and 6'9" height).

Rice crop duration was decreased by 4, 2 and 6 days earlier maturity due to increase in temperature grown under 4, 5.4 and 6.9' height plastic chamber respectively. The grain yield of Khumal 10 has increased with increase in average seasonal temperature and higher yield (6.05 t/ha) was found under third chamber. NR1105,BB 27 and 08 fan-10 varieties were found to yield higher grain yield under increased seasonal temperature up to 3.3^0 C and slightly reduced (0.06 t/ha) grown under third chamber (5.2^0 C higher seasonal temperature) than field. Khumal-8 rice variety was found to reduce the yield under elevated temperature grown under chamber condition than filed.

Similarly, three varieties (Khumal-10, NR1105,BB 27 and 08 fan-10) were resulted higher fresh biomass yield as compared to field condition whereas Khumal-8 had lower fresh biomass yield grown under increased seasonal temperature.

Wheat at Khumaltar

Wheat was sown on first week of December, 2016 at Khumaltar under same plastic chamber and open field as rice. Seed rate was 120 kg/ha and spacing was 20cm row to row distance. Fertilizer dose was applied at rate of 100:50:50 N: P_2O_5: K_2O kg/ha. Half of nitrogen was applied as basal and rest half used after one month of basal dose. Irrigation in wheat field was done when as needed. The main objective of the study is to select appropriate wheat variety for future.

Thus, an experiment was carried out in a split plot design in three different type or size of plastic chamber under irrigated condition to know the adaptability and behaviour of wheat varieties in 2073/74 at Khumaltar. Four conditions of study (3 plastic chamber and Field) as main plot (factor A) and (Swargadwari, Danphe, Dhaulagiri and WK 1204) as sub-plots (factor B) were carried out.

The average seasonal temperature increase was about 2.3 to 4.7^{0}C in chamber than field condition (Table 4).

Table 3: Agronomical parameters of wheat at Khumaltar, 2073/74 (2016/2017)

Treatment	FD	MD	PH (cm)	TP	EL (cm)	GP	FBM t/ha	GY (t/ha)
Chamber 4'								
Swargadwari	103	154	95	254	**12.07**	233	10.2	2.55
Danphe	106	160	**106**	319	9.73	**240**	11.5	3.14
Dhaulagiri	103	156	105	343	10.33	221	10.4	2.79
WK-1204	**107**	**163**	90	**357**	10.87	238	10.2	2.97
Chamber 5'4"								
Swargadwari	102	155	91	245	**12.00**	229	10.4	2.61
Danphe	106	162	**100**	280	9.27	227	10.2	2.63
Dhaulagiri	102	155	99	**317**	10.27	210	9.2	2.28
WK-1204	**105**	162	88	235	9.80	**236**	9.4	2.94
Chamber 6'9"								
Swargadwari	101	152	95	214	**12.33**	224	7.5	2.25
Danphe	92	159	**102**	273	9.47	230	8.5	2.65
Dhaulagiri	100	152	99	**293**	10.00	188	6.9	2.24
WK-1204	**105**	**161**	89	193	10.93	228	6.7	2.46
Field								
Swargadwari	103	155	92	266	**12.20**	208	9.4	2.88
Danphe	106	160	98	**363**	9.53	217	9.6	2.83
Dhaulagiri	104	156	**100**	331	10.53	193	9.8	2.84
WK-1204	**108**	**165**	87	300	10.87	**237**	9.4	3.05

FD=Flowering days, MD=Maturity days, PH=Plant ht, TP=tillers/plant, EL=Ear length, GP=Grain/panicle, FBW=Biomass wt, GY=Grain yield

Table 4: Average temperature of chamber and field for wheat growing period, 2073/74 (2016/17)

Treatments	Average Tmax	Average Tmin
Open field	24.8	8.3
Small Chamber (4')	28	9.7
Medium chamber (5'4")	30	10.2
Large chamber (6'9")	31	11.4

Two varieties of wheat (WK 1204 and Dhaulagiri) flowered earlier under elevated temperature compared to field condition. Similarly, other two varieties also flowered earlier grown under medium and large chamber.

Except Danphe variety grown under 4' height plastic chamber, wheat grain yield was found lower under increased temperature than normal filed condition. If we compare

performance of wheat varieties grown in third chamber and field condition, the yield of wheat (Swargadwari, Danphe, Dhaulagiri and WK 1204) was 22%, 6%, 21% and 26% lower in the third chamber (4.7^0C higher average seasonal temperature) than field condition.

The fresh biomass was found higher under first chamber condition (2.3^0C higher average seasonal temperature) for all wheat varieties whereas wheat grown under third chamber (4.7^0C higher average seasonal temperature) produced lower fresh biomass than field condition. Swargadwari and Danphe had higher fresh biomass under second chamber condition (3.6^0C higher average seasonal temperature).

3.2 Estimation of CO_2-C emission from agricultural and Pasture land

CO_2 emission from agricultural Crops

Soil CO_2 flux is the combined result of root respiration and microbial decomposition of soil organic matter (Hanson *et al* 2000). Farming practices including use of excessive fertilizers and mismanagement of natural resources has posed serious threat in contribution of CO_2 emission from soil. 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. 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 (Lloyd and Taylor 1994). 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_2emission rates in different cropping pattern to formulate the plan to reduce overall agricultural emission.

Methodology

The study was carried out at research and farmers' fields from three locations; Lumle, Ranighat and Bandipur to estimate CO_2-C emission from different crops. Selection of the sites and crops were done randomly. Soil temperature, pH and moisture were recorded in the study.

Collection of gas samples was done by Japanese closed chamber technique and finally subjected to measure with help of CO_2 monitor. Soil moisture, and pH were taken by combined soil moisture and pH meter. Soil temperature was taken from 8 cm depth.

The observation taken from different field categorized on the basis of standing crop in field and was analyzed accordingly. Results showed that cereals crops maize and wheat crop had lower emission whereas vegetable crops (Chilly and Brinjal) showed higher of about 2 times emission rate as compared with cereal crop.

The flux of carbon is hard to be estimated besides knowing soil status of fields. However, gas samples were analyzed; CO_2-C emission was found ranging from 101 to 322.0 mg/m2/hr. The lowest emission of 100.8 in wheat field at Parsa, Ranighat and the highest emission of 322.0 mg/m2/hr was found in chilly at ARS Lumle, Kaski. It was observed that the CO_2-C emission estimation on different crop was an important study to know the crop contribution in climate change. It help to reduce the emission from soil and will be beneficial for further studies and planning of cropping pattern as well. The presence of crops and fallow land also influences carbon dioxide emission from soil. Sometimes emitted gas absorbed by crop as in photosynthesis process. Thus, emission and contribution in global warming is depend land cover and vegetation.

The pH of the soil ranged from 6.0 to 6.3 and soil moisture index ranged from 7.8 to 8. Similarly, range of air temperature during collecting of gas was 21-23^o C at Lumle, kaski and 31 ^{o}C at Ranighat, Parsa. The CO_2-C flux was recorded the highest of 322 mg/ha/hr on vegetable crop (chilly) and the lowest of 100.8 mg/ha/hr in wheat at Ranighat, Parsa. It was observed that the CO_2-C emission was influenced by both soil temperature, moisture and application of manure and fertilizers in most of the districts. Study and analysis of gas emission showed higher emission in vegetable crop than cereal crops.

Table 5: CO_2-C Emission on different crops

S.N	Crops	Air Temperature (^{0}C)	C flux mg/m^2/hour	pH	Moisture (%)
1	Maize	23	150.4	6	8
2	Chilly	22	322	6.2	8
3	Brinjal	21	283	6.3	8
4	Tea	22	175.7	6.1	8
5	Wheat (Ranighat)	31	100.8	6.3	7.9

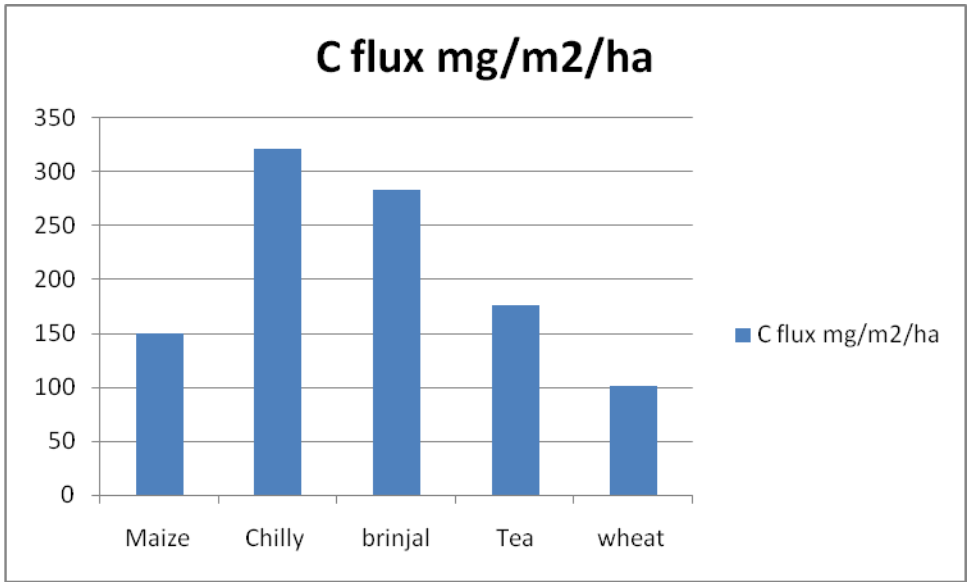

Fig. 2: CO_2- C emission from different crops

CO_2-C emission from pasture land

Agricultural farming practice leads to atmospheric CO_2 balance in two ways: directly because of the net carbon loss during soil respiration and other influencing factor of CO_2 balance in atmosphere is atmospheric CO_2 concentration. CO_2 sequestration from atmosphere by agricultural crops through photosynthesis plays major role in mitigating climate change.

Soil is the major source of CO_2 emission to the atmosphere as a greenhouse gases from agriculture sector. Over the recent past, changes in land-use, farming practice and clearing of forests to crops and pastures, have generated emissions of CO_2 to the atmosphere. A difficulty is that a temporal variation in soil CO_2 fluxes within sites was mainly influenced by soil carbon, soil temperature and moisture. Observation of emission was done in demo plot. The plot was not natural as pasture land.

Table 6: CO_2-C emission from different pasture field at ARS Bandipur, 2073/74 (2016/17)

S.N.	Pasture	Air temp	C flux $mg/m^2/ha$	Soil Temp.	Soil pH	Moisture (%)
1	Rhodes grass (*Chloris ngayans*)	31	153.4	29.5	6.5	8(full)
2	Joint Vetch	31	126.6	29	6	8
3	Signal (*Brachiaria decumberns)*	31	139.2	29	6	8
4	*Stylosanthes guianenisis*	31	174.5	29	6	8
5	*Setaria spp.*	31	79.7	29	6.5	8
6	Molases	31	133.5	29	6.25	8
7	*Summa setaria*	31	26.2	29	6	8
8	Forage peanut (*Arehis pintoi*)	31	105.7	29	6	8
9	Guinea grass	31	35.5	29	6.4	8
10	*Paspalum spp.*	31	60.6	29	6	8

The result of ARS Bandipur data showed that the emission ranges from 26.2 to 174 mg/ha/hr. It was found the highest in the land grown Sterile Setaria with 174.5 mg/ha/hr and the lowest in *Suma setaria* plot with 26.2 mg/ha/hr. One of the reasons of higher emission in sterile Setaria land might be due to higher fertility status in the plot. Soil temperature was (30 ^{0}C), moisture (3.0) and pH (6.2-6.9) were observed. Since the variation in soil temperature, moisture and pH were similar in the all plots, so the differences in emission rate might be due to the other factors like use of chemical fertilizer and organic manure. Observation taken from plot is neither natural condition nor highly fertilized. Real CO_2-C emission rate may be different in natural pasture land**.**

CO_2 – C emission estimation on mulch and no mulch condition

Mulching practice has vital role on soil physical, chemical and biological properties. Thus, it also has important role on addition of soil organic matter (SOM) in soil. Studies conducted in other parts of the world has also reflected that most of the mulching practice were done on wheat fields are mainly due to management practices such as; moisture availability, availability of soil organic matter and provides favourable conditions to soil microbes in the soil. Therefore, appropriate management of soil including mulching practice agricultural crops would be a viable option to reduce the carbon-dioxide emission from agricultural soil. Mulching practice increases Carbon sequestration in soil maintaining optimum production level sustaining soil productivity and fertility. With this objective, a study of mulch and no mulch condition on wheat was conducted by ARS Ranighat at Parsa. Wheat variety

Aditya was tested in the study. Carbon emission estimation from wheat field under mulch and no mulch condition was done and found following results.

Table 7: CO_2 emission from mulch and no mulch condition on wheat, 2073/74 (2016/17)

SN	Treatment	Air temp.	C flux $mg/m^2/ha$	Soil temp	pH	Soil moisture
1	Mulch	31	84.5	15.6	6	7.8
2	No-Mulch	31	117	15.3	6.6	8

Study on CO_2-C emission was carried out in research plots with mulch and no mulch conditions. Observation regarding soil and air CO_2 were taken from the study plots and analyzed. CO_2 emission in mulch and no mulch soil were recorded and found emission was lower in mulch as compared to no mulch. Above data table depicted that gas emission in mulch condition reduced by 38.6% as compared to no mulch condition. While with no mulch, the emission was recorded the highest of 117 mg/m^2/hour as compared to mulch of 84.5 mg/m^2/hour.

From the result it can be concluded that practice of mulching is beneficial in reducing GHGs emission from agricultural soil and on other hand, this practice also helps conserved soil moisture and organic content (SOM) in soil through extra addition crop residues as an organic matter. Thus, mulching in wheat will be agricultural practice not only for conservation of soil moisture also for reduction of carbon emission. Ultimately, the practice will help in mitigating climate change by reducing GHGs emission from agricultural land.

3.3 Carbon sequestration in fruit trees

In Nepal, the research works in carbon sequestration is very limited. Only few study of atmospheric carbon sequestration on forestry is going on. While the study on fruit trees in Nepal is very limited. In this context, while reviewing the past works, there are very few and scattered research works found in the country. Carbon and its sequestration into the soil by fruit plants are very important. Above ground biomass (AGB) and below ground biomass (BGB) of the fruit trees has been considered as carbon sequestration. That increasing biomass of trees helps to reduce carbon concentration in the atmosphere. Because, the green trees continuously absorb carbon during photosynthesis. This study has been carried out to estimate carbon balance and atmospheric carbon sequestration from fruit trees. Carbon sequestration estimation from fruit trees is an important study which helps to estimate actual contribution of horticulture in mitigating global warming. It might also be helpful for increasing the sequestration in soil and earth system by increasing fruit cultivation.

In carbon sequestration process, either CO_2 is captured from atmosphere or added in to the soil. Forestry and agriculture plays an important role in atmospheric CO_2 fixation. The horticulture, especially plantation crop contributes significantly to global CO_2 capture and offers opportunities of sequestering it into the soil, vegetation and wood products. Fruit trees help stabilize CO_2 concentration in the atmosphere by sequestrating and absorbing for long time. Atmospheric carbon gets sequestered into the soil and helps in building the soil health.

Table 8: Carbon Sequestration study on different fruits and fodder trees, 2073/74 (2016/17)

S.N	Fruit trees/Station	No. samples	Age of tree	DBH (m)	Ht tree (M)	C sequestred (t/yr/tree)
1	Orange (Palpa)	22	4	0.63	3.83	0.087
2	Orange (Parbat)	27	14	1.22	4.6	0.340
3	Orange (Kaski)	56	24	0.76	7.27	0.205
4	Avocado (Malepatan)	12	14	0.49	4.3	0.044
5	Mecademia nut (Malepatan)	56	24	0.76	7.27	0.250
6	Fodder trees *Ficus sps*	33	15	0.85	7.21	0.190

Study was carried out in varied fruit trees in different ARS and farmers tree garden. In this study, carbon stock was estimated by calculating Above Ground Tree Biomass (AGTB) and Below Ground Tree Biomass (BGTB).

Carbon sequestration in fruit trees depend upon their canopy size, age of tree, type of fruit and girth diameter. Study on carbon sequestration at Palpa in 2073/74 showed that 4 years old orange trees (sample size 22) sequestrated about 0.087 ton carbon and orange tree of 14 years in Parbat sequestrated 0.34 ton / year (sample size 27) at Parbat farmers' fields. In the farmers field higher rate of sequestration was due to higher of DBH and age. Whereas orange tree at Kaski farmers field showed only 0.205 ton carbon sequestration. Avocado trees of 14 years old at Malepatan pokhara sequestrated 0.044 ton/year (sample size 12). Variations in the sequestration from plant to plant were due to their age, size and species. Further study is required to conclude sequestration rate of the fruit trees.

3.4 Weather vulnerability assessment in farmers' perspective

Weather vulnerability and its impact on Nepalese agriculture is a matter of increasing concern especially in the context of climate change. Various effects in agriculture as a result of climate change and weather variability are being observed in most of the part of country presently. Impacts are not only on crop productivity, but threats are also on environment and human health as well. There are reports time and again from many places about such vulnerabilities induced by weather change on agriculture. Effects are more serious and intense in rural areas than in urban. It is very important to know farmers' knowledge level and coping mechanism to such climate change/weather variability effects. This will help to design and implement programs more efficiently and more appropriately. With this view, a survey was conducted in Kapilvastu and Rasuwa district in 2073/74. Selection of the district was based on the climate change vulnerability index ranking. A total of 63 farmers from Gajhehada, Jhunga, Suiti of Barganga Gaon Palika, Bimiha of Bhaskar Gaon Palika and Shimrauti of Pakdi Goan Palika of Kapilvastu district. Similarly, Pranshe, Gombo Danda, Grang, Bastole, Chitrepani and Dharapani of Kalika Goan Palika, Thulo Barko of Gosainkunda Gaon Palika and Gatlang of Parbati Kunda Gaon Palika of Rasuwa districts were interviewed with structured questionnaire. VDCs were selected in consultation with District Agriculture Development Office of Kapilvastu and Rasuwa district. The survey was conducted with the approach that examined and compared the impacts of climate change on farm income and food security; perception of CC in the local community; coping strategies against CC and factors affecting the coping strategies; and food security in a predominantly rainfed agricultural area. The water requirement was essentially fulfilled by rainfall, and irrigation canals using surface sources supplemented additional water.

Impact of climate change on farm income and food security

Farmers, practically observe changes in the surrounding nature and describe a number of response to the impacts of climate change. Everyone accepted the changes; however, there was considerable variation among the communities regarding the intensity that they perceived.

Change in the cultivation practices of crop in the last 10 years

The study took resident's perception about the changes in the cultivation practices of specific crops. The results showed that the time of sowing and maturity/harvesting of agricultural crops have undergone considerable change. The sowing time for rice has been delayed by one to two weeks due to the delayed in monsoon by one-two weeks; but the maturity time of rice has been delayed by 2 weeks due to the cultivation of

hybrid varieties. In contrast, the sowing and maturity time of other crops as well as vegetables and fruits have not been shifted backward or forward.

Change in agricultural production and food security

Changes in Disease, Insect and Weeds

In the context of climate change, the farmers revealed that the status of disease, insect and weeds of almost all crops under study have been increased as compare to the past years. Almost all farmers in the survey were agreed that all the crops are become more vulnerable now a days to disease, insect and weeds than in the past (Table 9).

Table 9. Farmers' perception on diseases insects and weeds incidence in Kapilvastu district

Crops	Insects		Diseases		Weeds	
	Increases	Decreases	Increases	Decreases	Increases	Decreases
Rice	89	11	91	9	88	12
Wheat	87	13	90	10	84	16
Potato	86	14	95	5	89	11

Cropping pattern

Since the study area was plain area, most of the farmers had followed rice-wheat, rice-vegetable, rice-pea-mustard, maize-wheat cropping pattern in the past. Due to even climate change impacts on agricultural sectors and inclination of farmers to change in cropping pattern is not observed in Kapilvastu district whereas in Rasuwa districts, fifteen percent farmers change their cropping pattern than last ten years, mainly they have maize-millet, rice-wheat, potato-bean, maize-wheat cropping pattern.

Perception on climatic factors

The farmers of selected VDCs of Kapilvastu and Rasuwa district were asked whether they had observed any changes in temperature and precipitation over the previous decade.

Most pressing problems and rank in order of Priority

The study took farmer's view about the most pressing problem due to climate change and the priority for action needed to cope up with the problems. As the study area is in terai and hilly region, more than eighty percent respondents from both districts reported that cold in winter and hot in summer has been

increased, and number of rainy days in both winter and summer has been decreased by nighty present.

Perception on temperature

Farmers' perception on temperature variation due to climate change varied on Kapilvastu and Rasuwa district. Forty percent of farmers responded that winter are cooler now a days than before and 63 percent farmers agreed that summer is getting hotter than the past years.

Table 10. Farmers' perception on seasonal temperature in Kapilvastu and Rasuwa Districts, 2073/74 (2016/17)

Farmer's Perception	Summer Season		Farmer's Perception	Winter Season	
	Kapilvastu	Rasuwa		Kapilvastu	Rasuwa
More hot	76	68	More cool	64	11
Same	12	25	Same	31	12
Less hot	12	7	Less Cool	5	77

Rainfall pattern and Rainfall related disasters: comparison between present and past

Majority of the farmers responded that rainfall magnitude has been decreased in rainy (monsoon) season in both districts. More than eighty percent have experienced a decrease in frequency of rainfall in monsoon season, eighty percent experienced lesser duration of rainfall and sixty five percent responded that the intensity of rainfall in monsoon season has been decreased.

On the other hand, farmers responded that rainfall magnitude has been decreased in other seasons as well. eighty percent of the respondents have a consensus that frequency of rainfall in other seasons have been decreased and total respondents have claimed that duration of rainfall in other seasons have decreased in last 10 years.

Coping strategies against climate change

The adaptation practices were also identified through the field survey. The data and interpretations of local people's adaptation mechanisms against climate change impacts are described below.

Adaptation strategies followed by community against CC impacts

Farmers of the study area have the understanding that there are adverse effects of climate change in their agricultural production and have their own coping strategies.

Adaptation strategies in Agriculture sector in Kapilvastu District

On the response to what adaptation strategies farmers are adapting, 74% of the total responded farmers indicated that the application of chemical fertilizers and pesticide is the better adaptation strategy to minimize such weather vulnerability. Use of hybrid/improved crop varieties was another most adapted strategy as reported by 89% farmers. Eighty five per cent farmers have claimed diversification of crops by growing vegetable instead of rice and cereals crops is another better practice. Seventy percent of the respondents have claimed use of shorter duration crop varieties to mitigate weather vulnerability.

Table 11. Farmers' perception on adaptation strategies in agricultural sector in Kapilvastu District, 2073/74 (2016/17)

Strategies	Farmer's response (in %)	
	Yes	No
Use of short duration variety of crops	70	30
Diversified to vegetable production instead of rice and cereals crops	85	15
Application of more chemical fertilizers and pesticides	74	26
Use of hybrid/improved crop varieties	89	11
Drought resistant crops	71	29

Adaptation strategies in Agriculture sector in Rasuwa District

On the response to what adaptation strategies farmers are adapting, 64% of the total responded farmers indicated that the application of chemical fertilizers and pesticide is not better adaptation strategy to minimize such weather vulnerability. Use of hybrid/improved crop varieties was another most adapted strategy as reported by only 8% farmers. Sixty per cent farmers have claimed diversification of crops by growing vegetable instead of rice and cereals crops is another better practice. Only five percent of the respondents have claimed use of shorter duration crop varieties to mitigate weather vulnerability.

Table 12. Farmers' perception on adaptation strategies in agricultural sector in Rasuwa District, 2073/74 (2016/17)

Strategies	Farmer's response (in %)	
	Yes	No
Use of short duration variety of crops	5	95
Diversified to vegetable production instead of rice and cereals crops	60	40
Application of more chemical fertilizers and pesticides	36	64
Use of hybrid/improved crop varieties	8	92
Drought resistant crops	5	95

Issues that community likes to discuss

Only thirty two percent of the respondents in Kapilvastu district and twenty nine percent of the respondents in Rasuwa district said that the community would like to discuss on climate change related issues. They are worried about the consequences of climate change on cropping pattern and people's livelihood.

Food security

As the climate change has adverse impact on agricultural sector and cropping pattern, the survey had tried to find out the latest food security condition, surface water availability and the activities or trainings farmers wanted to get for coping up with CC consequences. The results are described below.

Food security condition

Food security in most parts of the country have been affected by the climate change; neverthless, the surveyed districts were more effected .

In Kapilvastu district, only eleven percent farmers had food sufficiency for less than six months, 40 percent farmers had food sufficiency for more than nine months. Similarly, eight percent of the respondents had food sufficiency for less than nine months, whereas only 1 percent farmers had food sufficiency for less than three months.

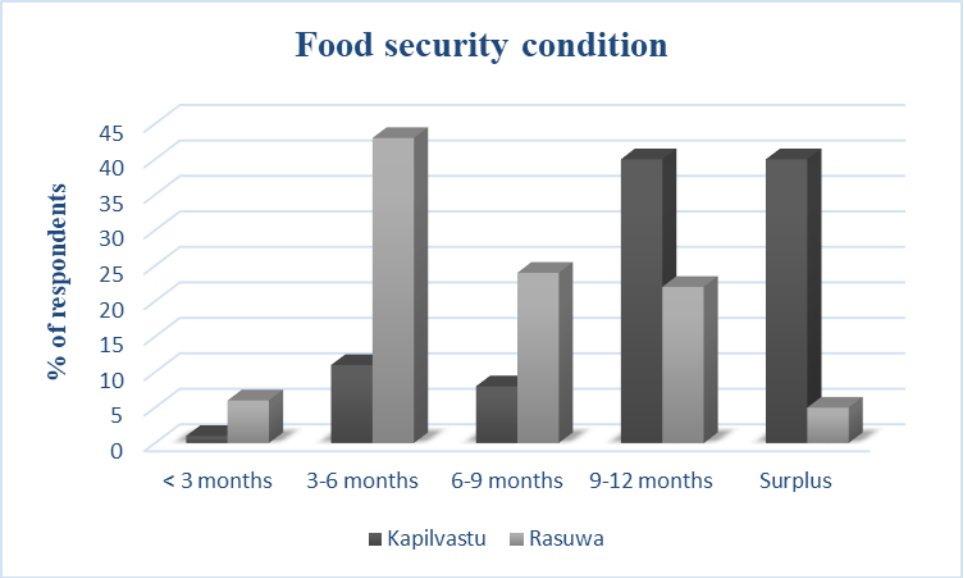

Fig. 3. Farmers' food status in Kapilvastu and Rasuwa districts

Irrigation Facility

Most of the respondents (67 percent) have one or two irrigation canals, and fifty one percent of them reported that they have lost the canal in recent years in Kapilvastu district whereas in Rasuwa district, only 18 percent household reported they have irrigation canals. The majority of respondents have observed that decrease in water table, no maintenance, urbanization and heavy rainfalls for irrigation canals loss in recent years. The results reveal that the rainfall pattern has been erratic, rainfall magnitude has been decreased and rainfall intensity has been increased. All these parameters signify that the VDCs is vulnerable to climate change.

4. TECHNOLOGY TRANSFER AND SERVICES

Services

The division made available of meteorological data to various stakeholders including research stations, students and other concerned organization. Technical information regarding agri-environment and its important on agricultural productivity and its impacts in agriculture was provided to various concern stakeholders.

Publications

Besides the annual report publication of division, has been published (Annex 4).

Information through media

Various interviews related to climate change and its impact on Nepalese agriculture were broadcasted/published on various media

5. VISITS

Visit of students from Trichandra Multiple Campus, Tribhuvan University regarding meteorological and climate change information.

6. OTHER ACTIVITIES

Participation in different training and workshop by different personals from the division is given in Annex 5.

7. BUDGET AND EXPENDITURE

The total annual budget and expenditure of the division for regular as well as special projects are provided in details in from Annex 6 to Annex 7. Revenue generated from various activities and Beruju status of the division is provided in Annex 8 and Annex 9, respectively.

8. KEY PROBLEMS

- Insufficient technical human resources to represent different disciplines.
- Lack of equipment like Gas chromatography for GHGs analysis.

9. WAY FORWARD

- Expansion of climate change research activities to other research stations.
- Establishment of Environment Unit in each Regional Agricultural Research Stations and commodity program of NARC.
- Strengthening research stations in terms of manpower and laboratory to conduct research related to climate change.
- Installation of Automatic Weather Station (AWS) in different research stations for agro-meteorological database and to support the researches.
- Coordination with different organizations to provide agro-met advisory based on weather forecasting for agriculture use.

10. REFERENCES

Hensen *et al*., 2000. Global Warming in the Twenty first century: An alternative scenario. Proc. Natl. Acad. Sci.

LIoyd and Taylor, 1994. On the Temperature Dependence on Soil Respiration, Functional Ecology, Vol. 8, No. 3, (June, 1994), pp 315-323.

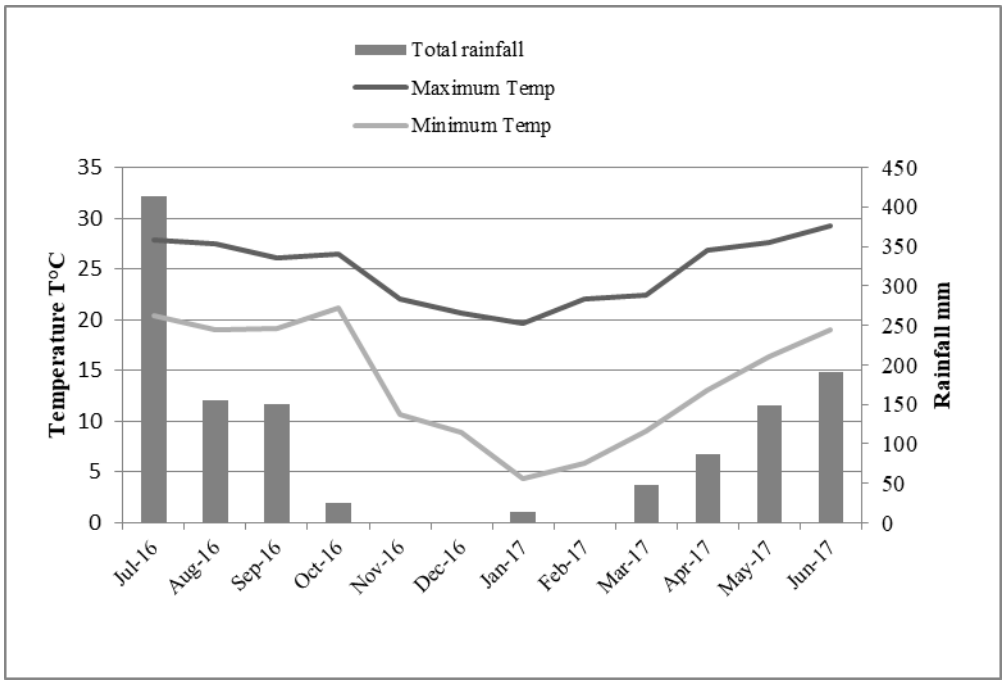

Figure 4: Temperature and rainfall pattern at Khumaltar, 2073/2074 (2016/17)

11. ANNEXES

Annex 1. Human Resources, 2073/74 (2016/17)

S.N.	Name of the Staff	Designation	Remarks
1	Dr. Deepak Bhandari	Principal Scientist (S5)	Chief
2	Mr. Suresh Kumar Rai	Senior Scientist (S-4)	
3	Mr. Ghanashyam Malla	Senior Scientist (S-4)	Deputed from MED
4	Mr Bishnu Prasad Paudel	Senior Scientist (S-3)	
5	Mr. Amit Prasad Timilsina	Scientist (S-1)	On study leave
6	Mr. Rameshwar Rimal	Scientist (S-1)	PPCR/BRCH/AMIS
7	Mr. Hari Devkota	Technical Officer (T-6)	
8	Mr. Alok Sharma	Technical Officer (T-6)	Deputed from PAC
9	Mrs. Yashoda Kunwar	Admin. Officer (A-6)	
10	Mr. Prabhat Sah	Account Officer (A-6)	
11	Mr. Hem Lal Bhandari	Technician (T-5)	
12	Mr. Raj Kumar Chalise	Driver	Deputed from NASRI
13	Mrs Rupa Parajuli	Lower Technician	

Annex 2. Summary of Progress of NARC Research Projects and Activities, 2073/74 (2016/17)

Project code number	Name of project/activity	Project/ Activity Leader	End Year	Major progress/achievements
32970002	**Vulnerability of climate change in agriculture**	**D Bhandari**	**Continuous**	
Activity 1	Collection, analysis and dissemination of agro-meteorological database of various locations of Nepal	A Sharma	,,	Meteorological database of 61 locations of Nepal collected and analysed (Decadal average precipitation, max and min temp).
Activity 2	Weather vulnerability assessment in farmers perspective	B P Paudel	,,	Survey conducted in Kapilvastu and Rasuwa districts. Farmers' perception is that summer is shorter and winter cooler, Incidence of disease, insect and weeds increased due to climate change.
Activity 3	Crop vulnerability study under different climatic variability	G Malla	,,	Among the varieties, Khumal-8 performed highest grain yield of 6.39 ton/ha in open field. In OTC condition, Khumal-10 performed better with the yield of 6.05 ton/ha in OTC.
Activity 4	Crop management study under changing climatic parameters	G Malla	,,	Wheat variety Danphe performed better than other varieties like WK-1204, Swargadwari and Dhaulagiri under elevated temperature in OTC. Yield of wheat variety WK-1204 was 3% lesser in OTC than field condition.
Activity 5	Estimation of GHGs emission from pasture agricultural land and livestock sectors	A Sharma		The CO_2-C flux was recorded the highest of 322.0 mg/ha/hr on vegetable crop (Chilly) and the lowest of 100.8 mg/ha/hr in wheat at Ranighat, Parsa.
Activity 6	CO_2-C emission on crops	G Malla		CO_2-C emission was lower (84.45 mg/m^2/hr) in mulch as compared to no mulch (117.07 mg/m^2/hr) in wheat.

Activity 7	Estimation of atmospheric C sequestration by fruit plants and in orchard	G Malla	,,	Orange tree in Parbat is highly potential to carbon sequestration (0.34 ton/yr/tree) whereas only 0.04 ton/year/tree was sequestrated by Avocado.
32900001	**FMP/AOE 329**	**Division Chief**	**Time bound**	**Activities accomplished**
Activity 1	Farm security	Division Chief		Farm security well maintained
Activity 2	Farm maintenance		,,	Farm maintenance good and well.
Activity 3	Research support (admin Lab services, etc)		,,	All research supports made available as per requirements
Activity 4	Annual Report Publication	B.P.Paudel	,,	100 units of Annual Report was Published

Annex 3. Summary progress of special research projects and activities, 2073/74 (2016/17)

Name of project /activity	Project/ Activity Leader	Begin Year	End Year	Major progress /achievements
PPCR	D Bhandari	2014	2019	Publication of Weekly Agro-met based advisory bulletin for 25 Districts (Jhapa, Morang, Sankhuwsabha, Dhankuta, Sunsari, Saptari, Siraha, Dolakha, Mahottari, Kavrepalanchoke, Bara, Dhading, Chitawan, Kaski, Mustang, Palpa, Rupandehi, Rukum, Dang, Banke, Surkhet, Jumla, Kailali, Doti and Darchula).

Annex 4. Publications, 2073/74 (2016/2017)

SN	Title of publication	Type	Language	Author	No. of copies
1.	Annual Report 2072/73 (2015/16). Agricultural Environment Research Division, Khumaltar, Lalitpur, Nepal	Report	English	Agricultural Environment Research Division, Khumaltar	100

Annex 5. Training/workshop/seminar attended by staff, 2073/74 (2016/17)

SN	Name of staff	Position	Name of Training/seminar/workshop	Duration	Place/Country	Organizer
1.	Dr. Deepak Bhandari	P. Scientist (S5)	International Workshop on Agricultural Meteorology Services	14-21 July, 2017	Korea	PPCR
2.	Dr. Deepak Bhandari	P. Scientist (S5)	Agro-met Advisory Bulletin	2-6 July, 2017	India	AMIS
3.	Mr. G.Malla	S. Scientist (S4)	,, ,,	,,	,,	,,
4.	Mr. Bishnu P Paudel	S. Scientist (S3)	,, ,,	,,	,,	,,
5.	Mr. Pravat Sah	Acc. Officer	,, ,,	,,	,,	,,

Annex 6. Regular annual budget and expenditure record, 2073/74 (2016/17)

Budget Code	Budget heads	Annual Budget	Expenses	Balance
21* **	**Staff expenses**			
21111	Basic Salary	5165573.70	5165573.70	00.0
21113	Allowance	132000.0	129000.0	3000.0
21119	Other allowance	20000.0	00.0	20000.0
21121	Cloth	90000.0	75000.0	15000.0
22* **	**Operational and Administrative expenses**			
22111	Water and electricity	42000.0	19317.35	22682.65
22112	Communication	142000.0	111186.0	30814.0
22211	Fuel vehicle	319000.0	314864.50	4135.50
22212	Operation maintenance	450000.0	448771.92	1228.08
22213	Insurance	50000.0	34856.30	15143.70
22311	Office expenditure	475000.0	474657.50	342.50
22314	Fuel others	30000.0	16990	13010.0
22321	Existing Assets Maintenance	500000.0	490871.66	9128.34
22412	Other service	1000000.0	410019.0	58981.0
22521	Production materials/ Service expenditure	600000.0	590404.0	9586.0
22612	Travel expenses	635000.0	629526.0	54740
22711	Contingency	50000.0	50000.0	00.0
	Total	**8800573.70**	**8592037.93**	**208535.77**
29* **	**Capital expenses**			
29231	Capital Improvement	250000.0	243912.08	6087.92
29311	Furniture and Fixers	00.0	00.0	00.0
29411	Vehicle	00.0	00.0	00.0
29511	Machinery and Equip	50000.0	47234.0	2766.0
	Total	**300000.0**	**291146.08**	**8853.92**
	Grand Total	**9100573.70**	**8883184.01**	**217389.69**

Annex 7. Special project (PPCR/BRCH/AMIS-NARC Project) budget and expenditure record, 2073/74 (2016/17)

Budget Code	Budget heads	Annual Budget	Budget released	Expenses	Balance
2100	**Labour Expenses**				
21111	Basic Salary	00	00	00	00
21113	Allowance	00	00	00	00
21119	Other Allowance	1386000.00	976800.00	976800.00	409200.0
21121	Cloth	00	-	-	-
2200	**Operational Expenses**				
22111	Water and electricity	00	00	00	00
22112	Communication	00	00	00	00
22122	Other Rent	100000.00	99998.00	99998.00	00
22211	Fuel vehicle	166000.00	161051.52	161051.52	4948.48
22212	Operation maintenance	180000.00	178373.00	178373.00	1627.00
22311	Office expenditure	440000.00	439583.80	439583.80	416.20
22314	Fuel others	00	00	00	00
22411	Service and consultant	00	00	00	00
22412	Other service	964000.00	785608.00	785608.00	178392.00
22511	Staff training	600000.00	528730.00	528730.00	71270.00
22512	Workshop (skill, people, awareness)	3000000.00	2992653.00	2992653.00	107347
22522	Program expenditure	1165000.00	631651.00	631651.00	533349.00
22611	Monitoring evaluation	1420000.00	1077871.00	1077871.00	342129.00
22612	Travel Expenses	100000.00	60948.00	60948.00	39052.00
22711	Contingency	306000.00	306000.00	306000.00	00
2900	**Capital Expenses**				
29311	Furniture and fixtures	500000.00	495735.52	495735.52	4264.48
29411	Vehicle	00	00	00	00
29511	Machinery &equipment Vehicles	5025000.00	4219194.00	4219194.00	805806.00
29611	Construction	00	00	00	00
29612	Capital improvement	00	00	00	00
29712	Software Expenses	00	00	00	0.0
Total		**15352000.00**	**12854196.84**	**12854196.84**	**2497803.16**

Annex 8. Revenue status, 2073/74 (2016/17) (*In Nepalese Rupees*)

Source	Total	Remarks
Administration Income	22000.00	
Research materials	1650.00	
Grand Total	**23650.00**	

Annex 9. Beruju status, 2073/74 (2016/17) (*In Nepalese Rupees*)

Beruju	Amount	Remarks
Beruju till last year	218000.0	
Beruju cleared this FY	218000.0	0
Remaining Beruju	00.0	