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Nepal Agricultural Research Council

Agricultural Environment Research Division

P. O. Box 5459, Khumaltar

Lalitpur, Nepal

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Cover Page Photo: Open Top Chamber

FOREWORD

Agriculture being prime sector of engagement and national GDP in the back drop of increasing population and food demand, is very sensitive to different threat posed on it. Assessment of environmental issues like, global warming, climate change and their consequences on agricultural sector is of pressing need in the country. Agricultural Environment Research Division under Nepal Agricultural Research Council has initiated diverse work on those issues independently or in collaboration with different organizations. Efforts have been made to develop hub of the climatic parameters data base of different locations of Nepal and their trend over seasonally and yearly. The division has also studied the temporal and spatial adaptive capacity of different crops and variety's as well as under the elevated temperature conditions. Estimating GHGs from different agricultural sectors, management practices and locations is also the working areas of this division.

This annual report is set of the detail activities and upshots for the FY 2069/70. It is expected that this annual report will serve as useful resource to agricultural researcher and policy makers.

First of all, I am very thankful to Mr. Suresh Kumar Rai, Mr. G. Malla, Mr. Amit Prasad Timilsina and Mr. Alok Sharma for continuous hard work to give final shape to this annual report.

I would also like to extend thanks to Mrs. Sarala Basnet, Mr. Pravat Sah and Mr. Raj Kumar Chalise for continued support. Last but not the lease, the Nepal Agricultural Research Council (NARC) holds recognition for its moral support. I would sincerely appreciate and welcome for constructive comments and criticism of the report.

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Anand Kumar Gautam, Ph. D.

Chief and Senior Scientist

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List of Abbreviations

°C	Degree Centigrade
°F	Degree Fahrenheit
AEU	Agricultural Environment Unit
AERD	Agricultural Environment Research Division
AFACI	Asian Food and Agriculture Co- operative Initiatives
ARS	Agriculture Research Station
Avg.	Average
C.D.	Critical difference
CC	Climate change
CCAFS	Climate Change, Agriculture and Food Security
CDR	Central Development Region
CO_2	Carbon di-oxide
CO_2- C	Carbon in CO_2 form
CT	Conventional tillage
CV	Coefficient of Variation
DHM	Department of Hydrology and Meteorology
F.Y.	Fiscal Year
GHG	Greenhouse Gas
GIS	Geographic Information System
ha	hectare
hr	hour
IWMI	International Water Management Institute
kg	kilogram
masl	meter above sea level
mm	millimeter
MoAC	Ministry of Agriculture and Co-operatives
MoE	Ministry of Environment
MT	Minimum tillage
N:P:K	Nitrogen, Phosphorous, Potash
NARC	Nepal Agricultural Research Council
ns	non significant
OTC	Open top chamber
S. Em±	Standard error of mean
t/ha	ton per hectare
Temp.	Temperature
Tmax	Maximum temperature
Tmin	Minimum temperature
VDC	Village Development Committee
ZT	Zero tillage

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संक्षिप्त वार्षिक प्रतिवेदन

कृषि वातावरण इकाईलाई आर्थिक वर्ष २०६९।७० मा स्तरोन्नति गरी कृषि वातावरण अनसन्धान महाशाखामा परिणत गरिएको छ । यस महाशाखाद्धारा आर्थिक वर्ष २०६९।७० मा विभिन्न अनसन्धानात्मक तथा सेवा मलक कार्यक्रमहरु संचालन भएका छन् । कृषि अनसन्धान केन्द्र (चरन), रसुवामा मध्यमान्चल विकासक्षेत्रको हिमाली जिल्लाको हावापानीलाई प्रतिनिधित्व गर्नका लागि स्वचालित हावापानी केन्द्र जडान गरिएको छ । कृषि क्षेत्रसंग आवद्ध सम्पूर्ण संघ, संस्थाहरुलाई वद्लिदो वातावरण, कृषिमा यसको प्रभाव साथै त्यसको न्यूनीकरणको उपायहरुको वारेमा आवश्यक सल्लाह, सुझाव तथा परामर्श प्रदान गरी सेवा पुर्याईएको छ । विभिन्न संघ, संस्था, अनुसन्धान केन्द्र, महाशाखाका साथै विद्यार्थीहरुलाई पनि आवश्यकता अनुसार हावापानी आंकडा प्रदान गरी सेवा प्रदान गरेको छ । यस महाशाखाद्धारा विभिन्न अनुसन्धानात्मक अध्ययनहरु संचालन भएका थिए र निम्नअनुसारका उपलब्धीहरु हासिल भएका छन् ।

- मध्य पहाडी क्षेत्र खुमलटारको हावापानीमा खुमल १३ जातको धान लगाउँदा खुमल ४ भन्दा बढि फलेको साथै आषाढको अन्तिम हप्तामा रोपिएको धानको उत्पादन उक्त समय भन्दा पछि रोपिएको धानको तुलनामा राम्रो पाईयो । त्यस्तै गहुंको WK १२०४ जात डांफे जात भन्दा बढि फल्ने र कार्त्तिकको तेस्रो हप्तामा छरिएको गहुं उक्त समय भन्दा ढिलो लगाईएको गहुंको तुलनामा राम्रो पाईयो ।

- धनुषा, काठमाण्डौं, ललितपुर, महोत्तरी, नुवाकोट, रुपन्देही र तनहुंको तुलनामा भक्तपुरको माटोवाट सवैभन्दा वढिकार्वनडाईअक्साईडमा पाईने कार्वन (CO_2-C) निस्किएको पाईएको छ । बन्दा लगाईएको माटोवाट सवैभन्दा वढि र ब्रोकाउली लगाईको खेतवाट सवै भन्दा कम कार्वन हावाको रुपमा निस्केको पाईयो साथै अन्नवाली लगाईएको माटोवाट तरकारी, तेल, घांसवाली र खाली जग्गा भन्दा वढि कार्वन निस्केको पाईएको छ ।

- विभिन्न घांसेवाली मध्येमा मोलासेस लगाईएको माटोवाट वढि र स्टाईलो लगाईएको माटोवाट सवैभन्दा कम कार्वन उत्सर्जन भएको पाईयो ।

- कृषि अनसन्धान केन्द्र (रानीघाट) मा गरिएको परिक्षणमा खनजोत गरी लगाईएको भन्दा खनजोत नगरी जिरो टिलरको सहायताले लगाईएको गहुंखेतवाट ३७ प्रतिशत वढि कार्वन उत्सर्जन भएको पाईएको छ ।

- धानको खुमल ४ जात सामान्य तापक्रममा भन्दा OTC मा लगाउंदा वढेको तापक्रमको असरले ५ देखी १२ दिन चांडो पाकेको पाईयो साथै १००० दाना को तौल पनि वढि पाईएको छ ।

- धनुषा, वारा, मकवानपुर चितवन तथा ललितपुरको अधिकतम, न्युनतम तापक्रम र वर्षा अध्ययन गर्दा तापक्रममा खासै परिवर्तन नआए पनि हिउंदमा पर्ने पानीमा भने निकै असर देखिएको छ । खासगरि हिउंदमा पानी कूनै वर्ष निकै र कूनै वर्ष कम पर्ने पाईएको छ ।

EXECUTIVE SUMMARY

The Agricultural Environment Unit has been upgraded to Agricultural Environment Research Division in this Fiscal Year 2069/70. This division has contributed to agricultural research sector through various efforts. To make weather data base, automatic weather station has been installed at Agricultural Research Centre (Pasture), Rasuwa as representative of hilly region of Central Development Region. Weather data has been shared and facilitated among different stakeholders including NGOs, INGOs and academic institution's researchers and students. It has also played important role to provide valuable information, suggestions and guideline regarding activities of Agricultural Environment Research Division, weather and climate of different parts of Nepal, agricultural technologies with respect to changing climate. The division encouraged the technical and administrative staff to update them through training, seminars and workshop. It has also made effort to discuss with experts and planner about future work and direction of agriculture environment research in Nepal. Besides these activities, various field as well as lab experiment has been accomplished on about the agriculture and their interaction with weather and climate and come up with valuable upshots as follows:-

- Rice variety (Khumal 13) was found better in terms of grain yield than Khumal 4 and second week of July was best time for transplanting in mid-hill condition (Khumaltar). Similarly, wheat variety WK 1204 was superior over Danphe for higher grain yield. Wheat sown on November first week resulted higher grain yield than delayed sowing which resembles with the previous year result at same location.

- Highest CO_2-C emission was observed in Bhaktapur district followed by Tanahu among nine districts *viz.*, Bhaktapur, Dhanusha, Kathmandu, Lalitpur, Mahottari, Nuwakot, Rasuwa, Rupandehi and Tanahu. Lowest CO_2-C emission was found in Dhanusha followed by Mahottari district. Field grown with Brocaulli emitted lowest CO_2-C followed by chilly, Tori, tomato, and wheat and highest was recorded in cabbage field followed by onion and potato. Field covered with cereal crops had higher CO_2-C emission followed by pasture and vegetables. Oilseed grown field had lower CO_2-C emissions than fallow land.

- Pasture field in ARS, Rasuwa and Bandipur with Molasses had highest CO_2-C emission followed by signal. Lowest was observed in stylo cropped field.

- In experiment field of ARS, Ranighat, CO_2-C flux was around 37 percent higher in zero tillage, which is vey contrast with the most of the finding around the world. One of the reasons might be higher temperature in field than conventional tillage.

- Khumal 4 variety of rice matured 5-12 days earlier in elevated temperature condition (OTC condition) than in open field. Average grain yield of the three dates of the transplanting under both conditions were same. However, the biomass yield and 1000 seed weight was higher under OTC in all three dates of transplanting.

- Little change in maximum and minimum temperature over the year in five locations of Central Development Region's districts (Dhanusha, Bara, Makwanpur, Chitwan and Lalitpur) was observed over the years. The variation in maximum and minimum temperature and rainfall was higher in winter season than the summer season in all five locations. Variation in winter rainfall was notably higher and therefore, demands development of short durational winter crop varieties and assured irrigation facilities.

1. WORKING CONTEXT

Nepal is an agricultural country with two third of population are getting involved in this sector. In addition, the increasing population and food demand make this sector of prime importance to be food secured country. Moreover, global warming and weather anomalies are becoming too alarming to overlook which plays very crucial role in whole agriculture system productivity. Climate variables either spatial or temporal can influence the crop productivity, production and the agricultural system as a whole. The database on agro-meteorological record from various stations will be helpful to interpret cause and effect whenever necessary and to explain and predict production performance in a given set of environment and use in crop modeling. 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 to agricultural scientist to plan breeding programs and crop management practices for the future. The contribution of agriculture sector to Green house gases (GHGs) emission is of great concern. The division is currently monitoring CO_2 emission from crop, pasture and horticultural cropped land under different management practices in different parts of the country. Agriculture sector also plays important role to minimize rising the CO_2 by sequestrating in form of biomass or organic matter in soil. The division is also to working on these aspects. It has taken collaboration as top priority and currently working together with national and international organizations in different aspects of researchable issues.

2. INTRODUCTION

2.1 Introduction

The Agricultural Environment Unit was established in the F.Y. 2000 in Khumaltar, Lalitpur under the Directorate of Planning and Coordination, Nepal Agricultural Research Council (NARC). It aims to contribute in the protection of the environment for secured and increased agricultural productivity for livelihood enhancement. The Agricultural Environment Unit was upgraded to Agricultural Environment Research Division in the Fiscal Year 2013.

2.2 Goal

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

2.3 Objectives

- Raise awareness and seek solutions for agriculture related environmental issues ensuring a safe and sustainable agricultural development.

- Assess impact of climate change on agriculture and study adaptation options for reducing vulnerabilities.
- Study agriculture research and development on system perspective using modern tools like GIS, crop models etc.
- Support commodity programs, divisions and research stations to develop climate resilient technologies.
- Assist NARC in preparing policy guideline on agriculture related environmental and climate change issues.

2.4 Strategies

- Identification and prioritization of environment related problems in agriculture.
- Develop system perspective agricultural technologies through decision support tools.
- Support to 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.
- Capacity enhancement of different stakeholders in understanding climate change and its impact on agriculture.

2.5 Current thrust areas for research

- Understand farmer's perception on climate change.
- Climatic variability of various location and response of crop.
- Crop performance under simulated environment (eg. elevated temperature)
- Yield characterization and forecasting.
- GHGs emission under different agricultural soil and system.
- Carbon sequestration in agricultural, plantation and horticultural crops.

2.6 Infrastructure and facilities

- **Automatic weather station:** Time series 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

2.7 Organization structure and human resources

The structure of this division is given in Fig 1 and detail of human resources in 2069/70 has been presented in Annex 2.3.

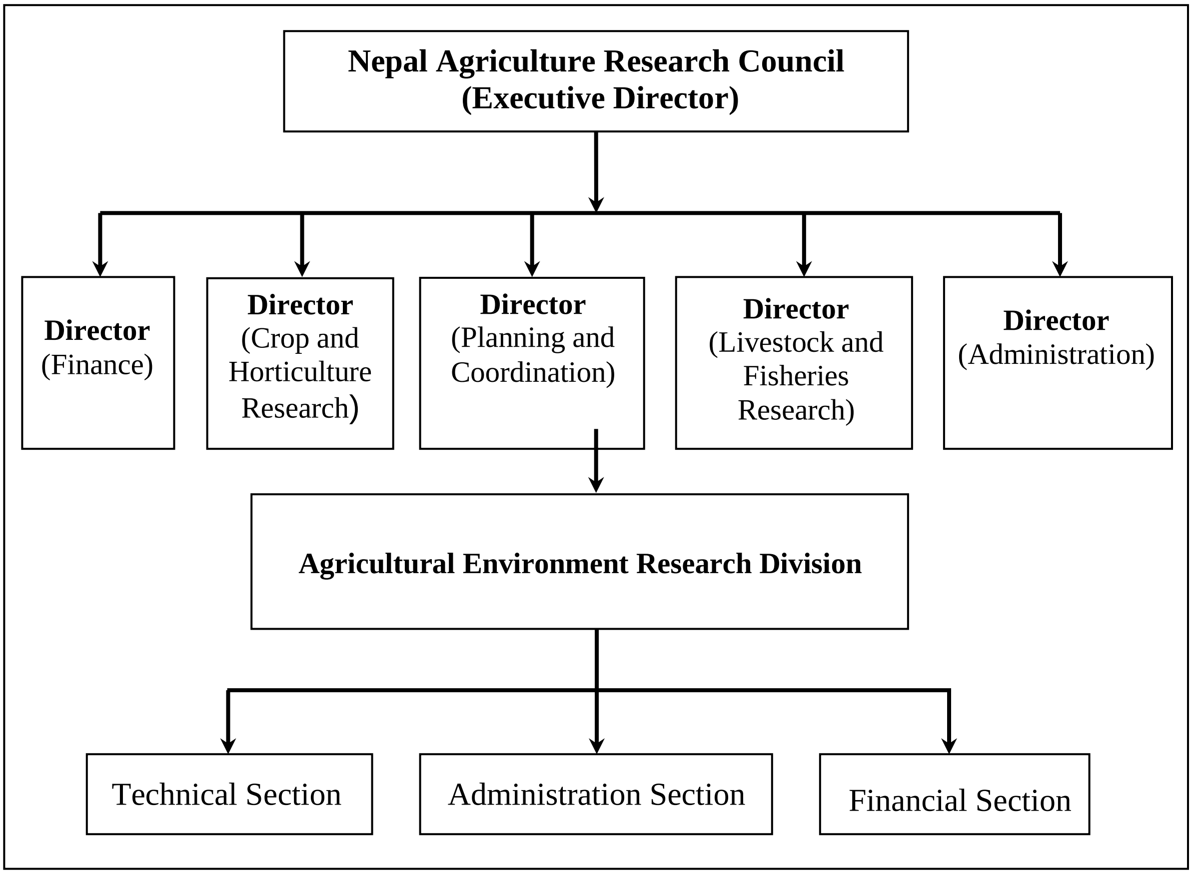


Fig 1: Organizational structure of Agricultural Environment Research Division

3. RESEARCH HIGHLIGHTS

3.1 Study on transplanting / seeding dates of rice and wheat to adapt climate variability

The Nepalese agriculture is heavily dependent on the natural rainfall brought by monsoon. The onset, duration, intensity and withdrawal have large impact on the crop production. Varying rainfall patterns has large impact on transplanting time and finally on economical yield.

With the objective of finding appropriate date of transplanting or sowing, two varieties of rice and wheat were transplanted or sown at Khumaltar condition in 2069/70.

A field experiment with two varieties of rice (Khumal 4 and Khumal 13) as main plot and three dates of transplanting (19th June, 29th June and 9th July) as sub-plots was carried out on split plot design during rainy season in 2012 at Khumaltar conditions. Fertilizers were applied @ 100:30:30 kg/ha $N:P_2O_5:K_2O$ in single dose.

Grain and biomass yield were non significant as affected by main plot however Khumal 13 produced higher grain yield (5.9 t/ha) compared to Khumal 4 (5.7 t/ha) which was attributed to significantly higher 1000 grain weight. Khumal 4 had significantly higher plant height. Khumal 13 flowered and matured 7 and 5 days earlier than Khumal 4, respectively (Table 1).

Third date of transplanting (9th July) resulted higher grain and biomass yield than other dates. Spike length and grains per panicle was significantly higher in rice transplanted on 9th July than crop transplanted on other dates. Rice transplanted beyond 19th June flowered and matured earlier. Crop sown on third date took 2 days lesser than second date to flower and 7 and 5 days lesser to flower and mature, respectively, than first date (Table 1).

Table 1: Agronomical parameters of rice at Khumaltar in 2069-70 (2012/13)

Treatment	Days to flowering	Days to maturity	Plant height (cm)	Tillers per hill	Spike length (cm)	Grains per panicle	Grain yield (t/ha)	Biomass yield (t/ha)	1000 grain weight
Varieties									
Khumal 4	106	103	140	10	26.7	183	5.7	11.0	17.9
Khumal 13	101	98	123	9	21.5	135	5.9	11.0	26.6
S.Em ±	0.6	0.7	0.80	0.07	1.1	6.8	0.3	0.43	0.6
C.D. at 5%	3.5	3.1	4.9	ns	ns	9.6	ns	ns	3.8
Dates of transplanting									
19th June	106	104	134	10	27.1	173	5.2	10.6	22.3
29th June	103	101	132	9	22.6	151	5.8	10.5	22.4
9th July	101	99	130	10	22.5	154	6.4	11.9	22.1
S.Em ±	0.7	0.9	2.37	0.6	1.2	11.4	0.5	0.74	0.8
C.D. at 5%	2.2	2.0	ns	ns	4.0	16.0	ns	ns	ns
CV (%)	1.6	1.5	4	15.3	12.5	17.6	20	16.5	8.3

Another experiment was carried out in split plot design with wheat varieties (WK 1204 and Danphe) as main plot and dates of sowing (6th Nov, 16th Nov and 26th Nov) as sub plot to find appropriate sowing dates and variety during winter season in 2069-70 at Khumaltar conditions.

All the parameters were non significant. The grain and biomass yield of WK 1204 was higher compared to Danphe which can be attributed to higher number of tillers per m^2 and grains per panicle. Danphe had higher 1000 grain weight than WK 1204.

Table 2: Agronomical parameters of wheat at Khumaltar 2069/70 (2012/13)

Treatments	Plant height (cm)	Tillers / m^2	Ear length (cm)	Grains per panicle	Grain yield (t/ha)	Biomass yield (t/ha)	1,000 grain weight (g)
Varieties							
WK 1204	81	240	9.1	44	3.5	6.3	39.0
Danphe	87	216	9	41	3.0	4.9	41.6
S.Em ±	2.0	19	0.5	1.2	0.5	0.6	1.9
C.D. at 5%	ns	ns	ns	ns	ns	ns	ns
Dates of Sowing							
6th Nov.	88	214	9.5	45	3.9	8.0	40.7
16th Nov.	88	224	9.0	43	3.0	4.6	40.4
26th Nov.	76	247	8.6	40	2.9	4.1	39.8
S.Em ±	2.3	19.7	0.3	3.2	0.4	0.6	2.0
C.D. at 5%	7.4	ns	ns	ns	ns	2.0	ns
CV (%)	6.6	21.2	7.8	18.5	30.6	11.5	12.7

As the wheat sown later than 6th November at Khumaltar conditions, grain and biomass yield had been decreased. Among three wheat dates of sowing, first date of sowing resulted higher grain yield (3.9 t/ha) than other dates which was due to more number of grains per panicle and higher 1000 grain weight. Biomass yield was significantly higher in crop sown on 6th November than others. Crop sown on third date had significantly lower plant height than other dates (Table 2).

3.2 Estimation of carbon emission from different cropping pattern at farmers' field.

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. However, the anthropogenic activities including deforestation, mechanization, use of excessive fertilizers and different cropping patterns has posed serious threat in environment and contribution of greenhouse gases from the agriculture sector. Food insecurity and loss of livelihood are foreseen due to loss of cultivated land and the country facing continuous drought and adverse weather condition. CO_2 emission from agricultural soil mainly depends on microbial activities on organic matter. Higher emission of CO_2 from soil depletes the organic matter content and thus reduces the soil productivity as well as fertility. Since agriculture sector is highly vulnerable and demands immediate adaptation measures, it is indispensible to know emission rate and measures for reducing emission from this sector.

The assessment was carried out in farmers and research field to estimate CO_2-C emission from different cropping patterns from nine districts as: Bhaktapur, Dhanusha, Kathmandu, Lalitpur, Mahottari, Nuwakot, Rasuwa, Rupendehi, Tanahu. Districts were selected randomly. Soil temperature, soil pH and soil moisture were recorded through soil pH and moisture tester. Collection of gas samples was carried out by closed chamber techniques. Soil temperature is important factor for microbial activity. Nitrification process does not begin unless the soil temperature reaches to 40°F and most favorable limits being 80 to 90°F (Brandy, 1964). Temperature above 40°C and less than 5°C, because of inactivation of the biological oxidation system, partial decrease of emission occurs (Pathak *et al*., 2003). So CO_2-C emission is also governed by soil temperate.

Among 174 samples, pH of the soil of ranged from 5.7 to 6.5. The soil moisture index ranged from 0 to 8 (Table 3).The CO_2-C flux was recorded highest of 188 mg/ha/hr in Bhaktapur district and lowest of 58 mg/ha/hr in Rupendehi. It was observed that the CO_2-C emission has influenced by the both soil temperature and moisture in most of the districts.

Table 3: CO_2-C emission and other parameters at different districts

District	Locations	Moisture index	Soil temp. (^oC)	Soil pH	CO_2-C (mg/ha/hr)
Bhaktapur	Bode	8.0	14.2	5.7	188
Dhanusha	Hardinath	2.2	19.8	6.1	58
Kathmandu	Mulpani	7.6	15.0	6.1	155
Lalitpur	Chapagau	8.0	13.4	6.0	115
Mahottari	Sarahawa	7.1	13.2	6.0	77
Nuwakot	Trishuli	4.0	23.7	6.2	130
Rasuwa	Dhunche	2.4	22.3	6.5	145
Rupendehi	Bhairahawa	0.0	25.1	5.8	56
Tanahu	Bandipur	0.8	20.1	6.3	178

Moisture (8=Sutured, 0=dry)

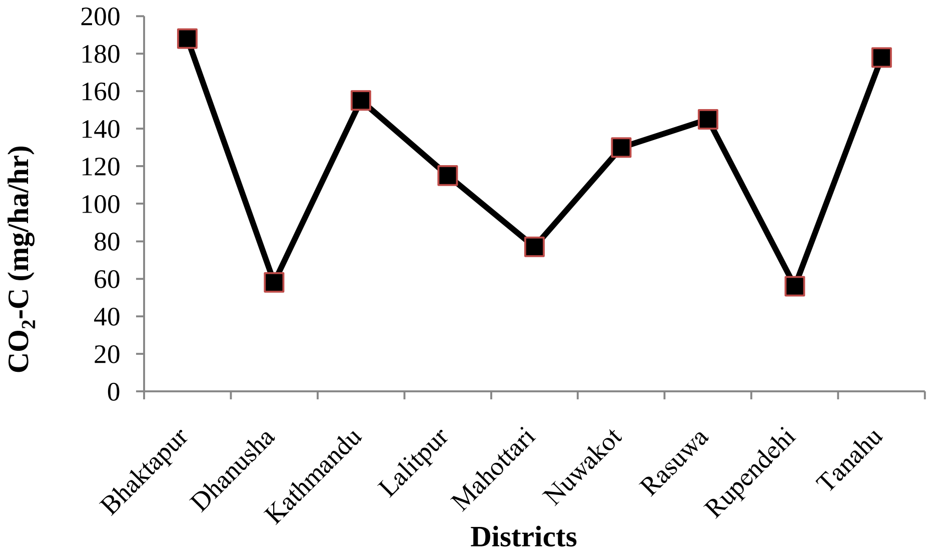


Figure 2: CO_2-C emission and soil temperature

The presence of crops also influences carbon dioxide emission from soil. The emission was found in a range of 5 to 314 mg/ha/hr with highest (314 mg/ha/hr) from the soil grown with Carrot in Bhaktapur district and lowest (5 mg/ha/hr) from Brocauli with analysis of 154 samples (Figure 3). The fallow land emitted 170 mg/ha/hr CO_2-C.

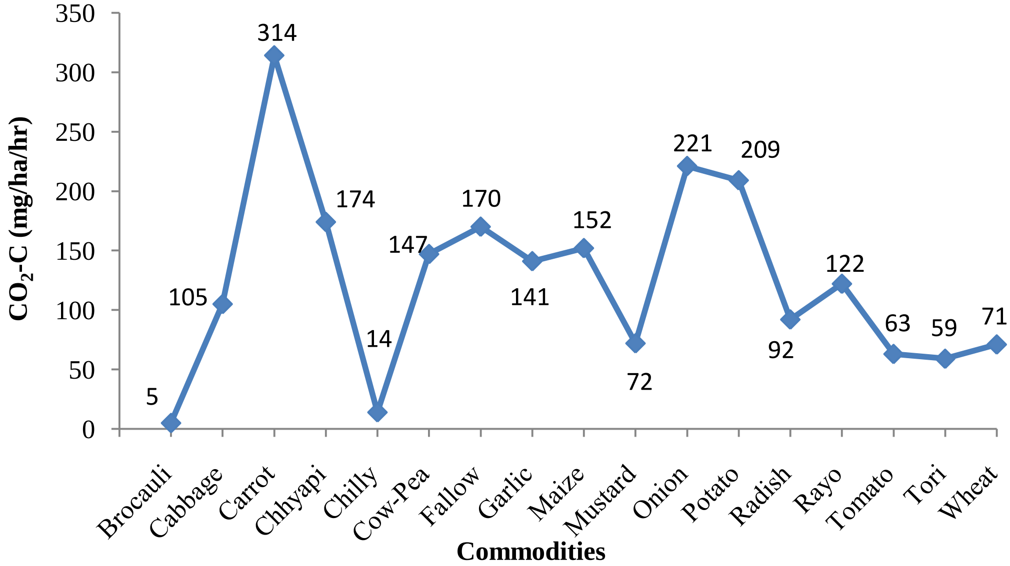


Figure 3: CO_2-C emission from soil grown with different crops

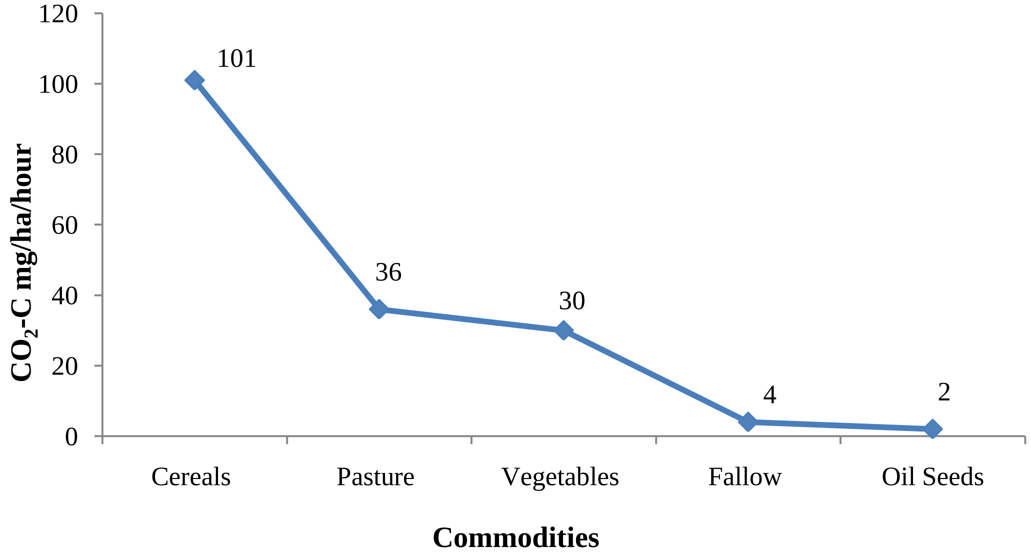


Figure 4: CO_2-C emission from soil grown with different commodity

The observation taken from different field was categorized on the basis of standing crop in field and analysis was done accordingly. Result showed that filed with standing cereal crop had higher emission (101 mg/ha/hr) whereas oilseed crop field (2 mg/ha/hr) showed lower emission (Fig 4).

3.3 Estimation of carbon emission from pasture field

Soil is important source of greenhouse gases from agriculture sector. The major greenhouse gases from agriculture sector are; carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Peat soils are considered to exhibit relatively high emission rates. Over the recent past, changes in land-use, mainly the clearing of forests to crops and pastures, have generated emissions of CO_2 to the atmosphere of similar magnitude than those caused by fossil fuel burning. Yet the flux of carbon induced by land-use and land cover changes is very uncertain to estimate. A difficulty is that one must account not only for the initial loss of carbon following conversion, but also for the delayed fluxes, which can evolve from an initial source to a later sink after recovery or re growth of secondary ecosystems. Following conversion, such residence times may decrease as when forests are cleared for pastures or croplands, or increase, as when croplands are abandoned or deforested. Thus, land-use change leads to atmospheric CO_2 increase in two ways: directly because of the net carbon loss during and after conversion, and indirectly because it reduces the global sink potential of the terrestrial biosphere, due to reduced turnover times of excess carbon.

The assessment was carried out in the field of ARS, Rasuwa and ARS, Bandipur to estimate CO_2-C emission from different pasture land. Soil moisture and pH were taken by soil moisture and pH meter and soil temperature with thermometer. Collection of gas samples was carried out by closed chamber technique and finally subjected to measure with help of CO_2 monitor. Forty-four samples has been collected and analyzed from two locations.

The result showed that the emission ranged from 63 to 247 mg/ha/hr. It was found highest in the molasses pasture land with 247 mg/ha/hr and lowest was observed in stylo land with 63 mg/ha/hr (Figure 5). Surprisingly, the emission from red clover was found significantly lower (65 vs.171) which might be due to other influencing factor including soil temperature, moisture. One of the reasons of higher emission in red clover pasture land is due to being leguminous crop.

Table 4. CO_2-C emission from different pasture field at ARS Rasuwa and Bandipur in 2012

Crops	Air Temp (°C)	Flux (mg/ha/hr)	Soil Temp (°C)	Soil pH	Moisture
Cocks foot	24.7	149	19.6	6.6	2.7
Desmodium	25.0	206	20.4	6.3	0.0
Forage Peanut	23.0	197	18.9	6.2	0.0
Gini	23.0	139	21.6	6.0	0.0
Molasses	24.4	247	21.5	6.0	0.0
Oat	26.0	144	17.0	6.6	4.5
Paspalum	24.4	163	20.3	6.0	0.0
PhurKhasro Khasro	22.3	134	19.8	6.6	5.0
Red clover	24.0	65	20.9	6.4	2.0
Setaria	24.8	136	20.7	6.5	1.6
Signal	25.0	236	18.9	6.8	2.5
Stylo	22.0	63	18.2	6.6	4.0

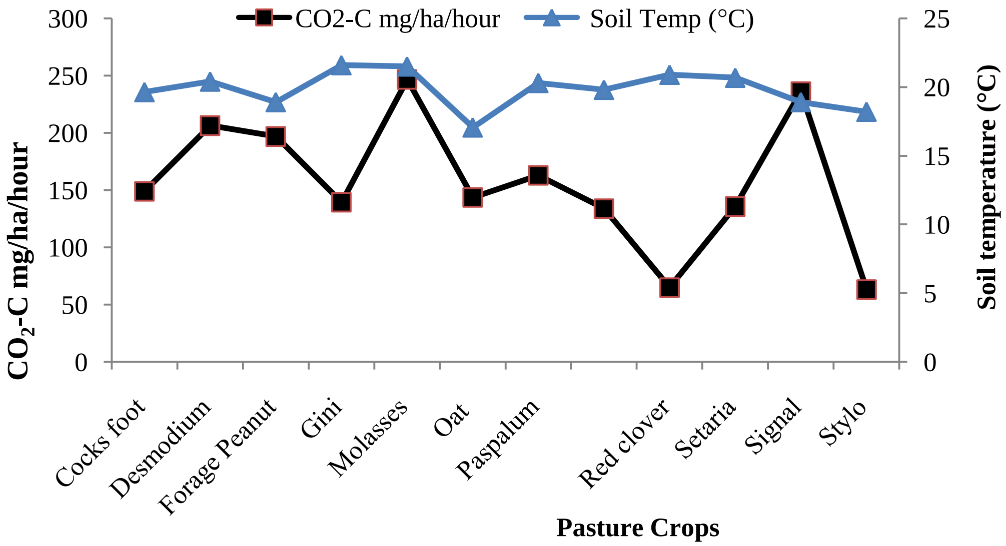


Fig 5. Comparison between CO_2-C flux and soil temperature in different pasture field.

3.4 Assessment of carbon emission estimation from different tillage practices

Tillage practices, as other management practices, play vital role which has direct and indirect impact on soil physical, chemical and biological properties ultimately on crop growth and development. Thus, it has remarkable impact on amount of carbon-dioxide emission. Most of the study conducted in different parts of world reflects higher emission of gas in conventionally tilled wheat field compared to minimum tillage. Therefore, appropriate management of soil can be the viable option to reduce the carbon-dioxide emission from agricultural soil and to increase its sequestration in soil with maintaining optimum production level which is of great concern through sustaining soil productivity and fertility. Thus, study of carbon emission from rice field under different tillage practices was done to estimate and analyze the pattern of emission.

Table 5: Flux estimation in different tillage practices in Wheat Bhairahawa (2012/13)

Tillage Practices	Air temp (°C)	Soil temperature (°C)	Soil pH	Soil moisture	CO_2 Flux	% change
Conventional	29.4	26.2	7.7	0	49	-
Zero tillage	30.6	26.4	5.8	0	67	36.73

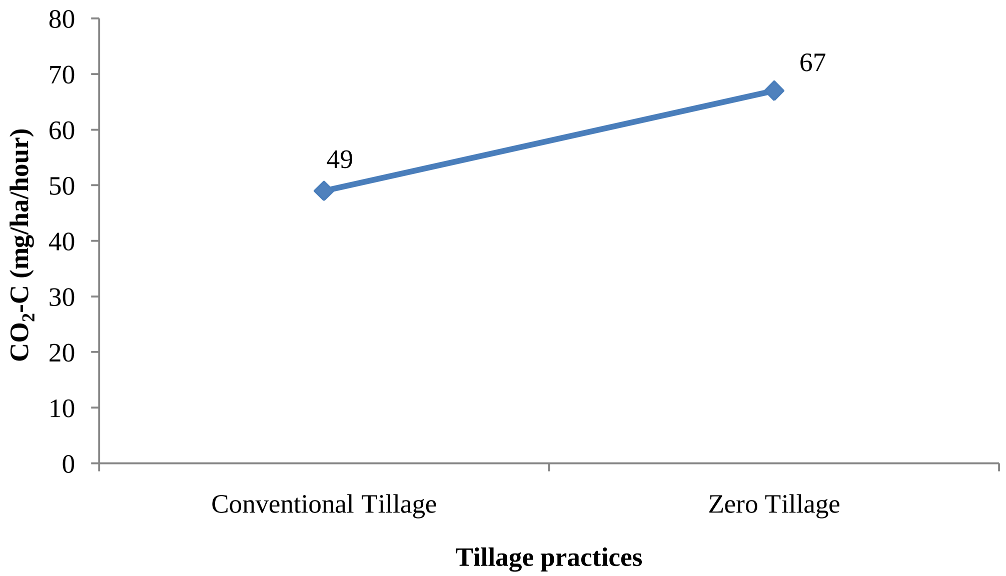


Fig 6: CO_2-C emission from different tillage practices in wheat at Bhairahawa

Forty-five samples from experiment conducted at Bhairahawa with two tillage practices *viz*. conventional tillage and zero tillage was analyzed. The result showed that higher CO_2-C flux in zero tillage fields than conventionally tilled field at time of harvesting stage of standing crop. CO_2-C flux is around 37 per cent higher in zero tillage, which is very contrast with most of the finding around the world. One of the reasons might be higher soil temperature and lower pH than conventional tillage. Further, detailed study has to be carried-out in this regard.

3.5 Study on crop adaptation in rice under different temperature regime in open top chambers (OTCs)

Air temperature is important to agriculture because it influences plant growth through photosynthesis and respiration, affects soil temperature, and controls available water in the soil. Farmers use soil temperatures and moisture to decide when to plant, what varieties of crops to choose, and to determine the likely development of key plant characteristics like flowering as well as incidence of insect pests and plant diseases.

Most plants have a range of temperature at which growth occurs. Some plants are more adaptable (such as grass) and can grow throughout the range, while other plants have more specific temperature requirements. When the temperature reaches the upper end of the spectrum, in general, plant photosynthesis declines. Optimal temperatures are different from plant to plant, and can even be different within one species.

An experiment was carried out in the field and open top chamber (OTC) in 2012 at Khumaltar under irrigated condition to know the appropriate planting dates in different temperature regime. Thirty days old rice seedling of variety Khumal 4 were transplanted in three different dates of transplanting; 19^{th} June, 29^{th} June and 9^{th} July at Khumaltar conditions in 2012 at 20 x 20 cm spacing in an area of one square meter. N: P_2O_5: K_2O was applied at the rate of 100:30:30 kg/ha. Nitrogen was applied in two split doses, half as basal dose and rest at 30 days after transplanting. Total Phosphorous and potash was applied as basal. Regular monitoring of disease and insect pest was done. Phenology and yield was recorded. CO_2-C emission from soil was recorded at different period of rice growth and averaged along with soil temperature and soil content.

Table 6: Grain yield and ancillary characters of rice under different dates of transplanting, 2012

Treat ment	Maturity days	No. of tillers/hill	Plant height (cm)	Panicle length (cm)	Grain yield (t/ha)	Biomass yield (t/ha)	No of grains/ panicle	1000 grain wt. (g)
CD1	106	9	156	27.2	5.6	14.9	168	18.7
CD2	105	5.1	151	26.4	5.0	19.9	170	18.6
CD3	105	8.9	132	26.2	5.6	18.5	147	17.0
FD1	111	8.5	141	26.7	5.8	13.5	262	18.4
FD2	115	7.5	129	25.5	4.6	12.4	200	16.0
FD3	117	11.1	126	23.5	5.9	12.7	149	15.7

C = fully covered chamber with plastic, F = open field condition, D1=19th June, D2=29th June, D3= 9th July

Table 7: Temperature of Open top chamber and field condition during rice season, 2012

S.N	Condtitions	Avg. T_{max} (°C)	Avg. T_{min} (°C)
1	Open Top Chamber	32.5	18.8
2	Open Field	27.6	18.3

The average daily maximum and minimum temperature on OTC was 4.9°C and 0.5°C higher in OTC than open field condition during crop life cycle (Table 7). The crop matured 5, 10 and 12 days earlier under OTC condition than field conditions in three transplanting dates due to increased temperature respectively. It showed that increased temperature during the rice growing period reduced the crop growth period in mid-hill condition. The average plant height was found higher in OTC compared to field condition in all three planting dates. Though, the average grain yield differed in both the conditions in different transplanting dates. The overall average grain yield of OTC and open field conditions was similar. However, the biomass yield in each transplanting dates was higher in OTC than field conditions. Similarly, thousand grain weights were higher in OTC in all three dates of transplanting (Table 6).

3.6 Climatic variability in the central development of Nepal

Developing countries are most likely vulnerable to climate change and major impacts can be seen on human health, agriculture and environment. Nepal also cannot untouched with this situation rather categorized under highly vulnerable country. More than two third of the population of Nepal depend on agriculture for their livelihood and the agriculture itself shares more than two third of national GDP. Majority of the cultivated land is highly dependent on the natural rainfall which makes the agriculture system very sensitive to even a short term weather change.

The weather in Nepal varies greatly. Eastern part of the Nepal receives normal monsoon starting date being 10th June and moves towards western part of the country. The quantity of the rainfall gets lower as monsoon moves westwards. Normally, it starts during June-July and remains till September. One or two rain showers during winter season are also common phenomenon in the country. Rice is very important staple food crop in the country which is grown in most of the parts during summer season. This also describes how important is rain for rice cultivation in the country. Due to lack of irrigation facility in almost every parts of the country, rainfed agriculture is dominant in the country.

Uncertain weather and/or climatic variability is one of the significant effects brought by the global warming. There have been changes in the onset, quantity and frequency of rainfall. Understanding these changes and the trends existed could help to take right initiation and measures to mitigate their adverse effects in agriculture on time. With this thought, the unit has been studying the effect of climate change in the country. Weather records from various parts of the country representing various environments are collected, examined and analyzed. There records are updated every year for most of the weather stations which are under NARC institutions as far as the records are available.

For this study, five locations of Central Development Region viz., Hardinath, Parwanipur, Hetauda, Rampur and Khumaltar were selected for studying climatic variability as per data available from Department of Hydrology and Meteorology (DHM). Maximum and minimum temperature (°C), rainfall (mm) were taken into study and averaged seasonally (rainy and winter season) and yearly. The finding was based on the linear trend analysis and coefficient of variation of undertaken study areas. The details of stations used for time series weather records have been presented in the Table 8.

Table 8: Details of the stations

S.N.	Dev. Region	District	Name of station	Latitude N	Longitude E	Altitude (masl)
1	CDR	Hardinath	Dhanusha	26°43'	85°58'	90
2	CDR	Parwanipur	Bara	27°04'	84°58'	115
3	CDR	Hetauda	Makwanpur	27°25'	85°03'	474
4	CDR	Rampur	Chitwan	27°37'	84°25'	256
5	CDR	Khumaltar	Lalitpur	27°40'	85°20'	1350

3.6.1 Yearly Climatic Variability

3.6.1.1 Yearly Temperature Variability

The yearly temperature of different locations of Nepal has been reported to vary due course of time. Among five locations, the yearly maximum and minimum temperature were in decreasing trend in Hardinath and Khumaltar while rest of the places had increased trend of temperature range over the years. In Rampur, the increment in both the temperature is higher with 0.02°C per annum. Hardinath experienced higher decrement in temperature followed by Khumaltar. In Parwanipur, both the temperature has increased with similar rate of 0.01 per year (Table 9)

Yearly variation in maximum temperature was similar in all locations except Hardinath with least variation. Minimum temperature was varied more in Khumaltar followed by Parwanipur. Least minimum temperature variation was found in Hardinath.

Table 9: Yearly climatic variability

Name of stations	CV (%)			Change per year		
	T_{max}	T_{min}	Rainfall	T_{max} (°C)	T_{min} (°C)	Rainfall (mm)
Hardinath	0.7	1.0	23.0	-0.001	-0.003	-1.2
Parwanipur	0.9	1.4	24.5	0.01	0.01	18.5
Hetauda	0.9	1.2	19.9	0.01	0.002	-2.3
Rampur	0.9	1.2	16.5	0.02	0.02	-12.5
Khumaltar	0.9	2.0	14.2	-0.0002	-0.0003	-2.0

3.6.1.2 Yearly Rainfall Variability

The rainfall intensity, amount and distribution have great importance in agriculture sector. Except Parwanipur, the total annual rainfall has decreased over the year in all locations. The degree of decrement is highest in Rampur with 12.5 mm per year. Parwanipur experienced 18.5 mm total annual rainfall increment. Parwanipur had maximum variation in annual rainfall (24.5 mm) over the year followed by Hardinath (23 mm). Least variation was found in Khumaltar.

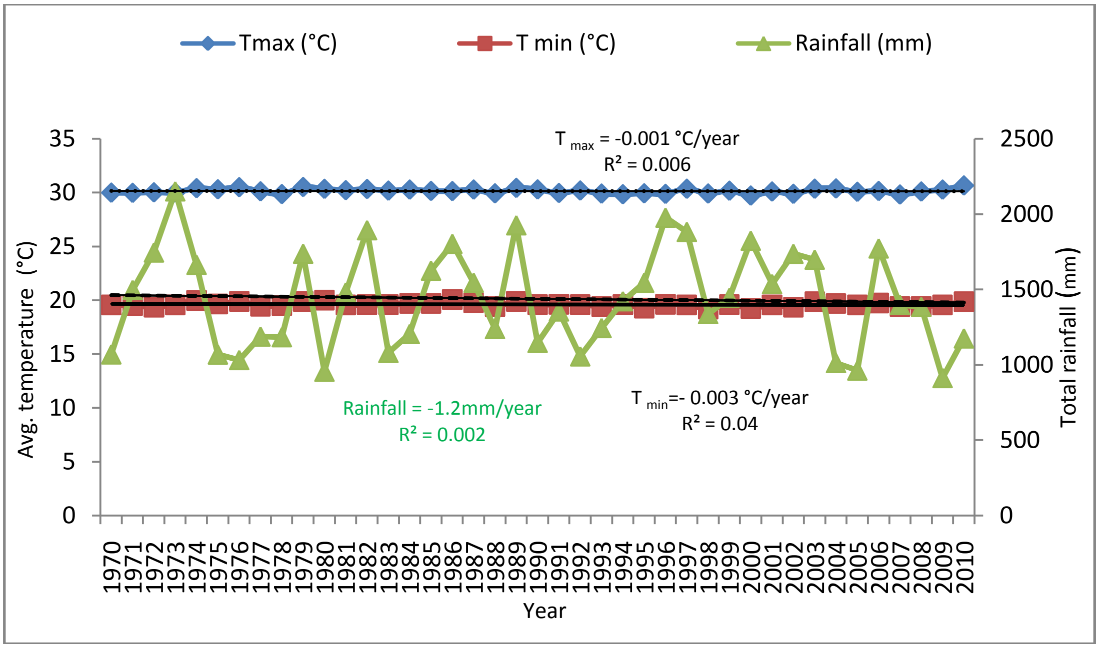


Figure 7: Average annual rainfall, maximum and minimum temperature, Hardinath (1970-2010)

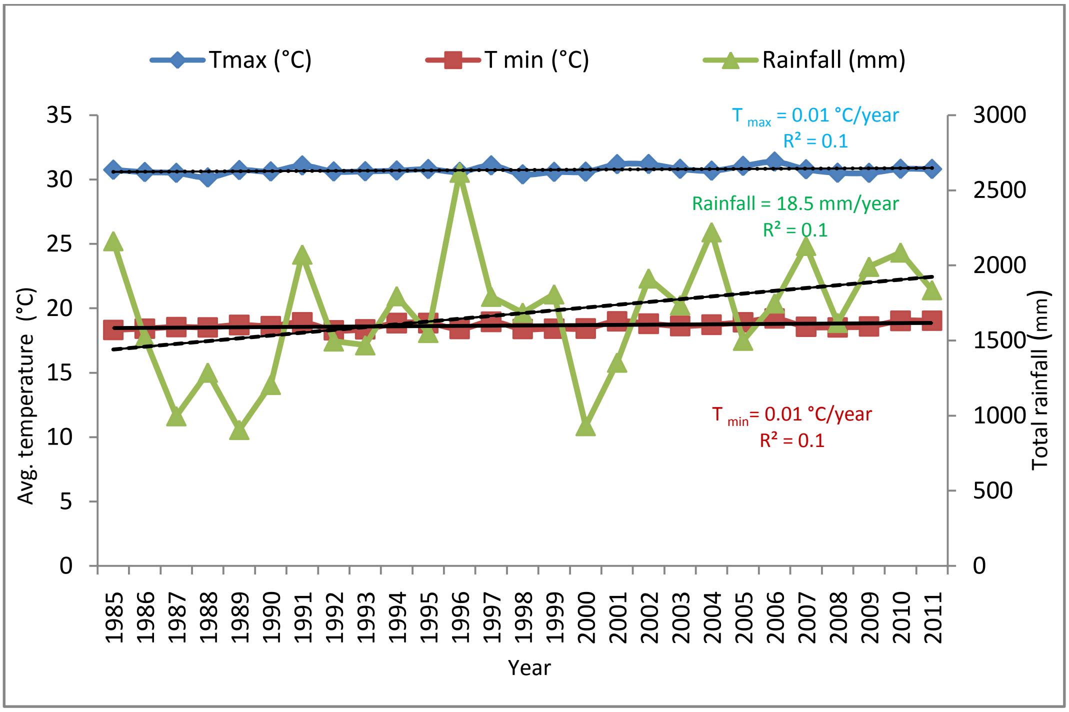


Figure 8: Average annual rainfall, maximum and minimum temperature, Parwanipur (1985-2011)

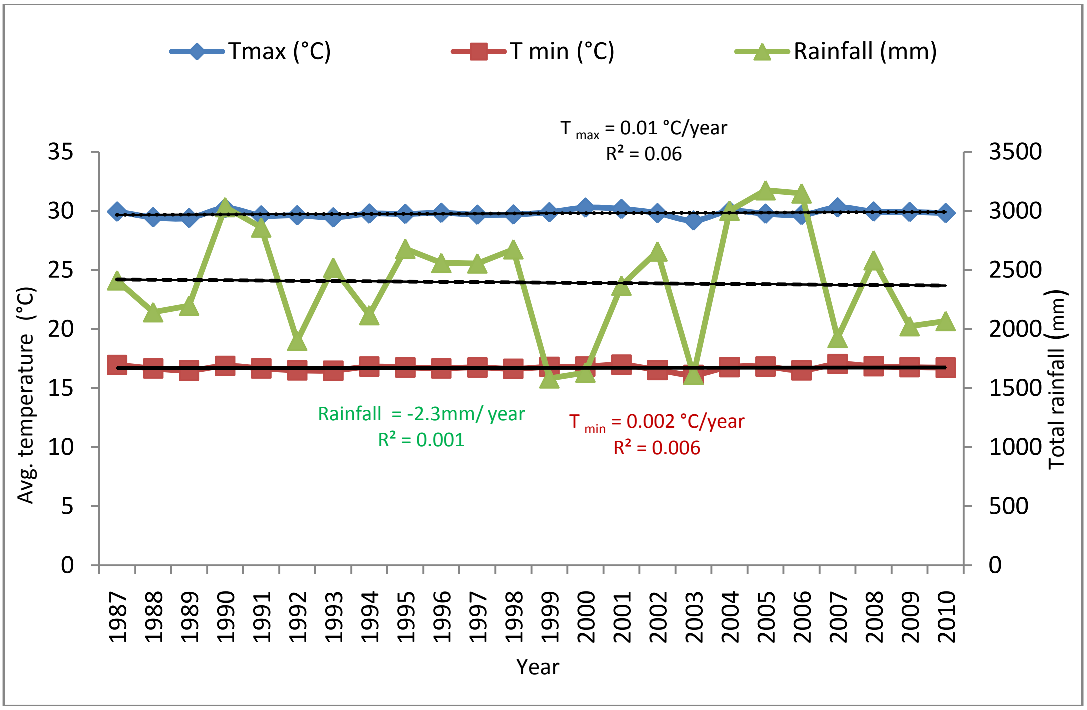


Figure 9: Average annual rainfall, maximum and minimum temperature, Hetauda (1987-2010)

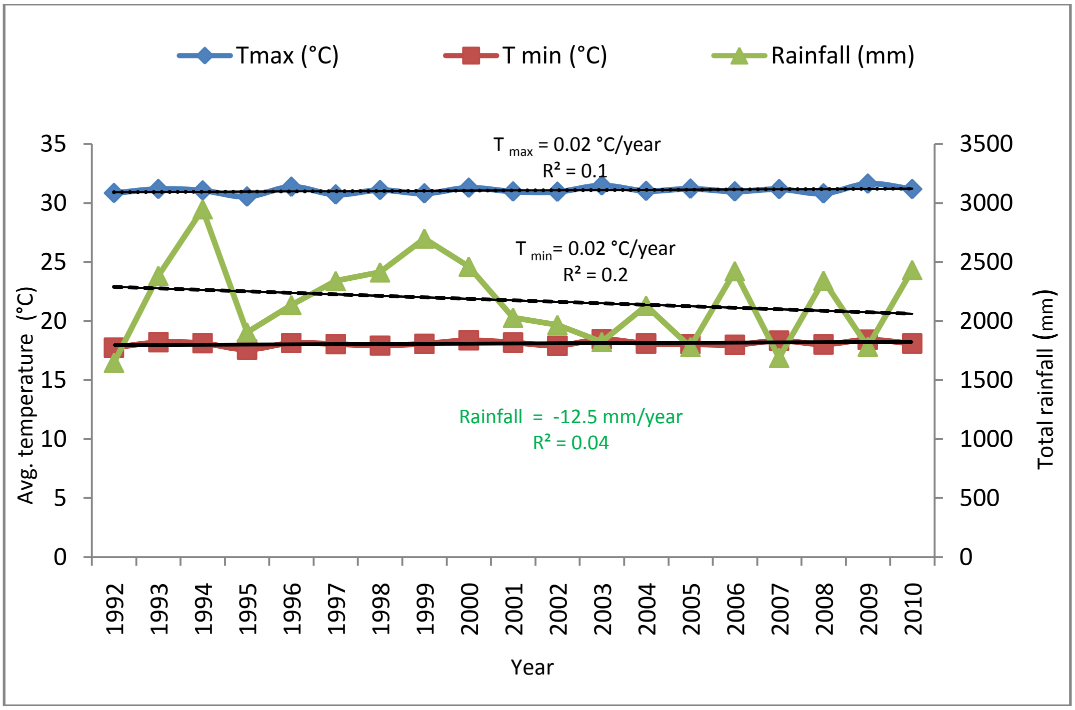


Figure 10: Average annual rainfall, maximum and minimum temperature, Rampur (1992-2010)

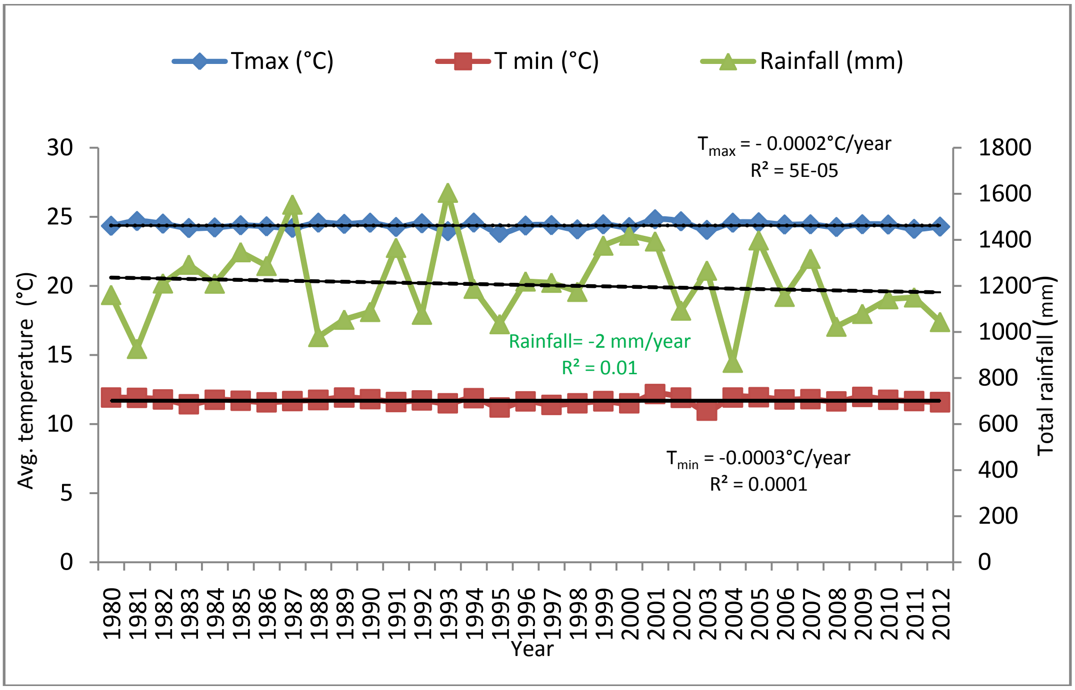


Figure 11: Average annual rainfall, maximum and minimum temperature, Khumaltar (1980-2012)

3.6.2 Seasonal Climatic Variability

3.6.2.1 Rainy Season Climatic Variability (15 June - 15 November)

3.6.2.1.1 Temperature variability

Maximum and minimum temperature in Hardinath and Rampur was in decreased trend with higher rate in Rampur. Rest of the places experienced increased temperature with highest in Parwanipur followed by Hetauda and least was in Khumaltar.

Highest variation in maximum temperature was observed in Rampur and minimum in Khumaltar while variation in minimum temperature was higher in Khumaltar (Table 10).

Table 10: Rainy season climatic variability

Name of stations	CV (%)			Change per year		
	T_{max}	T_{min}	Rainfall	T_{max}	T_{min}	Rainfall (mm)
Hardinath	1	1.3	28.3	-0.002	-0.001	-2.5
Parwanipur	1	1.6	27.3	0.01	0.01	12.5
Hetauda	1.2	1.5	26.5	0.01	0.004	-7.7
Rampur	1.4	1.3	21.6	-0.006	-0.004	-21.4
Khumaltar	0.9	1.7	17.2	0.006	0.0005	-5

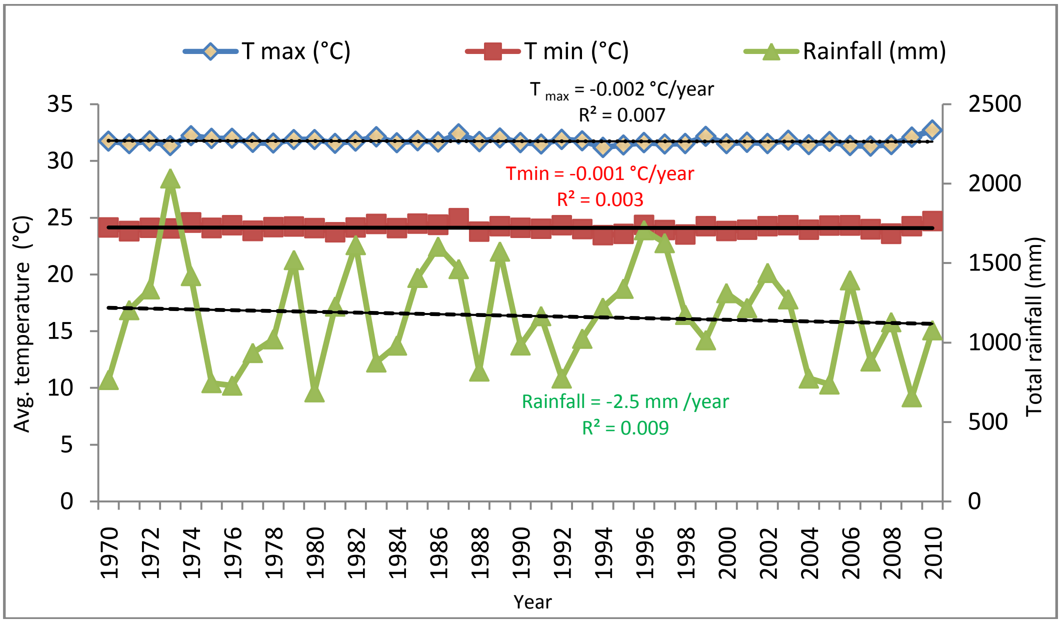


Figure 12: Average rainy seasonal rainfall, maximum and minimum temperature, Hardinath (1970-2010)

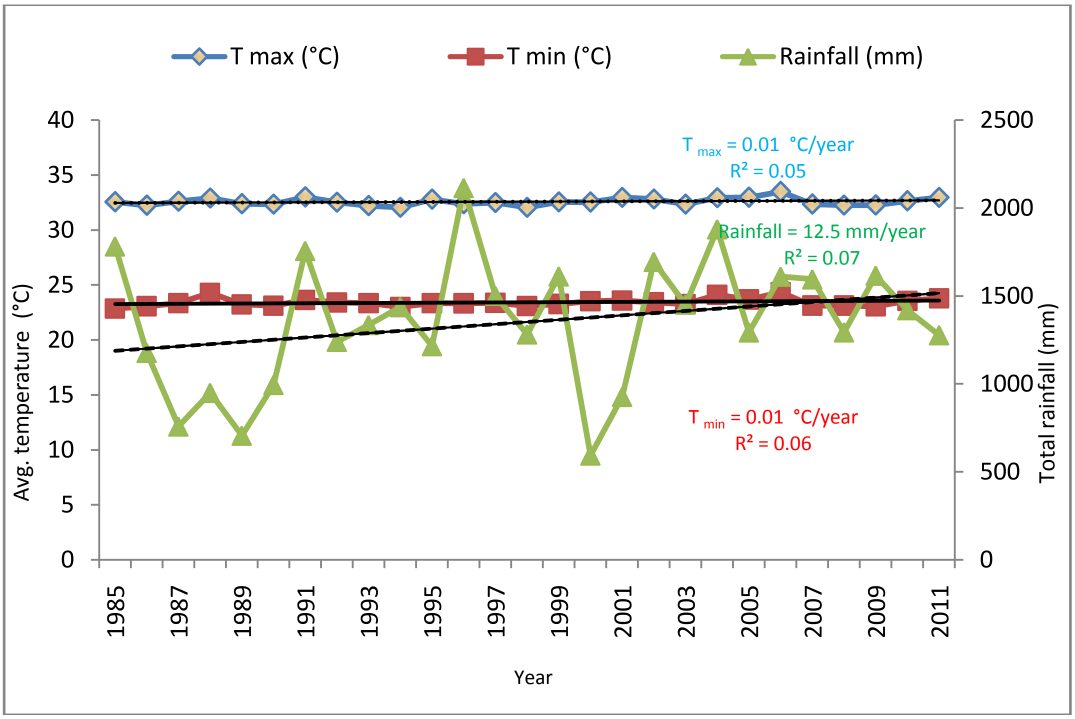


Figure 13: Average rainy seasonal rainfall, maximum and minimum temperature, Parwanipur (1985-2011)

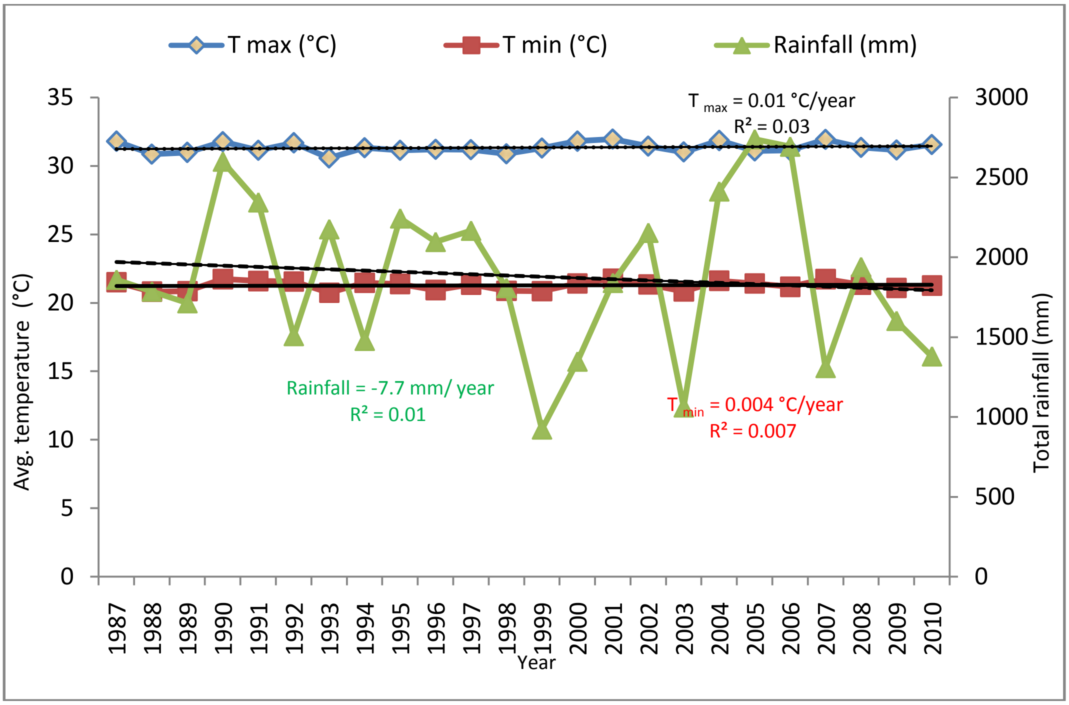


Figure 14: Average rainy seasonal rainfall, maximum and minimum temperature, Hetauda (1987-2010)

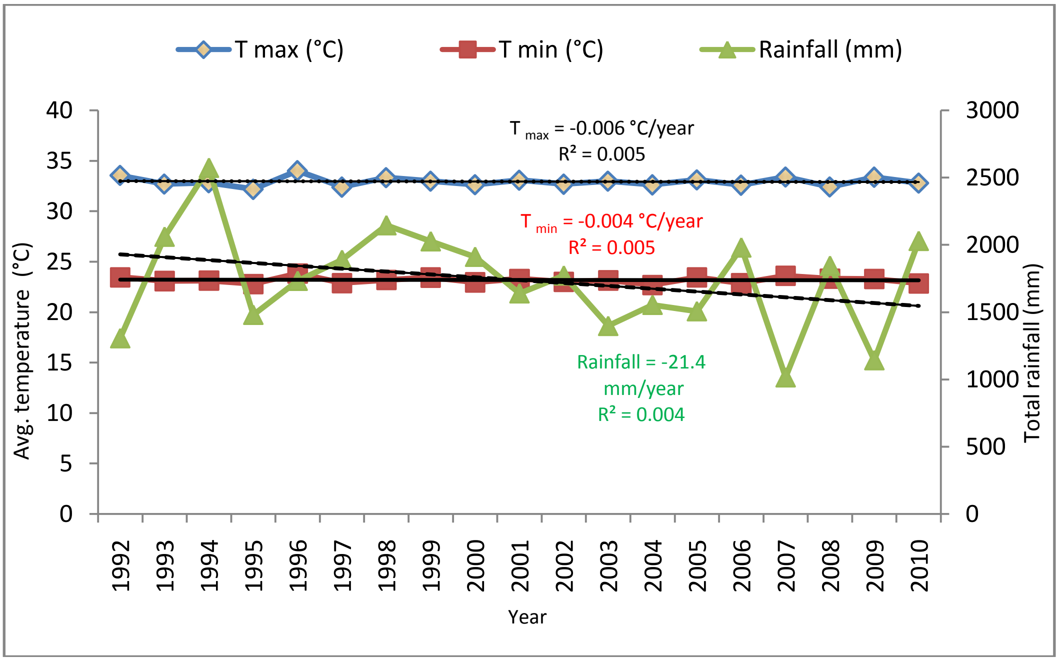


Figure 18: Average rainy seasonal rainfall, maximum and minimum temperature, Rampur (1992-2010)

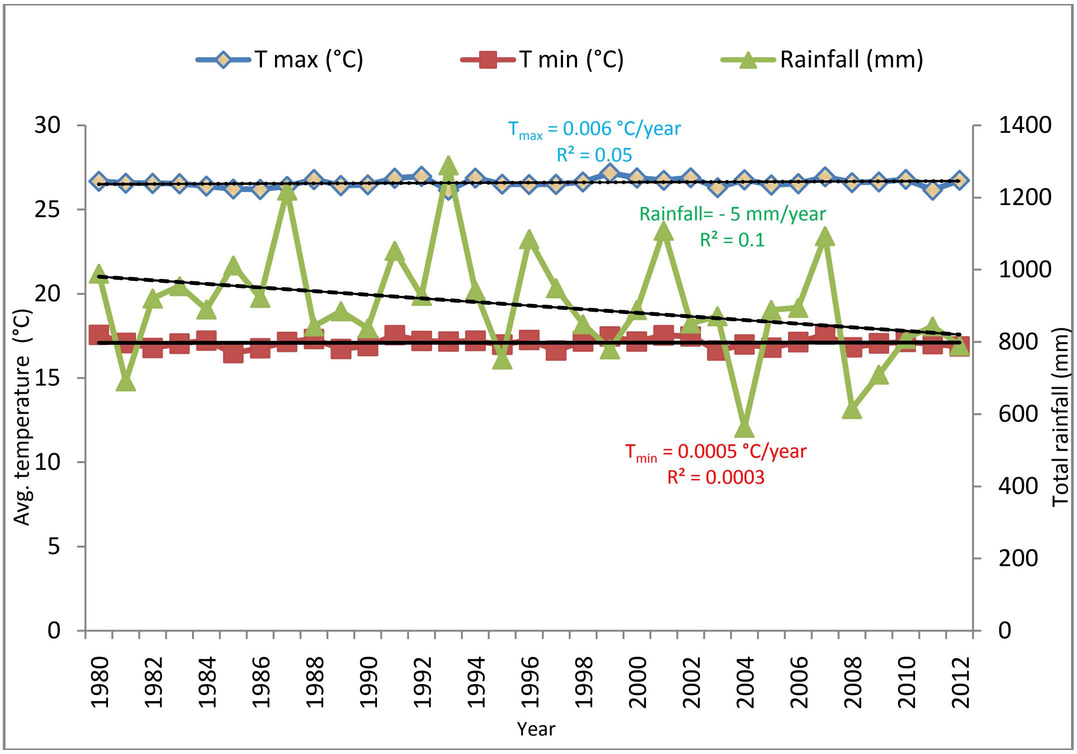


Figure 15: Average rainy seasonal rainfall, maximum and minimum temperature, Khumaltar (1980-2012)

3.6.2.1.2 Rainfall variability

Only Parwanipur experienced increased total summer rainfall per annum while in rest of the places rainy seasonal rainfall was decreased with highest rate in Rampur followed by Hetauda, Khumaltar and least in Hardinath. The summer rainfall varied most in Hardinath followed by Parwanipur, Hetauda, Rampur and least in Khumaltar (Table 10).

3.6.3 Winter Season Climatic Variability (15 November – 15 April)

3.6.3.1 Temperature variability

Winter maximum and minimum temperature was in decreasing trend in Hardinath and Khumaltar while other places had increasing trend. Hetauda experienced higher maximum temperature increment followed by Rampur and least by Parwanipur. Minimum temperature was increased with higher rate in Parwanipur and Hetauda followed by Rampur. Winter maximum and minimum temperature was varied more in Khumaltar and less in Hardinath (Table 11).

Table 11: **Winter seasonal climatic variability**

Name of stations	CV %			Change per year		
	T_{max}	T_{min}	Rainfall	T_{max} (°C)	T_{min} (°C)	Rainfall (mm)
Hardinath	1.4	2.6	52.3	-0.0006	-0.005	0.08
Parwanipur	1.6	3.7	68.0	0.008	0.01	0.4
Hetauda	1.5	3.5	36.2	0.02	0.01	0.7
Rampur	1.7	3.5	83.5	0.01	0.008	-2.4
Khumaltar	2.2	9.2	54.6	-0.01	-0.007	0.8

Maximum and minimum temperature varied greatly in winter than summer. Winter crops short duration varieties of crop; wheat, mustard, lentil and chickpea with higher adaptability in wide range of temperature should be developed for the areas with increasing trend of temperature and higher fluctuation. Proper irrigation facilities are necessary to adapt in elevated temperature during grain filling stages of winter crops.

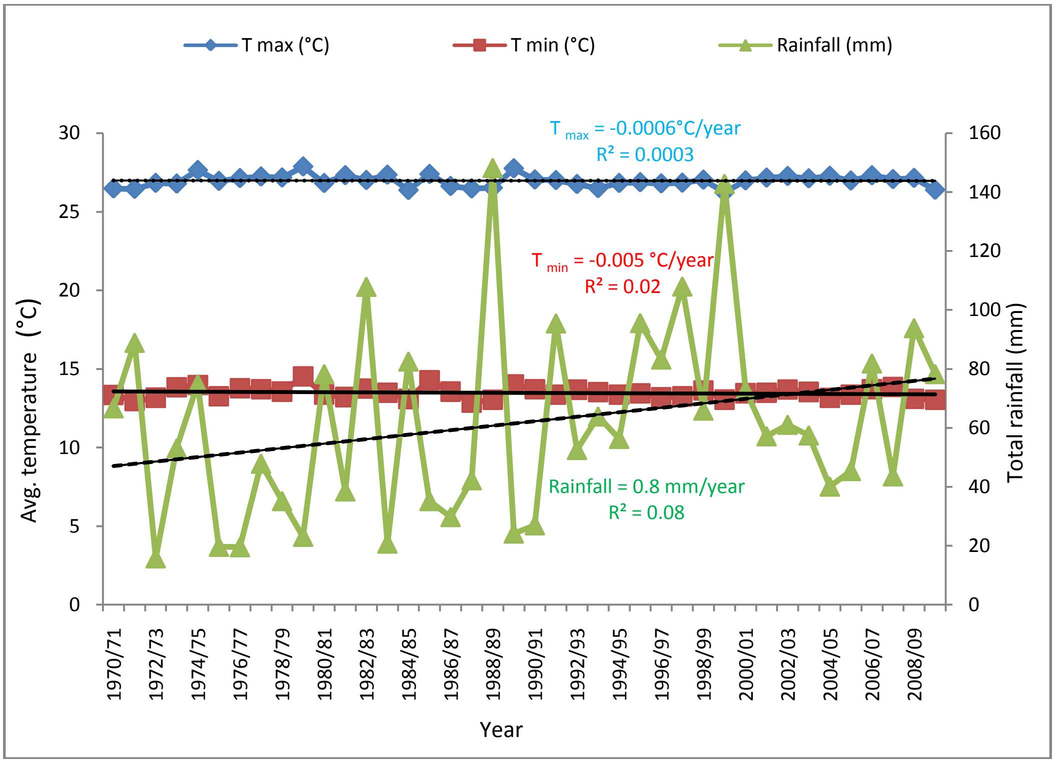


Figure 16: Average winter seasonal rainfall, maximum and minimum temperature,Hardinath (1970-2009)

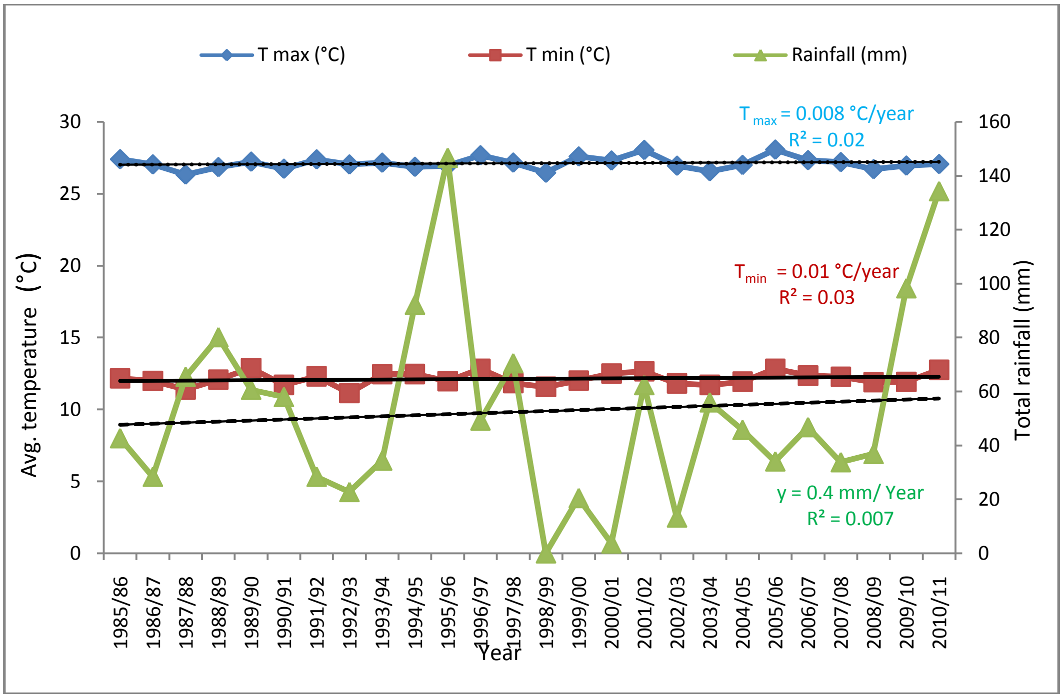


Figure 17: Average winter seasonal rainfall, maximum and minimum temperature, Parwanipur (1985-2011)

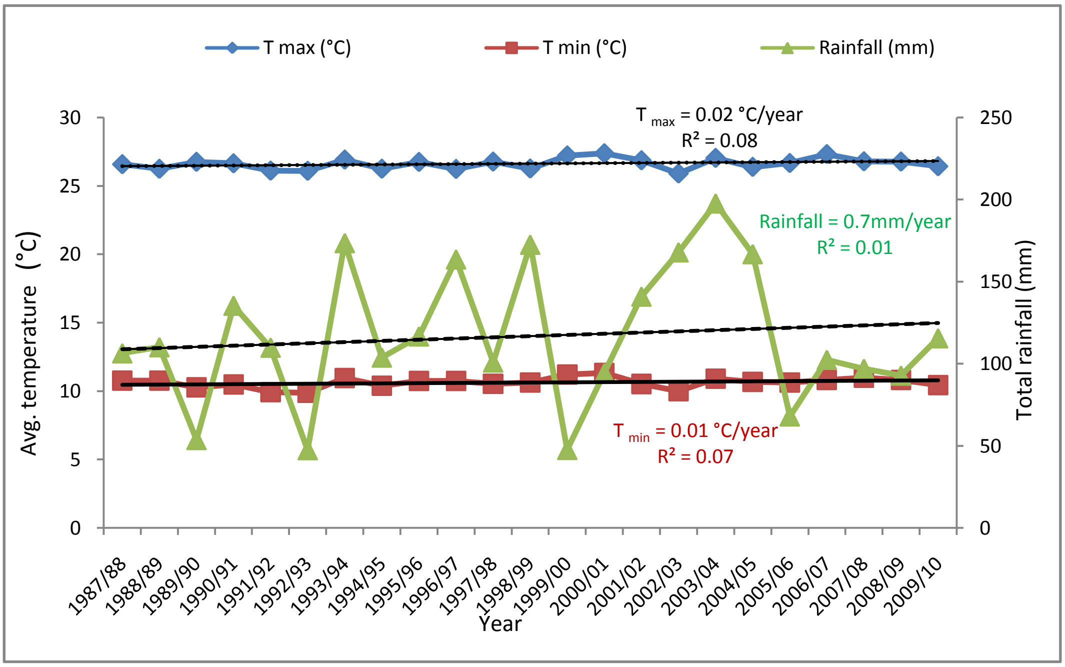


Figure 18: Average winter seasonal rainfall, maximum and minimum temperature, Hetauda (1987-2010)

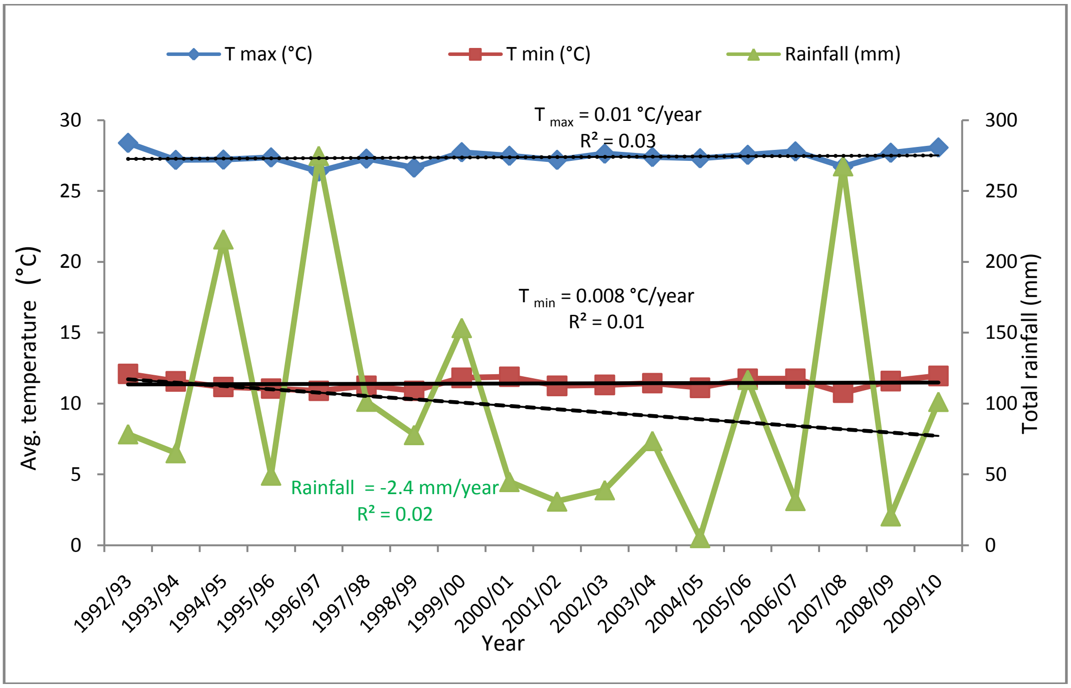


Figure 19: Average winter seasonal rainfall, maximum and minimum temperature, Rampur (1992-2010)

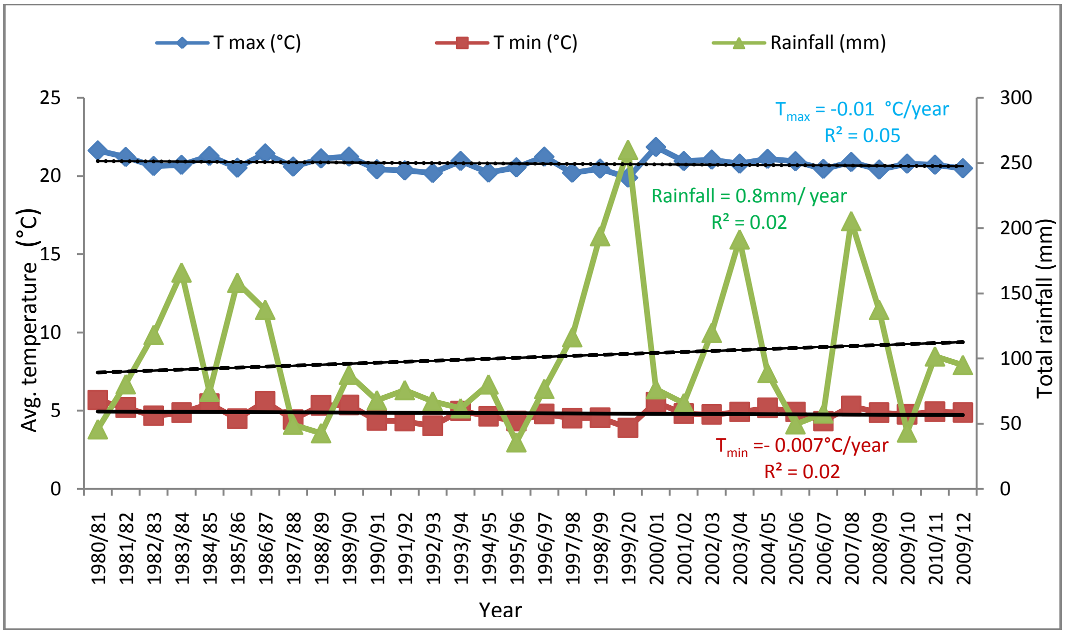


Figure 20: Average winter seasonal rainfall, maximum and minimum temperature, Khumaltar (1980-2012)

3.6.3.2 Rainfall variability

The change in annual winter rainfall was decreasing in Rampur. In other locations the trend was increasing with highest in Khumaltar followed by Hetauda, Parwanipur. Significantly higher amount of deviation in rainfall was observed in winter season compared to summer up to 83.5 percent. The variation was higher in Rampur followed by Parwanipur, Khumaltar and Hardinath. Least variation was observed in Hetauda (Table 11).

The higher unpredictability of winter rainfall suggest winter crop especially wheat grown with residual moisture and natural rainfall will be affected significantly in most parts of the Nepal.

4. PRODUCTION

Agricultural Environment Research Division does not have any mandate for production of crops, horticultural crops, livestock or fisheries.

5. TECHNOLOGY TRANSFER AND SERVICES

5.1 Training and workshop

- Agricultural Environment Unit organized one day workshop at NARI seminar Hall, Khumaltar with participation of technical personnel from various research stations. The general scenario of climate change in Nepal, its impacts on Nepalese agriculture and research strategies to cope the environmental issues were discussed.

5.2 Services

- The unit made available of meteorological data to various stakeholders including research stations, students and other concern organization.
- Technical information regarding climate change and its impacts in agriculture was provided to various stakeholders.

5.3 Publications

Besides the annual publication of Unit, number of research articles and papers has been published as given in annex 5.3.

5.4 Information through media

- Climate change and its impact on Nepalese agriculture have been disseminated through different interviews of FM Radio, TV programs.

5.5 Visits

- Students from HICAST, Environmental Science, TU and other stakeholders from different NGOs, INGOs visited to have different kind of information regarding Unit work, outputs and meteorological stations.

6. OTHER ACTIVITIES

Training/workshop attended by the unit scientist and paper presented/ published are provided in details in annex 6.1 and 6.2, respectively.

7. BUDGET AND EXPENDITURE

The total annual budget and expenditure of the Unit for regular as well as special projects are provided in details in annex 7.1 and 7.2, respectively. Revenue generated from various activities and Beruju status of the Unit is provided in annex 7.3 and 7.4, respectively.

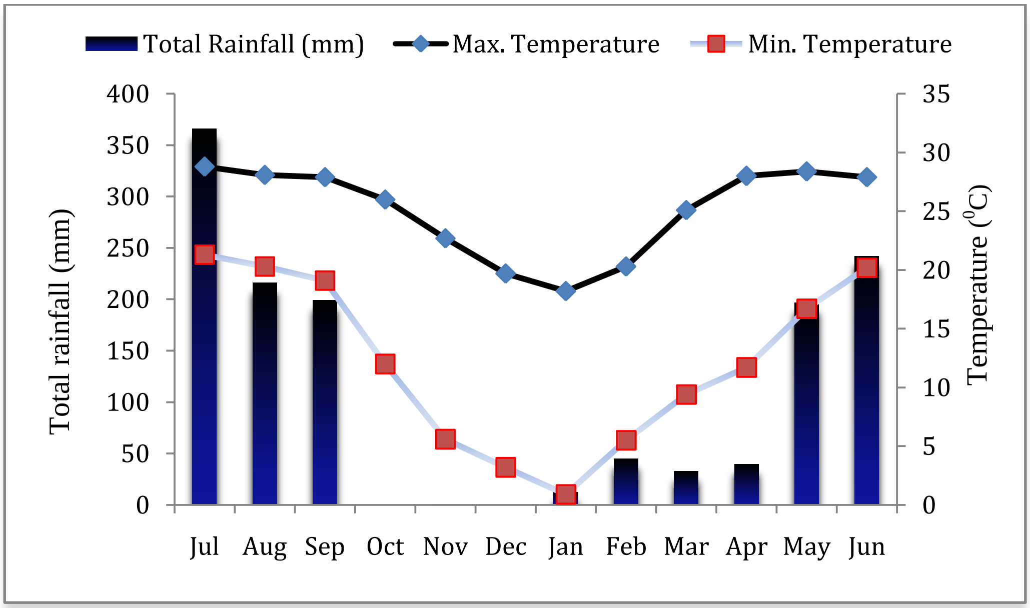
8. KEY PROBLEMS

- Lack of infrastructure for administrative block, laboratory, library and store.
- Lack of the technical human resources from all discipline.
- Lack of equipments like Gas Chromatography, SPAD meter, Leaf Area Index meter etc.

9. WAYFORWARD

- Expansion of climate change research activities to other research stations.
- Establishment of Environment Unit in each Regional Agricultural Research Stations, divisions and commodity program of NARC.
- Strengthening research stations in terms of manpower and laboratory to conduct unit mandated research.
- Installation of Automatic Weather Station (AWS) in different research stations for agro-meteorological database.
- Coordination with different organization for advance weather forecasting for agriculture use.
- Collaborate with concern stakeholder for Agri- advisory Service.

Annex 1.2 Monthly agro-meteorological data of Khumaltar 2069/70 (2012/13)



Annex: 2.3 Human Resources, 2069/70 (2012/13)

S.N.	Name of the Staff	Designation	Remarks
1.	Dr. Anand Kumar Gautam	S-4	Chief
2.	Mr. Ghanashyam Malla	S-3	Deputed from CPDD
3.	Mr. Amit Prasad Timilsina	S-1	Deputed from HCRP, Kabre
4.	Mr. Hari Devkota	T-6	On study leave
5.	Mr. Alok Sharma	T-6	Deputed from ARS, Pakhribas
6.	Mrs. Sarala Basnet	A-6	Administration
7.	Mr. Pravat Sah	A-6	Finance
8.	Mr. Raj Kumar Chalise	Driver (T-3)	Deputed from NASRI
9.	Mrs. Tara Thapa	Labor	Wages basis
10.	Mr. Gokul Thapa	Labor	Wages basis

Annex 3.1: Summary of Progress of NARC Research Projects and Activities, 2069/70 (2012/13)

Project code number	Name of project/activity	Project/ Activity Leader	End year	Budget allocated for this year	Major progress/ achievements
32965001	Crop Adaptation in Changing Climate Environment	AK Gautam	Conti-nuous	1025	
Activity 1	Study on planting dates of different crops under different temperature regime	G. Malla	,,		The Khumal 4 variety of rice matured 5-12 days earlier in elevated temperature condition (OTC condition) than in open field condition. Average grain yield of the three dates of the transplanting under both conditions were same. However, the biomass yield and 1000 seed weight was higher under OTC was higher in all three dates of transplanting.
Activity 2	Monitoring nutrient change in soil and plant, insect pest and diseases under different temperature regime	A Sharma	,,		Not significant insect and pest appearance was observed.
Activity 3	Study transplanting/seeding dates of rice and wheat to adapt climate variability	G Malla	,,		Rice variety (Khumal 13) was found better in terms of higher grain yield than Khumal 4 and second week of July was best time for transplanting in mid-hill condition (Khumaltar). Similarly, wheat variety (WK 1204) was superior over Danphe for higher grain yield. Wheat sown on November first week resulted higher grain

					yield than delayed sowing.
Activity 4	Analysis of Agro-Meteorological Database	G Malla	,,		Little change in maximum and minimum temperature over the year in five locations of Central Development Region's districts (Dhanusha, Bara, Makwanpur, Chitwan and Lalitpur) was observed over the year. The variation in maximum and minimum temperature, rainfall was higher in winter season than the summer season in all five locations. Variation in winter rainfall was notably higher and therefore, demands development of short durational winter crop varieties and assured irrigation facilities.
Activity 5	Simulating Climate Variability Impact on the Growth and Yield Of Different Crops	A Sharma	,,		Climatological data of 41 locations, soil data of 51 locations and crop management data of rice and what for the last 10 years CVTs has been updated for simulation study.
Activity 6	Soil Profile Study	A Sharma			The soil collection process has been finished and waiting for the soil analysis result.
Activity 7	Estimation of Carbon Emission from Rice and Wheat Crops	A Sharma	,,		Field covered cereals crops had higher CO_2-C emission followed by pasture and vegetables. Oilseed grown field had lower CO_2-C emissions followed by fallow land.
Activity 8	Estimation of Carbon Emission	HP Devkota	,,		Highest CO_2-C emission was observed in

	from Farmer's Field				Bhaktapur district followed by Tanahu among nine districts under study *viz.*, Bhaktapur, Dhanusha, Kathmandu, Lalitpur, Mahottari, Nuwakot, Rasuwa, Rupandehi and Tanahu. Lowest CO_2-C emission was found in Dhanusha followed by Mahottari district. Field grown with Brocaulli emitted lowest CO_2-C followed by Chilly, Tori, Tomato, and wheat and highest was found in cabbage field followed by onion and potato.
Activity 9	Study on atmospheric C sequestration under different tillage practices (combined from other project)	DR. AK Gautam	,,		In experiment field at ARS, Ranighat, CO_2-C flux is around 37 percent higher in zero tillage, which is vey contrast with the most of the finding around the world. One of the reasons might be 0.2 °C higher temperature in field than conventional tillage.
Activity 10	Estimation of atmospheric C sequestration in pasture/range land	Mr. A. Sharma/ Mr. H.P. Devkota	,,		Pasture field at ARS, Rasuwa and Bandipur with Molasses had highest CO_2-C emission followed by signal. Lowest was found in stylo cropped field.
32900001	**FMP/AOE 329**	**Division Chief**	**Continuous**	**490**	
Activity 1	Annual Report Publication				100 units of Annual Report Published
Activity 2	Participation on Different Workshop		,,		Two scientist from this division participated on summer workshop at Rampur
Activity 3	OTC and Other Lab Equipment Maintenance and Newspaper Expenses		,,		Lab Equipments are at good conditions and Repairing of OTC was done for crop

					production.
Activity 4	Working Group Meeting		,,		-
Activity 5	Office Maintenance		,,		Office maintained

Annex 3.2: Summary progress of special research projects and activities, 2069/70 (2012/13)

Name of project /activity	Project/ Activity Leader	Begin Year	End Year	Budget allocated for this FY	Major progress /achievements
Innovative community based agricultural development initiatives for increased climate resilience of rural people	A K Gautam	2011	2014	2,88,000	-Rice varietal performance is location specific. -Irrigated rice varieties also performed better under rain fed conditions. -Renovation of community pond to collect run-off water in Maubari VDC, Rupendehi District -Farmers Day and Visit
Agro-meteorological Information and Services (AMIS) Project	AK Gautam	2012	2015	8,70,000	-Sunsari district experiencing decreasing trend in mean Tmax during rice growing season -Dhanusha, Rupendehi and Banke experiencing increasing trend -Sunsari and Banke districts experiencing decreasing trend in Tmax in winter season -Central, western and mid-western Terai experiencing higher trend of growing degree days both during rainy and winter season

Annex 5.3 Publications, 2069/70 (2012/2013)

SN	Title of publication	Type	Language	Author	No. of copies
1.	Annual Report 2069/70 (2012/13). Agricultural Environment Research Division, Khumaltar, Lalitpur, Nepal	Report	English	Agricultural Environment Research Division, Khumaltar	100
2.	Asian Food and Agriculture Cooperation Initiative (AFACI)- Agro-meteorological Information and services (AMIS) Project	Leaflet	English	Agricultural Environment Research Division, Khumaltar, Lalitpur	1000

Annex 6.1 Training/ workshop/ seminar attended by staff, 2069/70 (2012/13)

SN	Name of staff	Position	Name of Training/seminar/workshop	Duration	Place/ Country	Organizer
1.	Ananda Kumar Gautam,	Chief Senior Scientist	Inception meeting on AFACI project	24th -28th Sept. 2012	South Korea	AFACI
2.	Ananda Kumar Gautam,	Senior Scientist	Training workshop on Launching CRAFT	9th -11th May 2013	India	CCAFT
3.	Ananda Kumar Gautam	Senior Scientist	Expert workshop on productions and services of the agro-meteorological information for adaptation to climate change	8th to 12th July 2013	Nepal	AGMIP
4.	Amit Prasad Timilsina	Scientist	Regional Training on Customization of Seas-onal and Medium Range Weather Forecast.	3rd -6th Feb. 2013	Nepal	Small Earth Nepal and CGEIS
5.	Alok Sharma	T-6	SATNET Regional Workshop on climate resilient small holder	24th –27th June. 2013	India	CCAF
6.	Pravat Sah Sarala Basnet	A-6 A-6	Public Procurement Moni-toring Office	4th – 6th Asadh 2070	Nepal	PPMO

Annex 6.2 Paper published, 2069/70(2012/13)

SN	Title of paper	Authors	Name of proceeding or journal
1.	" Study on rice at different planting dates under changing rainfall pattern at Khumaltat"	G Mall, AK Gautam, A Sharma, AP Timilsina	27th National Summer Crop Workshop
2.	" Study on rice and CO_2-C emission under different temperature regime in mid hill condition"- Poster presentation	G Malla, AK Gautam, A Sharma, AP Timilsina	27th National Summer Crop Workshop

Annex 7.1 Regular annual budget and expenditure record, 2069/70 (2012/13)

Budget Code	Budget heads	Annual Budget	Budget released	Expenses	Balance
40**	**Staff Expenses**	**23,19,000**	**23,19,000**	**23,17,839**	**1,161**
4000	Basic Salary	2,50,000	19,05,900	19,04,890	1,010
4010	Allowance	34,0500	-	-	-
4020	Provident fund	2,00,000	1,90,600	1,90,489	111
4040	Cloth	15,000	60,000	60,000	0
4050	Dasain expenses	96,000	1,44,100	1,44,060	40
4080	Insurance	50,000	18,400	18,400	0
*41***	**Operational Expenses**	**9,76,500**	**9,76,500**	**9,75,961.05**	**538.95**
4100	Travel Expenses	2, 50,000	2, 50,000	2, 50,000	0
4110	Vehicle Fuel Lubricants	3,40,500	3,40,500	3,40,279.50	216
4120	Wages to Labor	2,00,000	2,00,000	1,99,768.00	88.63
4130	Lab. & Research Supply	15,000	15,000	14,911.37	1,648.30
4140	Farm Supply	96,000	96,000	95,986.18	13.82
4150	Library & Publication	50,000	50,000	50,000	0
4160	Training workshop seminar	10,000	10,000	10,000	0
4180	Farm management project	1,50,000	1,50,000	1,50,000	0
42**	**Administrative Expenses**	**4,88,500**	**4,88,500**	**4,85,162.27**	**3,337.73**
4200	Rent Utilities	1,23,000	1,23,000	1,21,046.30	1,953.70
4210	Communication Expenses	42,000	42,000	41,086.47	913.53

4220	Repair & Maintenance	2,18,500	2,18,500	2,18,185.50	314.50
4230	Office Supplies	60,000	60,000	60,000	0
4260	Contingencies	45,000	45,000	44,844	156
43**	**Capital Expenses**	**7,60,000**	**7,60,000**	**7,57,601.02**	**2,398.98**
4330	Furniture and fixtures	-	-	-	-
4340	Machinery & equipments	7,60,000	7,60,000	7,57,601.02	2,398.98
4360	Computer and software	-	-	-	-
4370	Other Fixed Assets	-	-	-	-
Total		**45,44,000**	**45,44,000**	**45,36,563.34**	**7,436.66**

Annex 7.2 Special project (AFACI) budget and expenditure record, 2069/70 (2012/13)

Budget Code	Budget heads	Annual Budget	Budget released	Expenses	Balance
40**	**Staff Expenses**	**90,000**	**90,000**	**90,000**	**-**
4000	Basic Salary	-	-	-	-
4010	Allowance	90,000	90,000	90,000	-
4020	Provident fund	-	-	-	-
4040	Cloth	-	-	-	-
4050	Dasain expenses	-	-	-	-
4080	Insurance	-	-	-	-
*41***	**Operational Expenses**	**68,2000**	**68,2000**	**3,89,707.75**	**292292.25**
4100	Travel Expenses	2,45,000	2,45,000	16,175	77,825
4110	Vehicle Fuel Lubricants	57,000	57,000	50,097	6,903
4120	Wages to Labor	0	0	0	0
4130	Lab. & Research Supply	0	0	0	0
4140	Farm Supply	0	0	0	0
4150	Library & Publication	1,50,000	1,50,000	0	1,50,000
4160	Training workshop seminar	2,30,000	2,30,000	1,72,435.75	57,564.25
4180	Farm management project	0	0	0	0
42**	**Administrative**	**98,000**	**98,000**	**29,301**	**68,699**
4200	Rent Utilities	68,000	68,000	4,331	63,669
4210	Communication Expenses	0	0	0	0

4220	Repair & Maintenance	15,000	15,000	15,000	0
4230	Office Supplies	5,000	5,000	0	5,000
4260	Contingencies	10,000	10,000	9,970	30
43**	**Capital Expenses**	**0**	**0**	**0**	**0**
4330	Furniture and fixtures	-	-	-	-
4340	Machinery & equipments	-	-	-	-
4360	Computer and software	-	-	-	-
4370	Other Fixed Assets	-	-	-	-
Total		**8,70,000**	**7,80,000**	**4,19,008.75**	**4,50,991.25**

Annex 7.3 Special project (IWMI/CCAFS) budget and expenditure record, 2069/70 (2012/13)

Budget Code	Budget heads	Annual Budget	Budget released	Expenses	Balance
40**	**Staff Expenses**	**-**	**-**	**-**	**-**
4000	Basic Salary	-	-	-	-
4010	Allowance	-	-	-	-
4020	Provident fund	-	-	-	-
4040	Cloth	-	-	-	-
4050	Dasain expenses	-	-	-	-
4080	Insurance	-	-	-	-
*41***	**Operational Expenses**	**4,90,000**	**98,000**	**55,731**	**42,269**
4100	Travel Expenses	1,90,000	75,000	48,710	26,290
4110	Vehicle Fuel Lubricants	1,25,000	23,000	7,021	15,979
4120	Wages to Labor	0	0	0	0
4130	Lab. & Research Supply	0	0	0	0
4140	Farm Supply	0	0	0	0
4150	Library & Publication	45000	0	0	0
4160	Training workshop seminar	130000	0	0	0
4180	Farm management project	0	0	0	0
42**	**Administrative**	**98,000**	**98,000**	**29,301**	**68,699**
4200	Rent Utilities	30,000	30,000	30,000	0
4210	Communication Expenses	20,000	5,000	2,195	2805

4220	Repair & Maintenance	50,000	25,000	24,937.84	62.16
4230	Office Supplies	70,000	25,000	15,330	9670
4260	Contingencies	15,000	5,000	5000	0
43**	**Capital Expenses**	**3,85,000**	**1,00,000**	58,590.50	41,409.50
4330	Furniture and fixtures	-	-	-	-
4340	Machinery & equipments	1,00,000	1,00,000	58,590.50	41,409.50
4150	Vehicles	1,70,000	-	-	-
4360	Computer and software	80,000	-	-	-
4370	Other Fixed Assets	35000	-	-	-
Total		**10,60,000**	**2,88,000**	**191784.34**	**96215.66**

Annex 7.4 Revenue status, 2069/70 (2012/13)

(*In Nepalese Rupees*)

Source	Total	Remarks
Tender Form sell	2400	-
Assets Auction	10,800	-
Bank Interest	4,721.82	-
Other administration Income	19,034.82	-
Grand Total	**36956.64**	

Annex 7.5 Beruju status, 2069/70 (2012/13)

(*In Nepalese Rupees*)

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