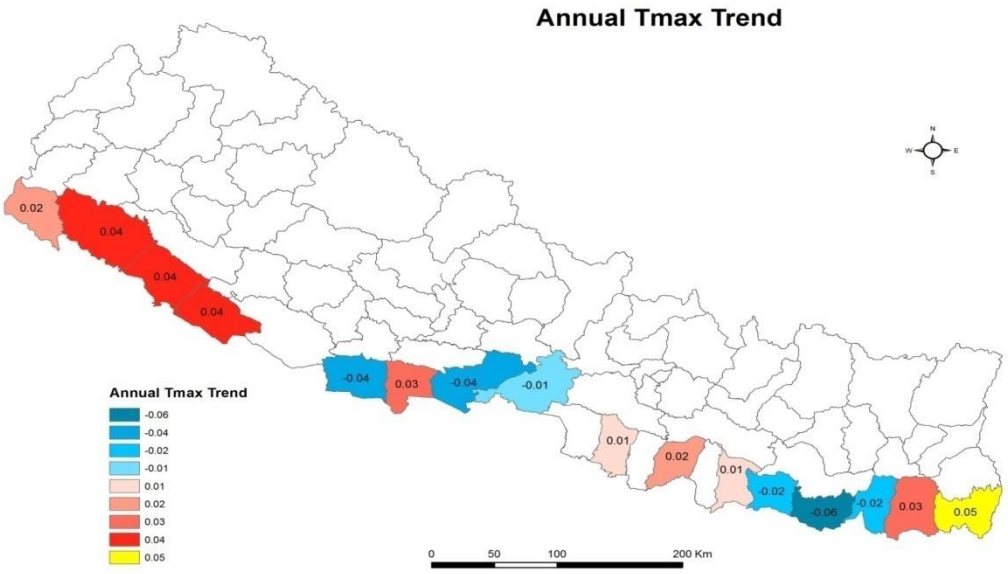
# ANNUAL REPORT

## 2070/2071 (2013/2014)




**Nepal Agricultural Research Council**

**Agricultural Environment Research Division**

**P. O. Box 5459, Khumaltar**

**Lalitpur, Nepal, 2014**

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## 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 2070/71. 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. G. Malla, Mr. B.P Paudel, Mr. Amit Prasad Timilsina, Mr. Alok Sharma and Hari P. Devkota 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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## 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 |
| MoAD | Ministry of Agricultural development |
| MoE | Ministry of Environment |
| MT | Minimum tillage |
| N:P:K | Nitrogen, Phosphorous, Potash |
| NARC | Nepal Agricultural Research Council |
| Ns | non significant |
| OM | Organic matter |
| 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 २०७०।७१ मा विभिन्न अनसन्धानात्मक तथा सेवा मलक कार्यक्रमहरु संचालन भएका छन् । कृषि अनसन्धान केन्द्र (चरन), रसूवामा मध्यमान्चल विकासक्षेत्रको हिमाली जिल्लाको हावापानीलाई प्रतिनिधित्व गर्नका लागि स्वचालित हावापानी केन्द्र जडान गरिएको छ । कृषि क्षेत्रसंग आवद्ध सम्पुर्ण संघ, संस्थाहरुलाई वद्लिदो वातावरण, कृषिमा यसको प्रभाव साथै त्यसको न्युनीकरणको उपायहरुको वारेमा आवश्यक सल्लाह, सूझाव 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 खूमलटारको हावापानीमा खूमल १३ जातको धान लगाउँदा खूमल ४ भन्दा बढि फलेको साथै आषाढको अन्तिम हप्तामा रोपिएको धानको उत्पादन उक्त समय भन्दा पछि रोपिएको धानको तूलनामा राम्रो पाईयो । त्यस्तै गहूंको WK १२०४ जात डांफे जात भन्दा बढि फल्ने र कार्त्तिकको तेस्रो हप्तामा छरिएको गहूं उक्त समय भन्दा ढिलो लगाईएको गहूंको तूलनामा राम्रो पाईयो ।

- धनूषा, काठमाण्डौं, ललितपूर, महोत्तरी, नूवाकोट, रुपन्देही र तनहूंको तूलनामा भक्तपूरको 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 गहूंखेतवाट ३७ प्रतिशत वढि कार्वन उत्सर्जन भएको पाईएको छ ।

- धानको खूमल 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 ।

- धनूषा, वारा, मकवानपूर चितवन तथा ललितपूरको अधिकतम, न्यूनतम तापक्रम र वर्षा अध्ययन गर्दा तापक्रममा खासै परिवर्तन नआए पनि हिउंदमा पर्ने पानीमा भने निकै असर देखिएको छ । खासगरि हिउंदमा पानी कुनै वर्ष निकै र कुनै वर्ष कम पर्ने पाईएको छ ।

# EXECUTIVE SUMMARY

The Agricultural Environment Unit has been upgraded to Agricultural Environment Research Division in Fiscal Year 2069/70. This division has contributed to agricultural research sector through various efforts. Automatic weather station has been installed at Agricultural Research Station (Doti), NMRP (Chitawan) and RARS (Tarahara, Sunsari) in order to prepare real time weather database. The data collected has been shared and facilitated among different stakeholders including NGOs, INGOs and academic institutions' researchers and students. It has also played important role to provide valuable information, suggestions and guideline regarding activities of Agricultural Environment Research Division as well as provide data regarding weather and climate of different parts of Nepal. AERD help to develop agricultural technologies with respect to changing climate. It has also made efforts to discuss with experts and planner about future work and direction of agricultural environment research in Nepal. Besides these activities, various field as well as lab experiments have also been accomplished on agriculture and their interaction with weather and climate came up with valuable results as follows:-

Rice variety (NR-1067-6-B-1-3-3-3) was found better in terms of grain yield than other three varieties Khumal-10, Sukha dhan-1 and NR 11082 but it matured 8 days after Khumal-10, Sukha dhan-1. In case of factor A or compared with open field and closed chamber, field condition yielded better in Khumaltar than open top chamber (OTC).

- Similarly, Wheat variety Monal -1 resulted higher grain yield of 4.4 ton/ha than other tested varieties which resembles Monal-1 would be good variety for the changing climatic condition.

- Highest $CO_2$-C emission was observed in ARS, Dhunche, Rasuwa followed by Tansen among six research centre *viz.*, Rasuwa, Tansen, Bandipur, Parwanipur, Nawalpur and Ranighat. Lowest $CO_2$-C emission was found ARS, Ranighat followed by Nawalpur centre. Field with fruit trees (Orange) emitted highest $CO_2$-C whereas lentil emitted lowest in the year.

- Pasture field in ARS, Bandipur with Sterile Setaria had highest $CO_2$-C of 173 mg/m2/hr emissions and lowest of 52.8 mg/m2/hr was observed in stylo cropped field.

- In experiment field of ARS, Ranighat, $CO_2$-C flux record showed Flat planting Zero Tillage with mulch emitted 43% lower $CO_2$-C emission as compared to Flat Planting-Zero Tillage with no mulch. Likewise, Bed Planting-Zero Tillage -mulch emitted 18%

lower than Bed Planting-ZT-No mulch. Furthermore, soil analysis showed 18% more organic matter in Zero Tillage + Flat planting with Mulch as compared to Zero Tillage Flat planting with NO mulch whereas, 11% less organic matter was recorded in Zero Tillage Bed planting with No mulch as compared to Zero Tillage Bed planting with Mulch.

- Carbon sequestration study carried out on fruit trees showed lower of 10kg/year by orange trees (age 12 years) followed by mango Parwanipur (11 years). Similarly, higher carbon sequestration of 160 kg/yr by mango plant of Sarlahi (41 years) followed by same fruit trees of 53kg/year (11 years). Thirteen years old Litchi, Nepalgunj showed 41kg/yr resembling, it is depend on size and age of the trees.

## 1. WORKING CONTEXT

Nepal is an agricultural country with two third of population involved in this sector. In addition, the increasing population and food demand make it the sector of prime importance in order to become food secured country. Moreover, global warming, spatial, temporal and weather anomalies are becoming too alarming to overlook since it plays very crucial role in whole agricultural system and productivity. 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. The agro-meteorological database can also be helpful 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 for agricultural scientists 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 and contributing in the climate change. 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 also plays important role to minimize emission of $CO_2$ by sequestrating in form of fruit trees or organic matter in soil. 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.

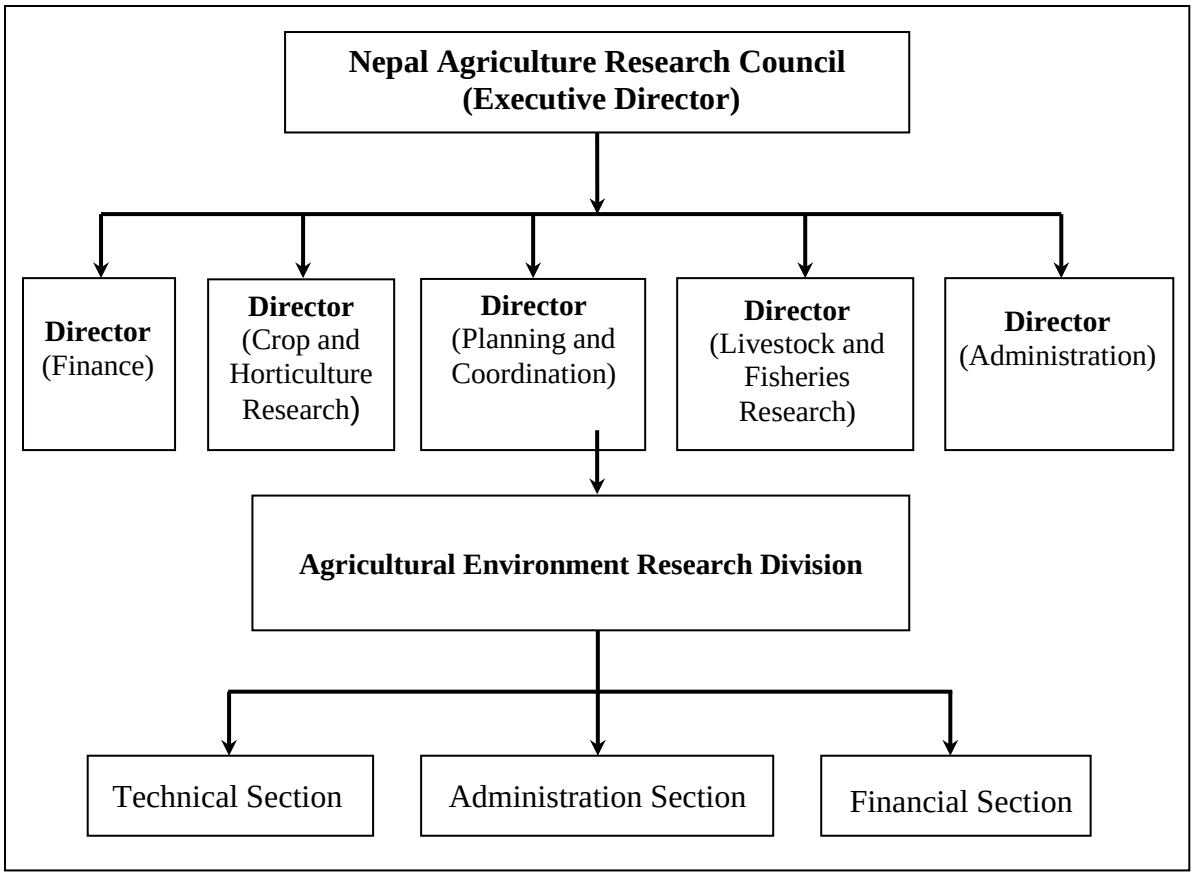


**Fig 1: Organizational structure of Agricultural Environment Research Division**

## 3. RESEARCH HIGHLIGHTS

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

Atmospheric air temperature is important to agriculture because it influences plant growth. It also affects soil temperature, moisture and controls available water in the soil. Farmers use soil temperatures and moisture to decide when to plant, which varieties of crops to choose and determine the likely development of key plant characteristics like flowering and incidence of insect pests and plant diseases. Thus, study on effects of temperature on different crops is necessary.

Most plants have a range of temperature at which growth occurs. Some plants are more adaptable (such as grass) that can grow throughout the range, while other plants have more specific temperature requirements. When the temperature reaches the upper end of the spectrum, generally there is declination in plant photosynthesis and physiological behavior changes. Optimal temperatures are different from plant to plant, and can be different even within a species. However, rice crop can adapt up to 45$^{o}$C maximum temperature although its average air temperature for growth is considered 22-30$^{o}$ C.

An experiment was carried out in the field and open top chamber (OTC) in 2013 at Khumaltar under irrigated condition to know the phenological behavior of rice variety in open top chamber. Twenty seven days old rice seedling of variety Khumal-10, NR-1067-6-B-1-3-3-3, Sukha dhan-1 and NR 11082 were transplanted in Open Top Chamber (OTC) and Fields in 2070-03-09 at Khumaltar at 20 x 20 cm spacing. 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 panicle initiation stage.

**Table 1: Agronomical parameters of rice at Khumaltar in 2068-69 (2011/12)**

| Treatment | Days to flowering | Days to maturity | Plant height (cm) | No. of tillers/hill | Grain yield (t/ha) | Biomass yield (t/ha) |
|---|---|---|---|---|---|---|
| Factor A | | | | | | |
| Chamber | 105 | 142 | 111.4 | 8 | 2.5 | 5.9 |
| Field | 103 | 141 | 101.1 | 8 | 3.4 | 8.7 |
| S.Em ± | 0.56 | 1.03 | 7.19 | 1.33 | 0.22 | 2.04 |
| C.D. at 5% | Ns | ns | ns | ns | ns | ns |
| Factor B | | | | | | |
| Khumal-10 | 102 | 138 | 118.7 | 7 | 2.9 | 7.2 |
| NR-1067-6-b-1-3-3-3 | 106 | 146 | 116.6 | 8 | 3.4 | 11.0 |
| Sukha Dhan-1 | 104 | 138 | 95.5 | 10 | 3.0 | 4.3 |
| NR-11082 | 103 | 146 | 93.9 | 5.6 | 2.5 | 6.9 |
| S.Em ± | 1.13 | 2.01 | 9.53 | 0.7 | 0.26 | 1.69 |
| C.D. at 5% | ns | 6.18 | ns | 2.18 | ns | ns |
| CV % | 2.67 | 3.46 | 21.98 | 22.46 | 21.85 | 55.73 |

**Table: 2 Average temperatures of chamber and field for rice growing period 2070/71**

| SN | Treatment | T Max. | T Min |
|---|---|---|---|
| 1 | Open Top Chamber | 34 | 20.0 |
| 2 | Field | 27 | 20.8 |

**Table: 3 Soil analysis result of rice field**

| Treatment | Ph | OM% | N% | p205 kg/ha | k20 kg/ha |
|---|---|---|---|---|---|
| Chamber | 6.05 | 3.6 | 0.14 | 183.9 | 109.7 |
| field | 6.41 | 3.8 | 0.15 | 138 | 143.5 |

Rice agronomical parameters and yield are heavily dependent on the management, soil fertility and atmospheric air temperature. The physical growth, heading and maturity have large impact on the rice production due to temperature rise and physiological growth of crop planted in OTC was vigorous as compared to field However, rise of about $7^{o}$ C temperature has no significant effects on rice grain yield (Table 2). The difference in T min was found nominal and lower of $0.08^{o}$ C was recorded in OTC as compared to field condition.

With the objective of finding rice crop adaptation in different temperature regime or sowing, two condition of rice (OTC and Field) were transplanted at Khumaltar condition in 2070/71.

A field experiment with two condition of rice (OTC and Field) as main plot and four varieties of rice (Khumal-10, NR-1067-6-B-1-3-3-3, Sukha dhan-1 and NR 11082) as sub-plots was carried out on split plot design during rainy season in 2013 at Khumaltar. Fertilizers were applied @ 100:30:30 kg/ha $N:P_2O_5:K_2O$ in split dose.

All agronomical parameters observed on the study were non-significant. However field produced higher grain yield (3.4 t/ha) compared to chamber (2.5 t/ha) which was attributed to better soil fertility in field condition. It was may be due to high temperature in OTC. It showed higher temperature and low fertility has negative impact on grain yield with 30% less production in chamber condition.

Maturity date and tillers/hill were significantly different. It was may be due to exponential rise of temperature in OTC, rest of the parameter being non-significant. Maturity dates of rice varieties khumal 10 and sukha dhan was as early as 138 days. Tillers/hill was significantly higher of 10/hill in rice sukha dhan than other variety. Rice variety NR 11082 showed only 6 tillers/hill or 3 nos lesser than sukha dhan (Table 1).

Total Phosphorous and potash was applied as basal. Regular monitoring of disease and insect pest was done. Phenology and yield was recorded. Soil sample analysis report showed slightly more organic matter in field as compared to OTC (Table, 3). It may be due to higher temperature which increases the microbial respiration by influencing microbial activities inside the chamber. Similarly, Phosphorus was lower of 33% in field and potash was higher of 31% in the in the field compared to OTC.

**Table 4: Agronomical parameters of Wheat at Khumaltar in 2070-71 (2013/14)**

| **Treatment** | **Days to flowering** | **Days to maturity** | **Plant ht (cm)** | **Pani Leng (cm)** | **Grain yid (t/ha)** | **Biomass yield (t/ha)** | **1000 gra wt (gm)** |
|---|---|---|---|---|---|---|---|
| FactorA | | | | | | | |
| | | | | 10 | | | |
| Chamber | 106 | 160 | 120 | | 3.8 | 5.1 | 49.0 |
| Field | 122 | 167 | 161 | 9.3 | 4.5 | 5.8 | 46.5 |
| | | | | 0.1 | | | |
| S.Em ± | 0.32 | 1.85 | 43.63 | 5 | 0.35 | 0.52 | 0.61 |
| C.D. at | | | | ns | | | |
| 5% | 1.99 | ns | ns | | ns | ns | ns |
| Factor B | | | | | | | |
| Munal-1 | 115 | 165 | 95 | 8.6 | 4.4 | 5.4 | 44.3 |
| WK- | | | | 9.7 | | | |
| 1204 | 118 | 167 | 227 | | 3.9 | 4.8 | 49.7 |
| Chyakhu | | | | 10. | | | |
| ra | 110 | 164 | 108 | 4 | 4.2 | 5.2 | 46.3 |
| WK- | 114 | 159 | 132 | 9.8 | 3.9 | 6.5 | 50.7 |

| 1481 | | | | | | | |
|---|---|---|---|---|---|---|---|
| S.Em ± | 0.7 | 2.49 | 65.31 | 0.14 | 0.31 | 0.35 | 0.67 |
| C.D. at 5% | 2.164 | ns | ns | 0.42 | Ns | 1.08 | 2.67 |
| CV % | 1.51 | 3.72 | 3.45 | 3.45 | 18.56 | 15.82 | 3.47 |

Another experiment was carried out in split plot design with wheat varieties (OTC Chamber and Open field) as main plot and Variety (Munal-1, WK 1204, Chyakhura and WK 1481) as sub plot to find out impact of increased temperature condition and four varieties during winter season in 2070-71 at Khumaltar conditions.

All the parameters were non-significant except days to flowering. Flowering days recorded was 16 days earlier in chamber condition than field condition. The grain yield was 18% lower in increased temperature condition compared to field due to climate change especially temperature rise. The biomass yield of OTC condition was 14 % lower compared to field which can be attributed to higher of 5.3$^{o}$C of temperature in chamber condition. Average T max and T min of OTC chamber was 26.9 $^{o}$C and 7 $^{o}$C and average T max and T min of the field condition was 21.6 $^{o}$C and 7.2 $^{o}$C respectively (Table, 4).

In case of factor B, all the parameters were non-significant except days to flowering and panicle length. As the wheat sown in 29$^{th}$ November 2013 at Khumaltar conditions, grain yield of Monal-1 showed higher of 4.4 ton/ha and lower of 3.9 ton was found in WK 1204. In case of biomass yield, higher of 6.5 ton/ha and 4.8 ton/ha in WK-1481 and WK 1204 was found respectively.

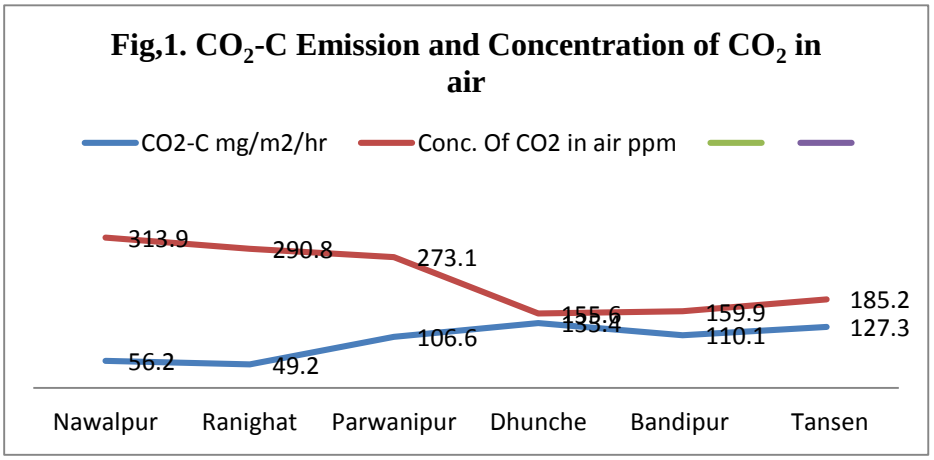
### 3.2 Estimation and analysis of CO2-C emission of different cropping pattern in farmers' field and research stations

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. Food insecurity, extinction of biodiversity and loss of livelihood are foreseen due to impact of climate change with occurence continuous drought and adverse weather condition. $CO_2$ 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 (Fang and Moncrieff 2001; Lloyd and Taylor 1994). Low level of soil moisture limits microbial and root respiration (Yuste *et al* 2003). Higher emission of $CO_2$ from soil depletes the organic

matter content and thus reduces the soil productivity as well as fertility. So, it is necessary to monitor $CO_2$ emission rates in different cropping pattern to formulate the plan to reduce overall emission.

The study was carried out in research field to estimate $CO_2$-C emission from different cropping patterns from six stations: Nawalpur, Ranighat, Parwanipur, Dhunche, Bandipur and Tansen. Study stations were selected randomly and a study was also carried out to estimate concentration of carbon in air. Soil temperature, pH and moisture were recorded through soil pH and moisture tester. Collection of gas samples was carried out by closed chamber techniques; soil temperature being an important factor for microbial activity.

Among the samples, $CO_2$-C emission was ranged from 49.2 to 135.4 mg/m2/hr. lower emission of 49.2 in Parsa ranighat and higher emission of 135.5 mg/m2/hr was found in Rasuwa Dhunche. Concentration or ppm of carbon in air was ranged from 155.6ppm to 313.9ppm; lowest concentration recorded in Rasuwa Dhunche and highest in Sarlahi Nawalpur. It was observed that the $CO_2$-C emission estimation was an important study to reduce the emission from soil and will be beneficial for further studies as well.




**Fig,1. $CO_2$-C Emission and Concentration of $CO_2$ in air**

pH of the soil ranged from 5.2 to 6.9. The soil moisture index ranged from 0 to 8 (Table 3).The $CO_2$-C flux was recorded highest of 135 mg/ha/hr in Rasuwa district and lowest of 49.2 mg/ha/hr in Ranighat, Parsa. It was observed that the $CO_2$-C emission was influenced by both soil temperature and moisture in most of the districts.

The presence of crops also influences carbon dioxide emission from soil. The emission was found in a range of 3.15 to 340.6mg/ha/hr with highest from the soil grown with Orange in Palpa district and lowest from DI pasture in Bandipur with analysis of 122 samples (Figure 1).

Lentil emitted lowest of 51.4 mg/ha/hr $CO_2$-C whereas orange emitted highest of 127.3mg/ha/hr.

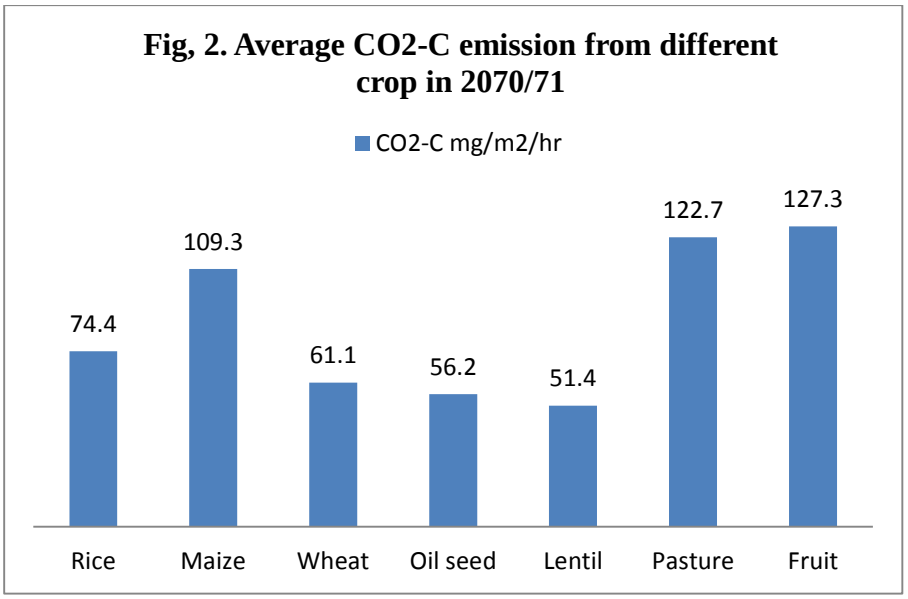



**Figure 3: $CO_2$-C emission from soil grown with different crops**

The observation taken from different field categorized on the basis of standing crop in field and was analyzed accordingly. Results showed that cereals, oil seed and Lentil (Grain Legume) crop had lower emission whereas pasture and fruit crop field showed higher emission as compared with other crop (Fig 2).

### 3.3 Estimation of carbon emission from pasture field

Soil is the major source of $CO_2$ 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. Recently, the flux of carbon induced by agricultural farming practices is very uncertain to estimate. A difficulty is that a temporal variation in soil $CO_2$ fluxes within sites was mainly influenced by soil temperature and moisture, while the main variation of flux was influenced by crop and land management. Thus, agricultural farming practice leads to atmospheric $CO_2$ balance in two ways: directly because of the net carbon loss during and after soil respiration and indirectly because it reduces atmospheric $CO_2$ concentration by sequestration of atmospheric $CO_2$ through photosynthesis.

The assessment was carried out in the field of ARS, Bandipur and ARS, Rasuwa 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. Sixty-four samples have been collected and analyzed from two locations.

The result of ARS Bandipur showed that the emission ranged from 52 to 173 mg /ha /hr. It was found highest in the Sterile Setaria land with 173 mg /ha /hr and lowest was observed in stylo land with 52.8 mg/ha/hr (Figure 5). The emission of Stylo was found lower (52.8 vs.173) which might be due to application of organic materials and chemical fertilizers and other influencing factor like soil temperature, moisture and soil texture. One of the reasons of higher emission in sterile Setaria land is due to higher microbial population and higher fertility status in the plot. Soil temperature (ranged 23.0-30.0), moisture (0.0-3.0) and pH (6.2-6.9) were almost similar in all the plots. $CO_2$ concentration was found from 138.5ppm to 216.1ppm at the Bandipur, which is lower compared to world average of 398ppm. It shows Bandipur area is good place with respect to human health since $CO_2$ concentration in the area is lower as compared to Terai and dense populated areas.

**Table 4. $CO_2$-C emission from different pasture field at ARS Bandipur in 2013**

| Treatment | Flux(mg/m2/hr) | Air CO2 conc. | Soil T | Soil pH | Moisture |
|---|---|---|---|---|---|
| Signal grass | 94.1 | 163.4 | 25.5 | 6.6 | 3.0 |
| Stylo | 52.8 | 138.5 | 29.8 | 6.8 | 0.0 |
| Setaria | 62.4 | 176.4 | 29.3 | 6.8 | 0.0 |
| Hedge desmodium | 164.4 | 141.3 | 30.0 | 6.8 | 0.0 |
| Sterile setaria | 173.0 | 151.3 | 25.7 | 6.8 | 1.0 |
| Green leaf desmodium | 97.4 | 216.1 | 29.1 | 6.9 | 0.0 |
| Paspalum | 150.5 | 145.1 | 23.0 | 6.8 | 1.0 |
| Silver leaf desmodium | 98.7 | 173.4 | 28.1 | 6.8 | 0.0 |
| Mo lases | 101.5 | 149.6 | 26.8 | 6.5 | 1.0 |
| Badame ghas | 80.5 | 155.7 | 25.6 | 6.5 | 0.0 |
| **Gini grass** | 118.9 | 151.3 | 25.2 | 6.2 | 0.0 |
| **Mean** | 108.6 | 160.2 | 27.1 | 6.7 | 0.5 |

**Table 5. $CO_2$-C emission from different pasture field at ARS Rasuwa in 2013**

| Treatment | Flux | Air CO2 conc. | Soil T | Moisture |
|---|---|---|---|---|
| Cock foot rasuwa | 56.1 | 166.5 | 20.6 | 8 |
| Phurke khasro | 71.3 | 214.4 | 20.6 | 8 |
| Cocks foot CV porto | 115.2 | 216.8 | 20.8 | 8 |

| | | | | |
|---|---|---|---|---|
| Phurke masino | 146.1 | 157.4 | 22.5 | 8 |
| Aerrow L eaf Clover | 214.0 | 148.5 | 23.1 | 8 |
| Buki | 161.0 | 169.9 | 23.1 | 8 |
| Sindure p | 208.4 | 160.8 | 23.3 | 8 |
| Rumba | 72.0 | 242.5 | 22.8 | 8 |
| Pangther Chhi | 183.9 | 164.2 | 22.8 | 8 |
| Pang chyumu | 120.3 | 110.4 | 24.2 | 8 |
| Dismodium | 120.3 | 110.4 | 24.2 | 8 |
| Tall Fescue creeping | 148.8 | 110.4 | 24.8 | 8 |
| Dhimchi | 13.4 | 116.8 | 24.2 | 8 |
| Tall Fescue Demeter | 284.7 | 122.2 | 23.2 | 8 |
| Red clover | 94.8 | 119.0 | 23.7 | 8 |
| Sindur pang | 27.4 | 133.0 | 22.1 | 8 |
| Paspalum | 84.7 | 180.2 | 20.7 | 8 |
| Chitre kher | 232.4 | 172.2 | 21.7 | 8 |
| White clover | 106.4 | 121.1 | 22.8 | 8 |
| Setaria | 247.8 | 137.4 | 21.3 | 8 |

The result of ARS Rasuwa or above table showed that the emission ranged from 13.4 to 284.7mg/ha/hr. It was found highest in the Tall Fescue Demeter land and lowest was observed in Dhimi land (Figure 5). The emission of $CO_2$ is dependent on soil management and application of organic materials and chemical fertilizers. Other important influencing factors for $CO_2$ emission could be soil temperature, moisture and soil texture. One of the reasons for higher emission in Tall Fescue Demeter land is due to higher fertility status in the plot. Soil temperature (ranged 20.6-24.8), moisture (8) and pH were almost similar in the all plots. So difference of emission rate may be due to the others factors like use of chemical fertilizer and organic coumpond. $CO_2$ concentration ranged from 110.4 ppm to 242.5 ppm at the Rasuwa, which is lower as compared to world average of 398ppm. It shows air of Rasuwa is quite good with respect to human health.

### 3.4 Assessment of carbon emission estimation from different tillage practices

Tillage practice plays vital role which plays important role on improvement of soil physical, chemical and biological properties. Thus, it also plays important role on amount of carbon-dioxide emission from soil. Most of the study conducted in different parts of world reflects higher and lower emission of gas from wheat field depends upon management practice such as: moisture availability, availability of soil organic matter and soil microbes in the soil. Therefore, appropriate management of soil can be the viable option to reduce the carbon-dioxide emission from agricultural soil and increase its sequestration in soil maintaining optimum production level sustaining soil productivity and fertility. Thus, study of carbon

emission from wheat field under different tillage practices was done to estimate and analyze the pattern of emission.

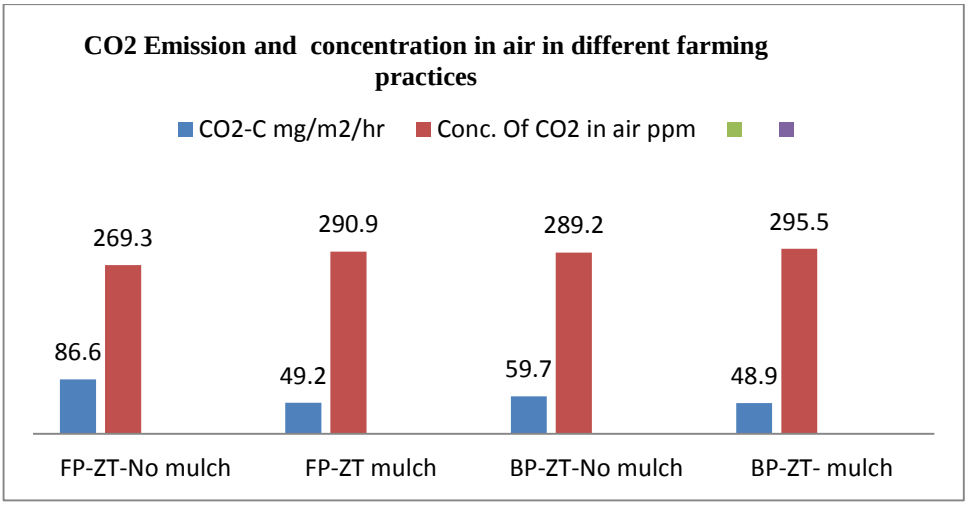



**Figure 4: $CO_2$-C emission from soil grown with different practice**

FP = Flat planting, BP = Bed Planting and ZT = Zero tillage

**Table 4: $CO_2$-C emission from soil grown with different practice**

| S.N | Farming practice | % OM in soil | $CO_2$-C mg/ha/hr | Air tem $^{o}C$ | Soil Tem |
|---|---|---|---|---|---|
| 1 | ZT+Flat planting +NO mulch | 2 + 1.6= 1.8 | 86.6 | 17.5 | 16.5 |
| 2 | ZT+Flat planting+ Mulch | 2.2 (18%) | 49.2 | 16.5 | 16.0 |
| 1 | ZT+Bed planting + Mulch | 1.6+ 1.5= 1.6 | 59.7 | 15.5 | 16.1 |
| 2 | ZT+Bed planting + No mulch | 1.4 (11%) | 48.9 | 15.8 | 15.7 |

$CO_2$-C emission study was carried out in Ranighat Parsa in different tillage and resources conservational practice and the observation was taken from studied plots on the basis of random method and analysis was done accordingly. Result showed that the concentration of $CO_2$-C in the atmospheric air in surrounding area at Ranighat was found similar (270-290ppm). And found not more difference with respect to air concentration. In case of soil emission, Flat planting ZT with mulch emitted 43% lower $CO_2$-C emission as compared to FP-ZT with no mulch whereas, BP-ZT-mulch emitted 18% lower than BP-ZT-No mulch. Furthermore, soil analysis showed 18% more organic matter in ZT+Flat planting+ Mulch as compare to ZT+Flat

planting + NO mulch. Similarly 11% lower organic matter was recorded in ZT+Bed planting + No mulch as compared to ZT+Bed planting + Mulch. Thus, result showed mulching practice in the field is beneficial as compared to no mulch condition (Fig 4). Thus, the practice would be good for reducing GHGs emission from agricultural soil as well as for carbon sequestration.

### 3.6 Carbon sequestration in agricultural land and plantation crops

Carbon dioxide ($CO_2$) capture and sequestration (CCS) could play a vital role in reducing greenhouse gas emissions, while enabling low-carbon electricity generation from agriculture.

Carbon sequestration is either capture from atmosphere or addition in earth. Forestry and agriculture plays an important role in atmospheric $CO_2$ emission and fixation. The horticulture, especially plantation crop contributes significantly to global $CO_2$ capture and offers opportunities to reduce the emissions by sequestering it in to 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. Atmospheric capture by plantation crop, soil organic matter (SOM) largely depends on the periodic input of organic materials for the transformation of soil organic carbon (SOC) into $CO_2$, $H_2O$ and mineral salts in the soil.

In the present global climate change scenario, attempts are being made to estimate the mitigation potential in developing countries. However, in Nepal the research works in carbon sequestration is very limited at present. 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 is very important. Atmospheric carbon in above ground biomass and below ground biomass of the fruit trees has been apprehended (Captured) these days in the country which helps to reduce Carbon concentration in the atmosphere. This research has been carried out to study carbon balance and atmospheric carbon sequestration in the soil from fruit trees. Carbon sequestration estimation is an important study which helps to estimate actual contribution of agriculture in mitigating global warming and climate change. It might also be helpful for increasing the sequestration in soil and earth system.

Table: Carbon Sequestration study data of Mango trees at Nawalpur, Sarlahi in 2013/14

| SN | Fruit crop | Age | | Ht. of tree | AGB (t) | BGB (t) | Total (Ton) | C Stock (Ton) | C.se/yr/plat |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Orange(Palpa) | 12 | Mean | 4.97 | 0.163 | 0.042 | 0.206 | 0.121 | 0.010 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | CV | 8.32 | 60.765 | 60.765 | 60.765 | 668.420 | |
| | | | STD | 0.41 | 0.099 | 0.026 | 0.125 | 0.074 | |
| | | | | | | | | | |
| 2 | Mango (Parwanipur) | 11 | Mean | 6.05 | 0.197 | 0.051 | 0.248 | 0.134 | 0.012 |
| | | | CV | 25.64 | 69.435 | 69.435 | 69.435 | 69.435 | |
| | | | STD | 1.55 | 0.136 | 0.035 | 0.172 | 0.093 | |
| | | | | | | | | | |
| 3 | Mango (Sarlahi) | 41 | Mean | 11.77 | 9.671 | 2.514 | 12.185 | 6.580 | 0.160 |
| | | | CV | 21.02 | 97.161 | 97.161 | 97.161 | 52.467 | |
| | | | SD | 2.48 | 9.396 | 2.443 | 11.839 | 6.393 | |
| | | | | | | | | | |
| 4 | Mango (Sarlahi) | 11 | Mean | 10.18 | 0.86 | 0.22 | 1.08 | 0.59 | 0.053 |
| | | | CV | 15.57 | 71.61 | 71.61 | 71.61 | 38.67 | |
| | | | SD | 1.59 | 0.62 | 0.16 | 0.78 | 0.42 | |
| | | | | | | | | | |
| 5 | Litchi (Nepalgung) | 13 | Mean | 4.73 | 0.482 | 0.125 | 0.608 | 0.535 | 0.041 |
| | | | CV | 16.99 | 81.925 | 81.925 | 81.925 | 72.094 | |
| | | | SD | 0.80 | 0.395 | 0.103 | 0.498 | 0.438 | |

Study was carried out in varied fruit trees in different ARS and RARS. 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 area, age of tree, type of fruit and many more. Study carried out on carbon sequestration at Nawalpur Sarlahi in 2013/14 showed that 41 years old mango trees sequestrated about 160 kg carbon and same tree of 11 years sequestrated only 12kg/year (at Parwanipur). Litchi at Nepalgunj also sequestrated 41kg /year. Orange trees at Palpa sequestrated 10kg/year. Variations in the sequestration from plants were due to their age, size and being of different species. Maximum CV was observed from all plants. This might be due to not performing replicated studies and less data about the study.

## 3.6 **Weather vulnerability assessment in farmers perspective**

### 3.6.1 Introduction

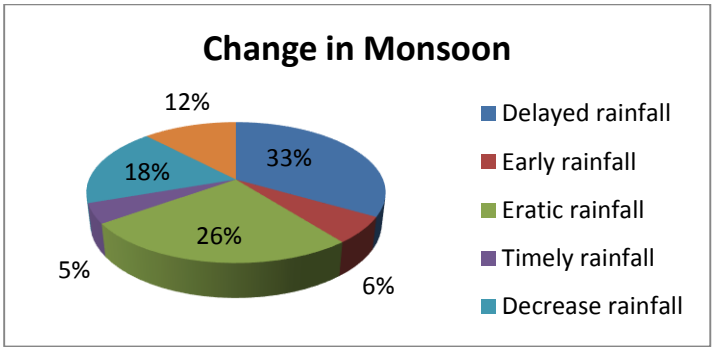
Weather variability and its impact on Nepalese agriculture have been emerging important issue. Due to climate change, various effects have been witnessed which are

causing threat to human kind and environment. Similarly, weather variability and vulnerability due to weather pattern change is causing threat to agricultural environment. It is reducing agricultural productivity, especially rice and wheat. The effects of weather change are much more serious in rural areas than in the developed areas. The vulnerability of weather change on agriculture has been reported from time to time from farmers of rural places. Thus, now is about time to start taking initiatives to address the issues of weather vulnerability and their effect on agricultural productivity. However before taking any program planning, it would be worth accessing farmers' awareness, their perspective and local measures being adapted by farmers at local level to address such issues, and the changes being felt by them in all agriculture. Considering all this, weather vulnerability assessment survey was conducted in districts namely Doti in the year 2070/71.

### 3.6.2 Methodology

In order to access the farmers' knowledge, survey was done in Doti district in the year 2070/71. The selection of districts was made on the basis of climate change vulnerability index (MoE, 2010). A total of 66 farmers (Sana gaun 20, Dipayal Silugadhi-15, Khirsen-16 and Mude gaun) were interviewed with the questionnaire and the surveyed VDCs were decided on consultations with ADO office.

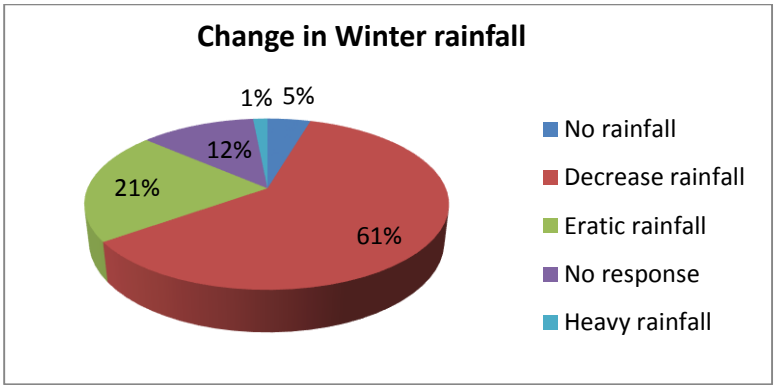
### 3.6.3 Result and discussions




In the survey, farmers were asked how they understood about monsoon change and majority were found familiar about the phenomenon among which 33% of farmers complained delayed rainfall experience. Erratic rainfall was noticed by 26% and only 5% farmers stated timely rainfall. Almost all farmers of Doti district were found aware about the vulnerability due to climate change in the study.

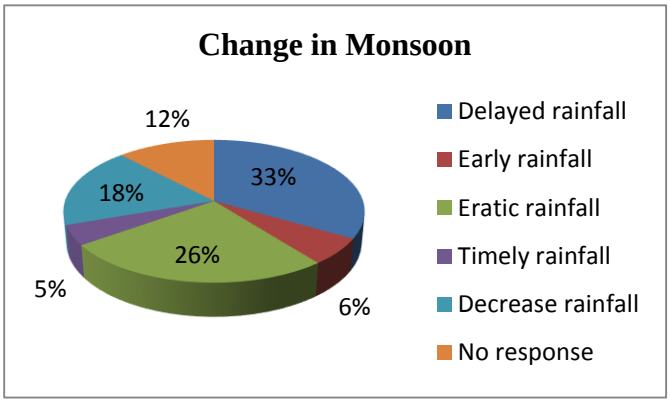
Winter rainfall has its own importance particularly in the rain fed areas where irrigation is not available. More than 73% of total cultivated area in the country is non-irrigated. One or two showers during winter period give relief to winter crops. Farmers' concerns

were also for the changes in winter rainfall caused due to change in climate. Around fifty eight per cent of the responses received indicated that winter rainfall has decreased in quantity these days compared to the past. However, 27 per cent responses indicate almost no rain in the winter season (Figure 23). About 10 per cent respondents indicated no winter rain in the last five years. Some of the farmers also mentioned less snowfall compared to past years (4%).




**Change in normal rainfall (time, amount)**

Rainfall is one of the most important components for agriculture livelihood of farmers. Rainfall pattern has been changing and winter rain has decreased 61% in Doti according to the farmers. Only about 1% has reported increased rain falls in the winter season whereas 5% said there was no rain in winter season. It has been highly variable over the past years as reported by most of the farmers in all VDC. Thus varied responses were received on change in rainfall among the effects of climate change over the past years.




**Crops affected due to monsoon change**

Early, erratic and decreased rains were reported by 6, 26 and 18 per cent farmers respectively with change in monsoon pattern. Study showed that crops grown were also highly affected due to monsoon change as presented in the figure below. Out of total responses, 33 per cent indicated there was delayed monsoon and only 5 percent viewed normal rain. Rice, wheat, potato and vegetables were the highly affected crop in the district by such changes.

In the weather vulnerability study, different inquiries were made with farmers about climate change, most affected crops and monsoon pattern. Farmer's perspectives were found quite informative for future planning to reduce weather vulnerabilities in agriculture.

## 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 Research Division organized one day workshop in 2071/3/23 Monday at National Wheat Research Program (NWRP) Bhairahawa with participation of DOA technical personnel from various districts and scientist of NARC. The general scenario climate and its impacts on Nepalese agriculture were discussed.

### 5.2 Services

- The division 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 media personnel's

### 5.5 Visits

- Students from HICAST, Environmental Science, TU 3rd in 2071/15 year visited to have different kind of information regarding meteorological stations.

## 6. OTHER ACTIVITIES

Training/workshop attended by the division 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 division 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 division is provided in annex 7.3 and 7.4, respectively.

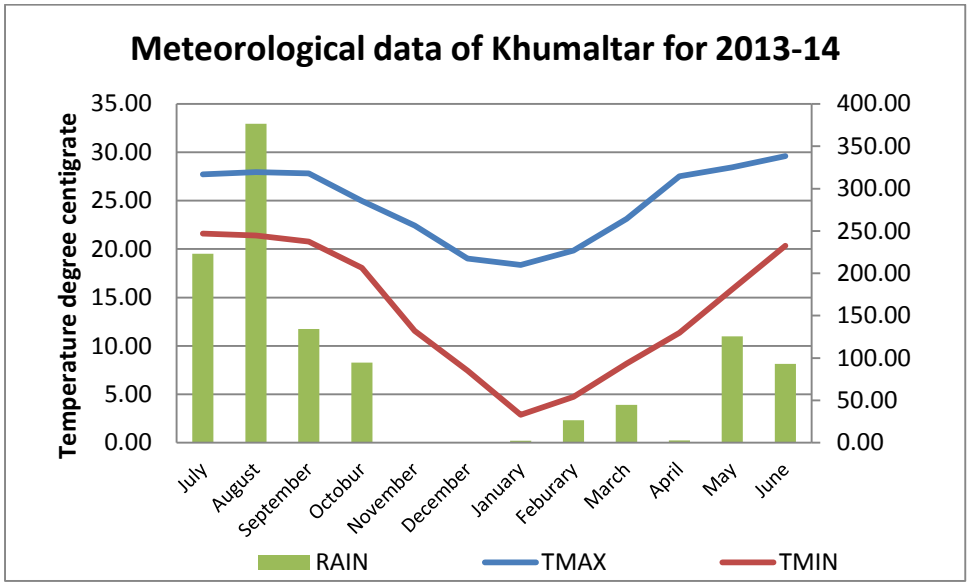
## 8. KEY PROBLEMS

- 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 2070/71 (2013/14)**




**Annex: 2.3 Human Resources, 2070/71 (2013/14)**

| 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, |
| 4. | Mr. Hari Devkota | T-6 | |
| 5. | Mr. Alok Sharma | T-6 | Deputed from PAC |
| 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, 2070/71 (2013/14)**

| Project code number | Name of project/activity | Project/ Activity Leader | End year | Budget allocated for this year | Major progress/ achievements |
|---|---|---|---|---|---|
| 32970002 | Vulnerability of climate change in agriculture | AK Gautam | Conti-nuous | 770 | |
| Activity 1 | Collection, analysis and dissemination of agro- meteorological database of various locations of Nepal | A. Sharma | ,, | | Maximum of 41 agro-meteorological database from various locations of Nepal were collected and analyzed and dissemination of agro-meteorology information was done accordingly as demand |
| Activity 2 | Weather vulnerability assessment in farmers perspective | A Gautam | ,, | | Farmers said Rice, Wheat, potato and some Vegetables were found affected by weather and efforts made for reducing weather vulnerability like irrigation, intercultural operation and tunnel for vegetable production |
| Activity 3 | Crop vulnerability study under different climatic variability | G Malla | ,, | | Rice variety (NR-1067-6-B-1-3-3-3) was found better in terms of grain yield than other three varieties Khumal-10, Sukha dhan-1 and NR 11082 but it matured 8 days late compared to Khumal-10, Sukha |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | dhan-1. In case of factor A or when compared between open field and closed chamber, field condition was found good in Khumaltar condition than open top chamber (OTC). Similarly, field condition was superior over OTC chamber for higher grain yield. |
| | | | | | |
| Activity 5 | Crop management study under changing climatic parameters | G Malla | ,, | | Wheat variety Monal - 1 resulted higher grain yield of 4.4 ton/ha than other three tested varieties which resembles Mnal-1 would be good variety for the changing climatic condition. |
| Activity 6 | Estimation of GHGs emission from pasture agricultural land and livestock sectors | A Sharma | | | Pasture field in ARS, Bandipur with Sterile Setaria had highest $CO_2$-C emission and lowest was observed in stylo cropped field. |
| Activity 7 | Training on climate outlooks | A Gautam | ,, | | Training on climate out looks was conducted successfully and presented temperature and rainfall scenario of 16 Terai districts. |
| 32970001 | Carbon sequestration in agricultural land and plantation crop | G Malla | | 340 | Highest $CO_2$-C emission was observed in ARS, Dhunche, Rasuwa followed by Tansen among six research centre *viz.*, Rsuwa, Tansen, Bandipur, Parwanipur, Nawalpur and Ranighat. |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | Lowest $CO_2$-C emission was found ARS, Ranighat followed by Nawalpur district. Field with fruit trees (Orange) emitted highest $CO_2$-C whereas lentil emitted lowest in the year. |
| Activity 1 | Study on atmospheric sequestration under different tillage practice | G Malla | ,, | | In experiment field at ARS, Ranighat, Flat planting ZT with mulch emitted 43% lower $CO_2$-C emission as compared to FP-ZT with no mulch. Whereas, BP-ZT-mulch emitted 18% lower than BP-ZT-No mulch.. |
| Activity 2 | Estimation of atmospheric C sequestration by fruit plants and in orchard | A K Gautam | ,, | | Carbon sequestration on Orchard at Nawalpur, Parwanipur, Nepalgunj, paripatle, Tarahara was studied and found highest C sequestration at Sarlahi, Nawalpur 160 kg /mango tree /year followed by citrus. Lowest was found in orange tree field @ 10 kg/plant/year. |
| Activity 3 | Estimation of atmospheric C sequestration by pasture land | | | | |
| **32900001** | **FMP/AOE 329** | **Division Chief** | **Time bound** | **550** | |
| Activity 1 | Farm security | **Division Chief** | | | In the perspective of security chamber site was kept well and good |
| Activity 2 | Farm maintenance | | ,, | | Regular visit was made chamber site and maintained kept well and good condition. |

| | | | | | |
|---|---|---|---|---|---|
| Activity 3 | Research support ( admin Lab services, etc) | | ,, | | Repairing of OTC was done for crop production. |
| Activity 4 | Annual Report Publication | | ,, | | 100 units of Annual Report was Published |

**Annex 3.2: Summary progress of special research projects and activities, 2070/71 (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.<br>-Irrigated rice varieties also performed better under rain fed conditions.<br>-Renovation of community pond to collect run-off water in Maubari VDC, Rupendehi District<br>-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<br>-Dhanusha, Rupendehi and Banke experiencing increasing trend<br>-Sunsari and Banke districts experiencing decreasing trend in Tmax in winter season<br>-Central, western and mid-western Terai experiencing higher trend of growing degree days both during rainy and winter season |
| PPCR | AK Gautam | 2014 | 2019 | | Some infrastructure development of coordinate office and designed agro advisory bulletin for farmers. |

**Annex 5.3 Publications, 2070/771 (2013/2014)**

| SN | Title of publication | Type | Language | Author | No. of copies |
|---|---|---|---|---|---|
| 1. | Annual Report 2070/71 (2013/14). Agricultural Environment Research Division, Khumaltar, Lalitpur, Nepal | Report | English | Agricultural Environment Research Division, Khumaltar | 100 |
| 2 | 2nd Annual Technical Report, on Production and Services of Agro-meteorological Information for the adaptation to climate change in Nepal | Report | English | Agricultural Environment Research Division, Khumaltar, Lalitpur | 100 |
| 3. | National level workshop on climate outlooks and climate change | Workshop | | Bhairahawa | 1 |

**Annex 6.1 Training/ workshop/ seminar attended by staff, 2070/71 (2013/14)**

| SN | Name of staff | Position | Name of Training/seminar/workshop | Duration | Place/ Country | Organizer |
|---|---|---|---|---|---|---|
| 1. | Ananda Kumar Gautam, | Chief Senior Scientist | Agro-meteorological information for adaptation to CC | 03rd -07th June 2014 | Mongolia | AMIS |
| 2. | Ananda Kumar Gautam, | Chief Senior Scientist | Expert consultation meeting on adaptation to CC on crop production | 23rd -24th November 2013 | Bangladesh | |
| 3. | Ananda Kumar Gautam | Chief Senior Scientist | Expert Exposure Visit | 8th to 14th July 2014 | India | PPCR |
| 4. | Alok Sharma | TO6 | ARC-GIS | Feb.14-21, 2014 | Nepal | SSD/NARC |

**Annex 6.2 Paper published, 2070/71(2013/14)**

| SN | Title of paper | Authors | Name of proceeding or journal |
|---|---|---|---|
| 1. | Comparative Study of $CO_2$-C Emission in the Farmer's Field (CCAFS- sites) of National Wheat Research Program (NWRP) | G Mall, AK Gautam, SK Rai, A Sharma and HP Devkota | 11th National Outreach Workshop |
| 2. | Study on Wheat at different seeding dates under Changing Climate Parameters at Khumaltar | G. Malla, Dr.AK. Gautam, A. Sharma, A. Timilsina and H. P. Devkota | 29th National Winter Crop Workshop |

**Annex 7.1 Regular annual budget and expenditure record, 2070/71 (2013/14)**

| Budget Code | Budget heads | Annual Budget | Budget released | Expenses | Balance |
|---|---|---|---|---|---|
| **40**** | **Staff Expenses** | **32,73,000** | **32,73,000** | **32,45,079** | **27921** |
| 4000 | Basic Salary | 25,99,000 | 2599000 | 2579808 | 19,192 |
| 4010 | Allowance | 1,09,000 | 1,09,000- | 1,08,000- | 999- |
| 4020 | Provident fund | 2,60,000 | 2,60,000 | 2,57,980 | 2019 |
| 4040 | Cloth | 83,000 | 83,000 | 82,500 | 500 |
| 4050 | Dasain expenses | 2,00,,000 | 2,00,000 | 1,94,990 | 5010 |
| 4080 | Insurance | 22,000 | 22,000 | 21,800 | 200 |
| *41*** | **Operational Expenses** | **16,60,000** | **16,60,000** | **15,10,362** | **1,49,637** |
| 4100 | Travel Expenses | 3, 50,000 | 3, 50,000 | 348768.00 | 1232.00 |
| 4110 | Vehicle Fuel Lubricants | 3,90,000 | 3,90,000 | 385914.30 | 4085.70 |
| 4120 | Wages to Labor | 370,000 | 370,000 | 287400.00 | 82600.00 |
| 4130 | Lab. & Research Supply | 70,000 | 70,000 | 68,853.16 | 1146.84 |
| 4140 | Farm Supply | 130,000 | 130,000 | 129087.90 | 912.10 |
| 4150 | Library & Publication | 1,50,000 | 1,50,000 | 109192.50 | 40807.50 |
| 4160 | Training workshop seminar | 100,000 | 100,000 | 81895.00 | 18105.00 |
| 4180 | Farm management project | 1,00,000 | 1,00,000 | 99251.40 | 748.60 |
| **42**** | **Administrative Expenses** | **8,80,000.00** | **8,80,000.00** | **8,47,952.88** | **32,047.12** |
| 4200 | Rent Utilities | 3,00,000 | 3,00,000 | 2,88,996.80 | 11003.00 |
| 4210 | Communication Expenses | 80,000 | 80,000 | 65052.20 | 14947.80 |

| | | | | | |
|---|---|---|---|---|---|
| 4220 | Repair & Maintenance | 3,65,000 | 3,65,000 | 3,61,888.50 | 3111.50 |
| 4230 | Office Supplies | 75,000 | 75,000 | 72450.38 | 2549.62 |
| 4260 | Contingencies | 60,000 | 60,000 | 59,565.00 | 435.00 |
| **43**** | **Capital Expenses** | **56,20,000** | **23,85,000** | **23,83,273.11** | **1,726.89** |
| 4330 | Furniture and fixtures | - | - | - | - |
| 4340 | Machinery & equipments | 55,00,000 | 22,65,000 | 22,64,998.11 | 1.89 |
| 4360 | Computer and software | 100,000 | 1,00,000 | 98,500.00 | 1,500.00 |
| 4370 | Other Fixed Assets | 20,000 | 20,000 | 19,775.00 | 225.00 |
| **Total** | | **1,14,33,000** | **81,98000** | **79,86,667.37** | **211332.63** |

**Annex 7.2 Special project (AFACI) budget and expenditure record, 2070/71 (2013/14)**

| Budget Code | Budget heads | Annual Budget | Budget released | Expenses | Balance |
|---|---|---|---|---|---|
| **40**** | **Staff Expenses** | **106,000.0** | **106000.0** | **0.00** | **106,000.0** |
| 4000 | Basic Salary | - | - | - | - |
| 4010 | Allowance | 106,000.0 | 106,000.0 | | 1,06,000.0 |
| 4020 | Provident fund | - | - | - | - |
| 4040 | Cloth | - | - | - | - |
| 4050 | Dasain expenses | - | - | - | - |
| 4080 | Insurance | - | - | - | - |
| *41*** | **Operational Expenses** | **6,95,000.0** | **6,95,000.0** | **4,83,543.00** | **106,000.0** |
| 4100 | Travel Expenses | 2,95,000.00 | 2,95,000.00 | 294440.00 | 560.00 |
| 4110 | Vehicle Fuel Lubricants | 40,000.00 | 40,000.00 | 40,000.00 | 0.00 |
| 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 | 60,000.00 | 60,000.00 | 0 | 60,000.00 |
| 4160 | Training workshop seminar | 3,00,000.00 | 3.00000.00 | 1,49,103.00 | 150897.00 |
| 4180 | Farm management project | 0 | 0 | 0 | 0 |
| **42**** | **Administrative** | **363,000.00** | **229773.07** | **139610.00** | **190163.07** |
| 4200 | Rent Utilities | 3,28,000.00 | 2,94,773.07 | 1,09,610.00 | 1,85,163.07 |
| 4210 | Communication Expenses | 0 | 0 | 0 | 0 |

| | | | | | |
|---|---|---|---|---|---|
| 4220 | Repair & Maintenance | 20,000.00 | 20,000.00 | 20,000.00 | 0 |
| 4230 | Office Supplies | 5,000.00 | 5,000.00 | 0 | 5,000.00 |
| 4260 | Contingencies | 10,000.00 | 10,000.00 | 10,000.00 | 0.00 |
| **43**** | **Capital Expenses** | **0** | **0** | **0** | **0** |
| 4330 | Furniture and fixtures | - | - | - | - |
| 4340 | Machinery & equipments | - | - | - | - |
| 4360 | Computer and software | - | - | - | - |
| 4370 | Other Fixed Assets | - | - | - | - |
| **Total** | | **11,64,000.00** | **1130773.07** | **623153.00** | **507620.07** |

## Annex 7.3 Special project (IWMI/CCAFS) budget and expenditure record, 2070/71 (2013/14)

| 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** | **178269.00** | **112069.0** | **66200.00** |
| 4100 | Travel Expenses | 1,90,000 | 76290.00 | 67870.00 | 8420.00 |
| 4110 | Vehicle Fuel Lubricants | 1,25,000 | 67979.00 | 44199.00 | 23780.00 |
| 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 | 22,000 | 0 | 22,000 |
| 4160 | Training workshop seminar | 130000 | 1,20,000 | 0 | 1,20,000 |
| 4180 | Farm management project | 0 | 0 | 0 | 0 |
| **42**** | **Administrative** | **185,000.00** | **77537.16** | **67257.10** | **10280.06** |
| 4200 | Rent Utilities | 30,000 | 0 | 30,000 | 0 |
| 4210 | Communication Expenses | 20,000 | 7805.00 | 0.00 | 7805.00 |

| | | | | | |
|---|---|---|---|---|---|
| 4220 | Repair & Maintenance | 50,000 | 5062.16 | 2825.00 | 2237.16 |
| 4230 | Office Supplies | 70,000 | 54670.00 | 54432.10 | 237.90 |
| 4260 | Contingencies | 15,000 | 10,000 | 10000 | 0 |
| **43**** | **Capital Expenses** | **3,85,000** | **291409.5** | 285896.20 | 5513.30 |
| 4330 | Furniture and fixtures | - | - | - | - |
| 4340 | Machinery & equipments | 1,00,000 | 41409.50 | 36205.20 | 5204.30 |
| 4150 | Vehicles | 1,70,000 | 1,70,000.00 | 169800.00 | 200.00 |
| 4360 | Computer and software | 80,000 | 80,000.00 | 79891.00 | 109.00 |
| 4370 | Other Fixed Assets | 35000 | - | - | - |
| **Total** | | **10,60,000** | **547215.66** | **465222.30** | **81993.36** |

## Annex 7.4 Special project (NDRI) budget and expenditure record, 2070/71 (2013/14)

| Budget Code | Budget heads | Annual Budget | Budget released | Expenses | Balance |
|---|---|---|---|---|---|
| **40**** | **Staff Expenses** | **288750.00** | **288750.0** | **288750.0** | **0.0** |
| 4000 | Basic Salary | - | - | - | - |
| 4010 | Allowance | **2**88750.0 | **2**88750.0- | **2**88750.0 | -0.0 |
| 4020 | Provident fund | - | - | - | - |
| 4040 | Cloth | - | - | - | - |
| 4050 | Dasain expenses | - | - | - | - |
| 4080 | Insurance | - | - | - | - |
| *41*** | **Operational Expenses** | **1,14,000.00** | **1,14,000.00** | **113923.0** | **77.00** |
| 4100 | Travel Expenses | 64,000.00 | 64,000.00 | 64,000.00 | 0.00 |
| 4110 | Vehicle Fuel Lubricants | 50,000.00 | 50,000.00 | 49923.00 | 77.00 |
| 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 | 0 | 0 | 0 | 0 |
| 4160 | Training workshop seminar | 0 | 0 | 0 | 0 |
| 4180 | Farm management project | 0 | 0 | 0 | 0 |
| **42**** | **Administrative** | **50,000.00** | **50,000.00** | **649950.0** | **50.00** |
| 4200 | Rent Utilities | 0.0 | 0 | 0.0 | 0 |
| 4210 | Communication Expenses | 0.0 | .00 | 0.00 | 0.0 |
| 4220 | Repair & Maintenance | 10,000 | 10,000 | 9950.00 | 50.0 |

| | | | | | |
|---|---|---|---|---|---|
| 4230 | Office Supplies | 10,000 | 10,000 | 10,000 | 0.0 |
| 4260 | Contingencies | 30,000 | 30,000 | 30,000 | 0 |
| **43**** | **Capital Expenses** | 0.0 | 0.0 | 0.0 | 0.0 |
| 4330 | Furniture and fixtures | - | - | - | - |
| 4340 | Machinery & equipments | 0.0 | 0.0 | 0.0 | 0.0 |
| 4150 | Vehicles | 0.0 | 0.0 | 0.0 | 0.0 |
| 4360 | Computer and software | 0.0 | 0.0 | 0.0 | 0.0 |
| 4370 | Other Fixed Assets | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | | **452750.00** | **452750.00** | **42623.00** | **127.00** |

## Annex 7.5 Special project (PPCR_NARC project) budget and expenditure record, 2070/71 (2013/14)

| Budget Code | Budget heads | Annual Budget | Budget released | Expenses | Balance |
|---|---|---|---|---|---|
| **40**** | **Staff Expenses** | **13,00,000** | **13,00,000** | **166800.0** | **1133800** |
| 4000 | Basic Salary | 550000.00- | 550000.0 | 0.0- | 550000.00 |
| 4010 | Allowance | 750000.00 | 750000.00 | 166800.0 | 583200.0 |
| 4020 | Provident fund | - | - | - | - |
| 4040 | Cloth | - | - | - | - |
| 4050 | Dasain expenses | - | - | - | - |
| 4080 | Insurance | - | - | - | - |
| *41*** | **Operational Expenses** | **1395000.00** | **1395000.00** | **129868.50** | **1265131.50** |
| 4100 | Travel Expenses | 240,000.00 | 240,000.00 | 15375.00 | 224625.00 |
| 4110 | Vehicle Fuel Lubricants | 155,000.00 | 155,000.00 | 46403.50 | 108596.50 |
| 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 | 100,000.00 | 100000.00 | 0 | 100,000.00 |
| 4160 | Training workshop seminar | 900,000.00 | 900000.00 | 68090.00 | 831910.00 |
| 4180 | Farm management project | 0 | 0 | 0 | 0 |
| **42**** | **Administrative** | **771,000.00** | **771,000.00** | **331226.30** | **439773.70** |
| 4200 | Rent Utilities | 550,000.0 | 550,000.0 | 114397.0 | 435603.0 |
| 4210 | Communication Expenses | 0.0 | .00 | 0.00 | 0.0 |
| 4220 | Repair & Maintenance | 80,000 | 80,000.00 | 76541.50 | 3458.50 |

| | | | | | |
|---|---|---|---|---|---|
| 4230 | Office Supplies | 75,000 | 75,000.00 | 74,777.80 | 222.20 |
| 4260 | Contingencies | 66,000 | 66,000 | 65510.00 | 490.00 |
| **43**** | **Capital Expenses** | 99,50,000.00 | 99,50,000.00 | 3765964.50 | 6184035.50 |
| 4330 | Furniture and fixtures | 750000.00 | 750000.00 | 743596.50 | 6403.50 |
| 4340 | Machinery & equipments | 6250000.00 | 6250000.00 | 479168.00 | 5770832.00 |
| 4150 | Vehicles | 600,000.00 | 600,000.00 | 493200.00 | 106800.00 |
| 4360 | Computer and software | 2350,000.00 | 2350,000.00 | 2050,000.00 | 300,000.00 |
| 4370 | Other Fixed Assets | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | | **13416000.00** | **13416000.00** | **4393859.30** | **9022140.70** |

**Annex 7.6 Revenue status, 2070/71 (2013/14)**

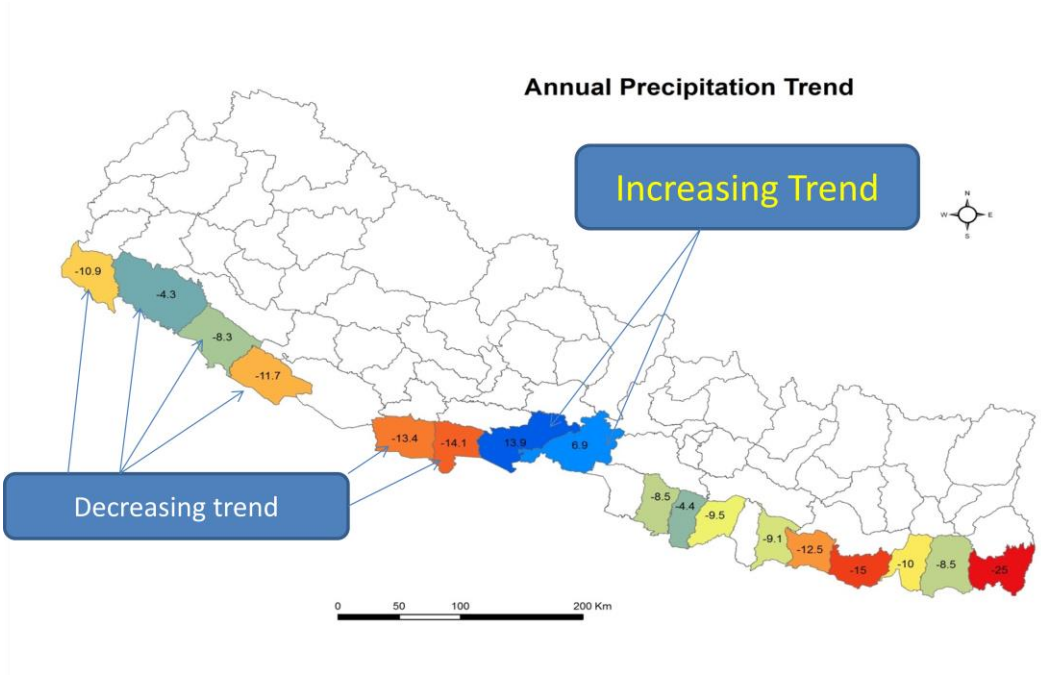
(*In Nepalese Rupees*)

| Source | Total | Remarks |
|---|---|---|
| Tender Form sell | | - |
| Assets Auction | | - |
| Bank Interest | 44,900.94 | - |
| Other administration Income | 32000.00 | - |
| **Grand Total** | **76900.94** | |

**Annex 7.7 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 |


Annual Precipitation Trend
Increasing Trend
Decreasing trend
-10.9
-4.3
-8.3
-11.7
-13.4
-14.1
13.9
6.9
-8.5
-4.4
-9.5
-9.1
-12.5
-15
-10
-8.5
-25
0
50
100
200 Km