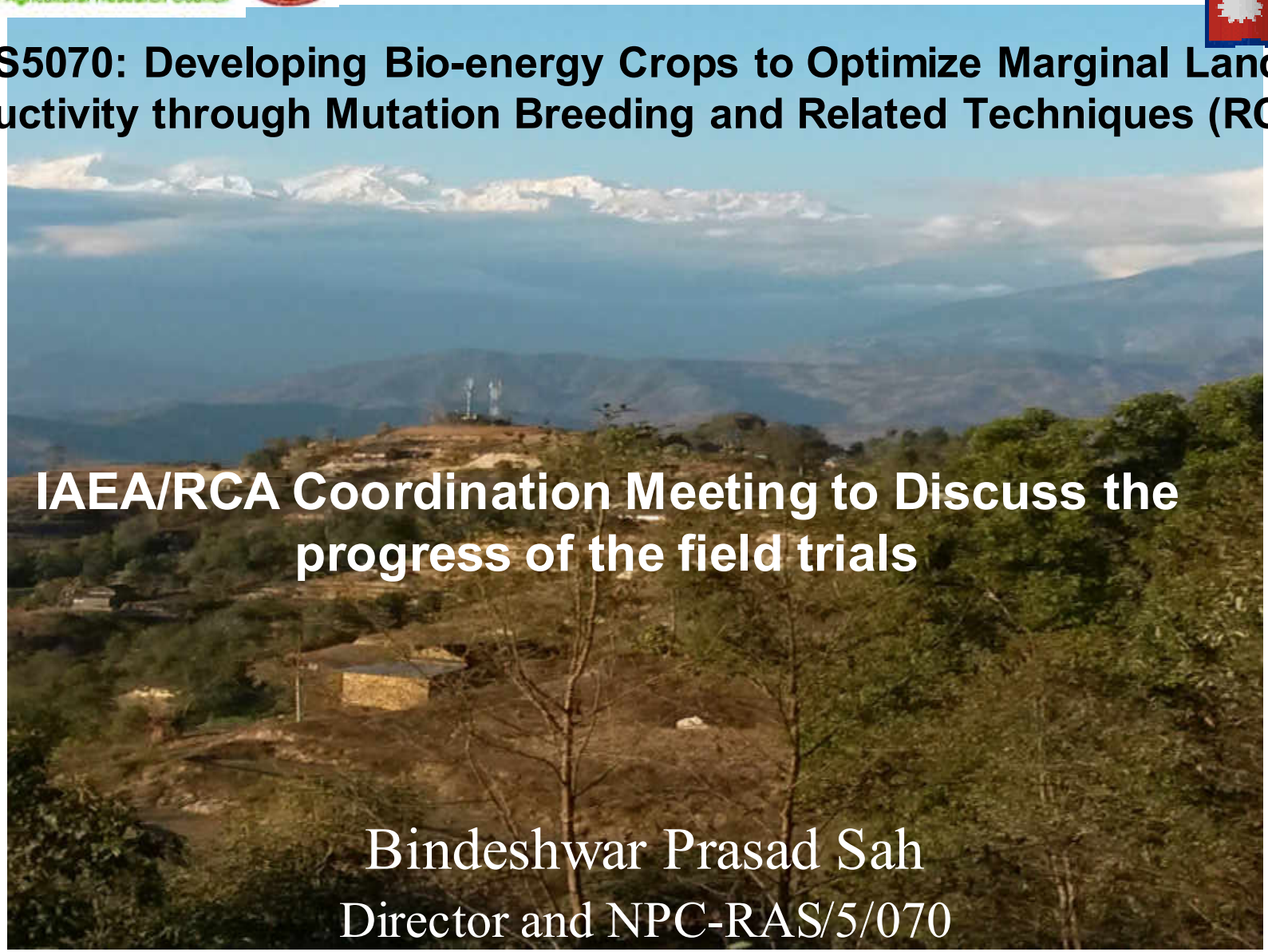
NARC
Nepal Agricultural Research Council

# RAS5070: Developing Bio-energy Crops to Optimize Marginal Land Productivity through Mutation Breeding and Related Techniques (RCA)



## IAEA/RCA Coordination Meeting to Discuss the progress of the field trials


Bindeshwar Prasad Sah

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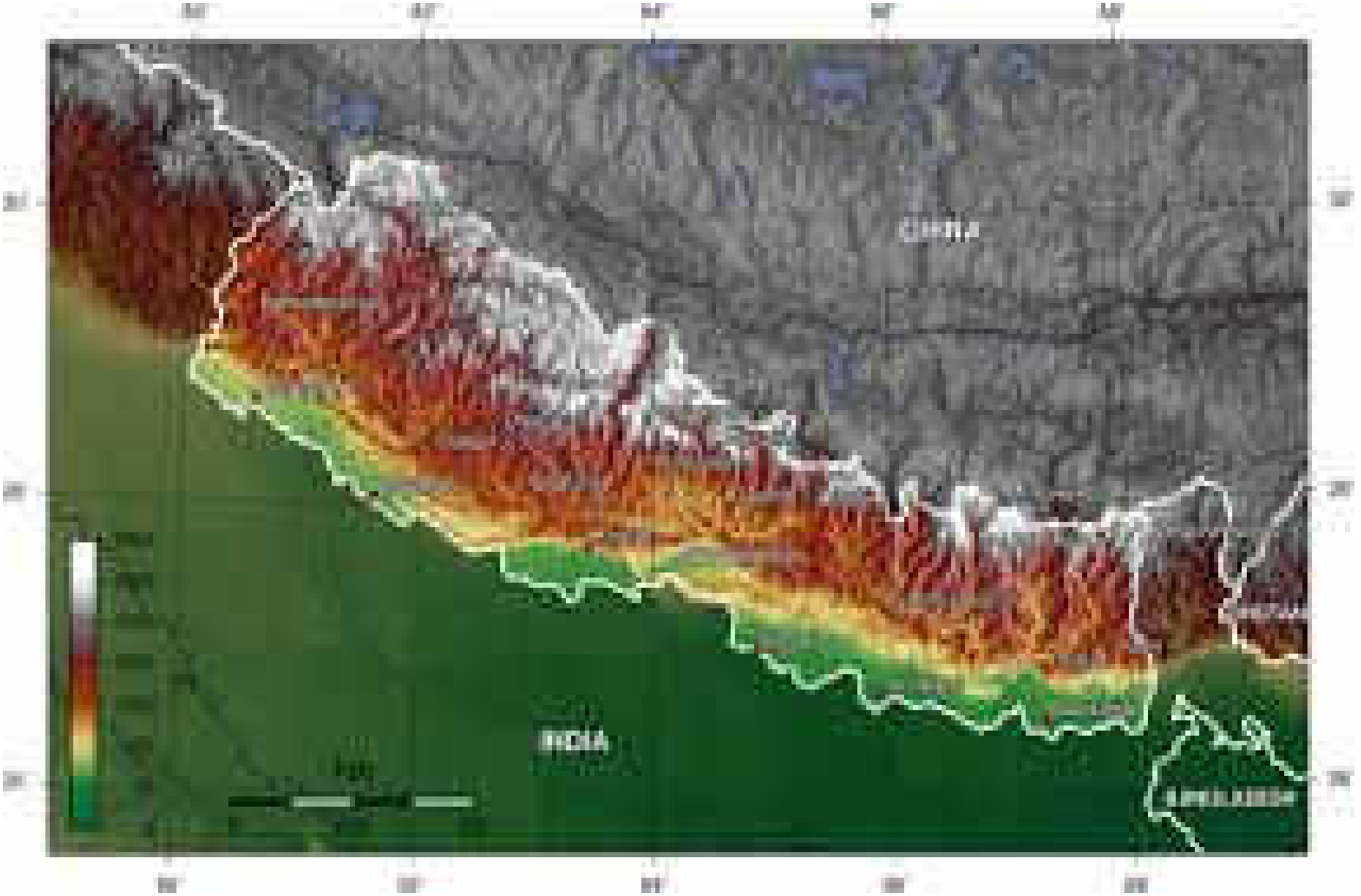
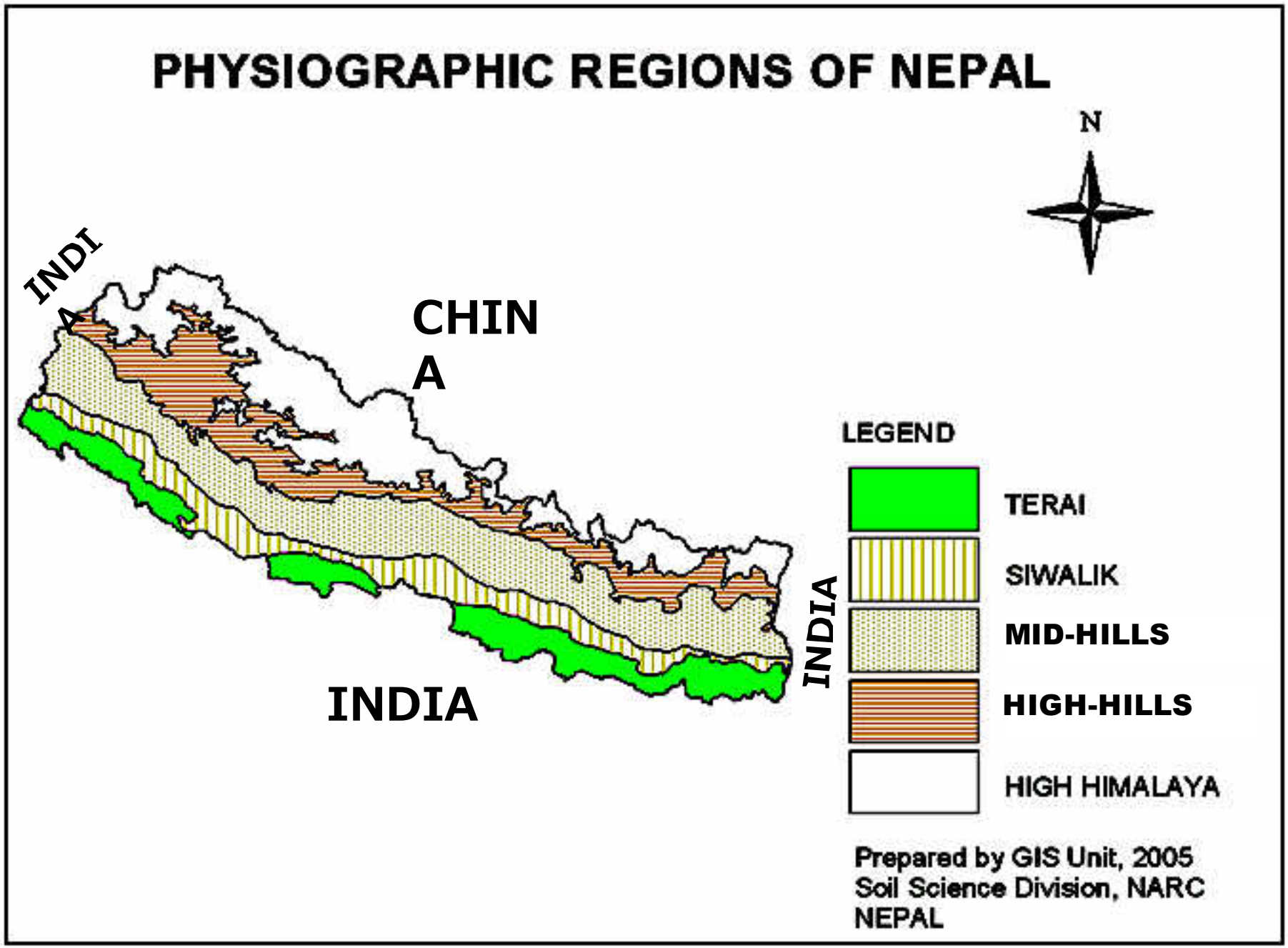
National Agricultural Research Institute/ NARC

Khumaltar, Lalitpur, Nepal

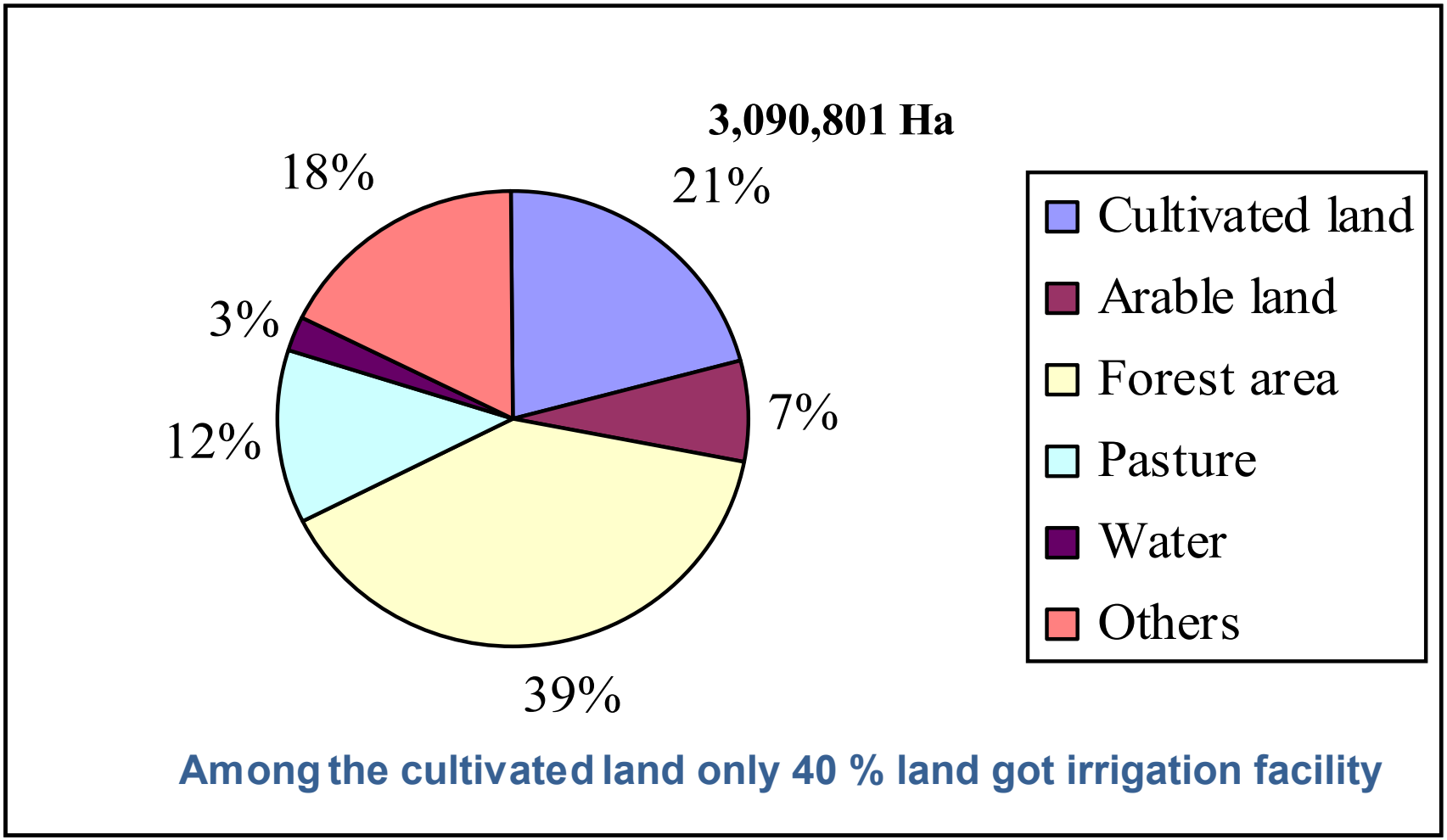
# Nepal is a landlocked country: 3 sides India and 1 side China.


INDIA

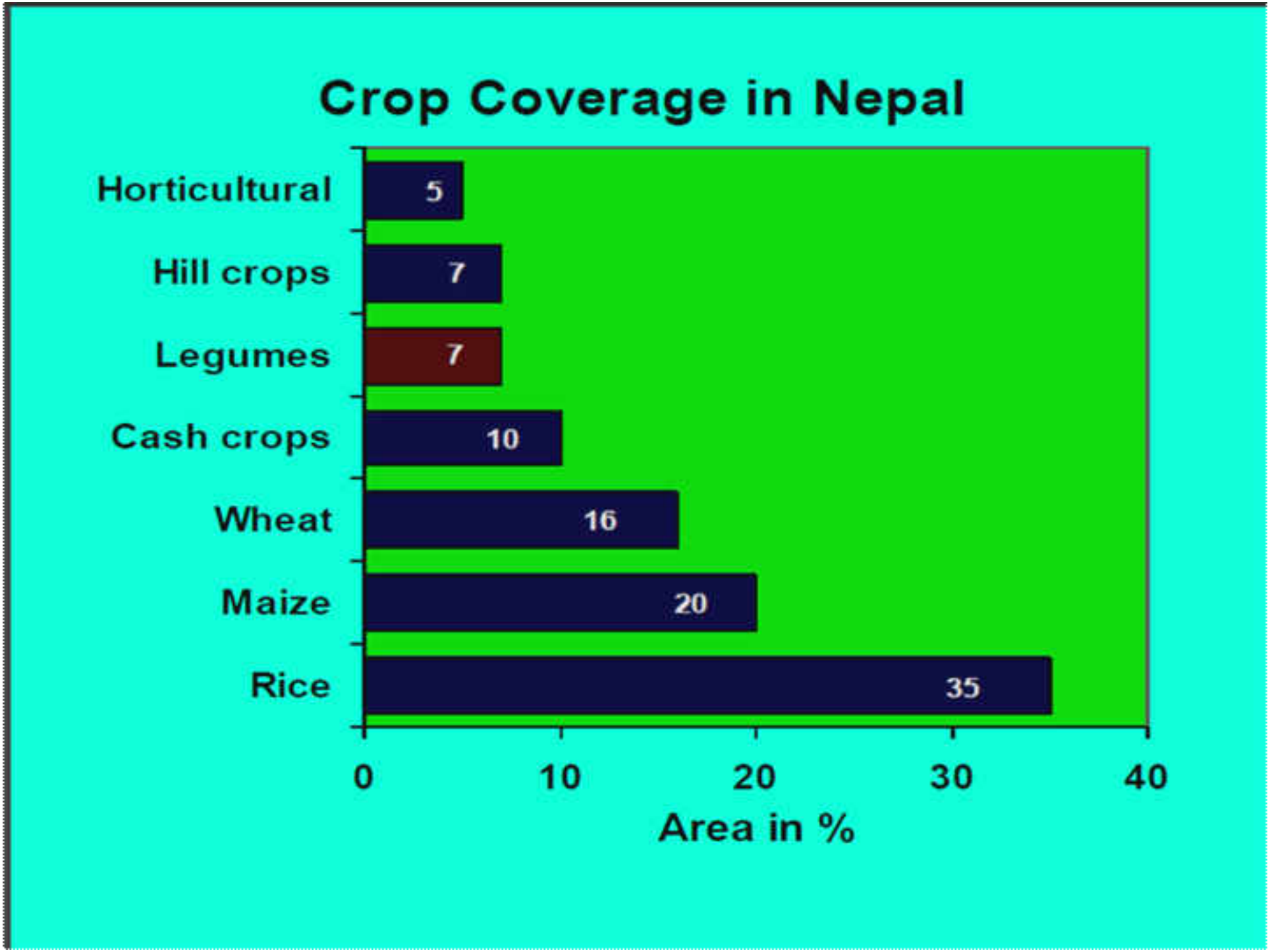

PHYSIOGRAPHIC REGIONS OF NEPAL
N
INDI
A
CHIN
A
INDIA
INDIA
LEGEND
TERAI
SIWALIK
MID-HILLS
HIGH-HILLS
HIGH HIMALAYA
Prepared by GIS Unit, 2005
Soil Science Division, NARC
NEPAL

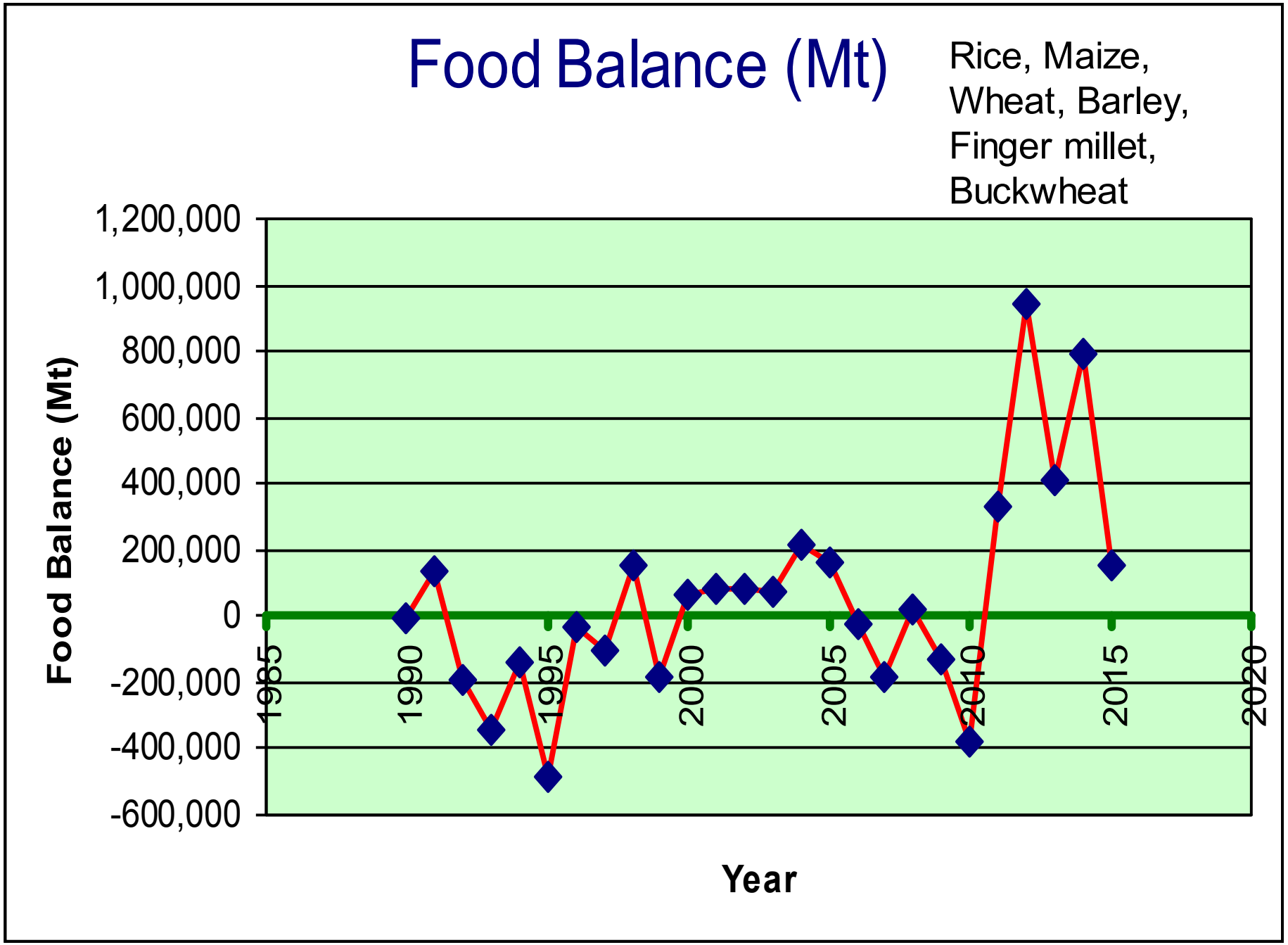
# Facts of Nepal

- Total population: 27,539,000
- Population engaged on agriculture : from 93 to 65.6%
- Land coverage: 14,718,100 Hectare

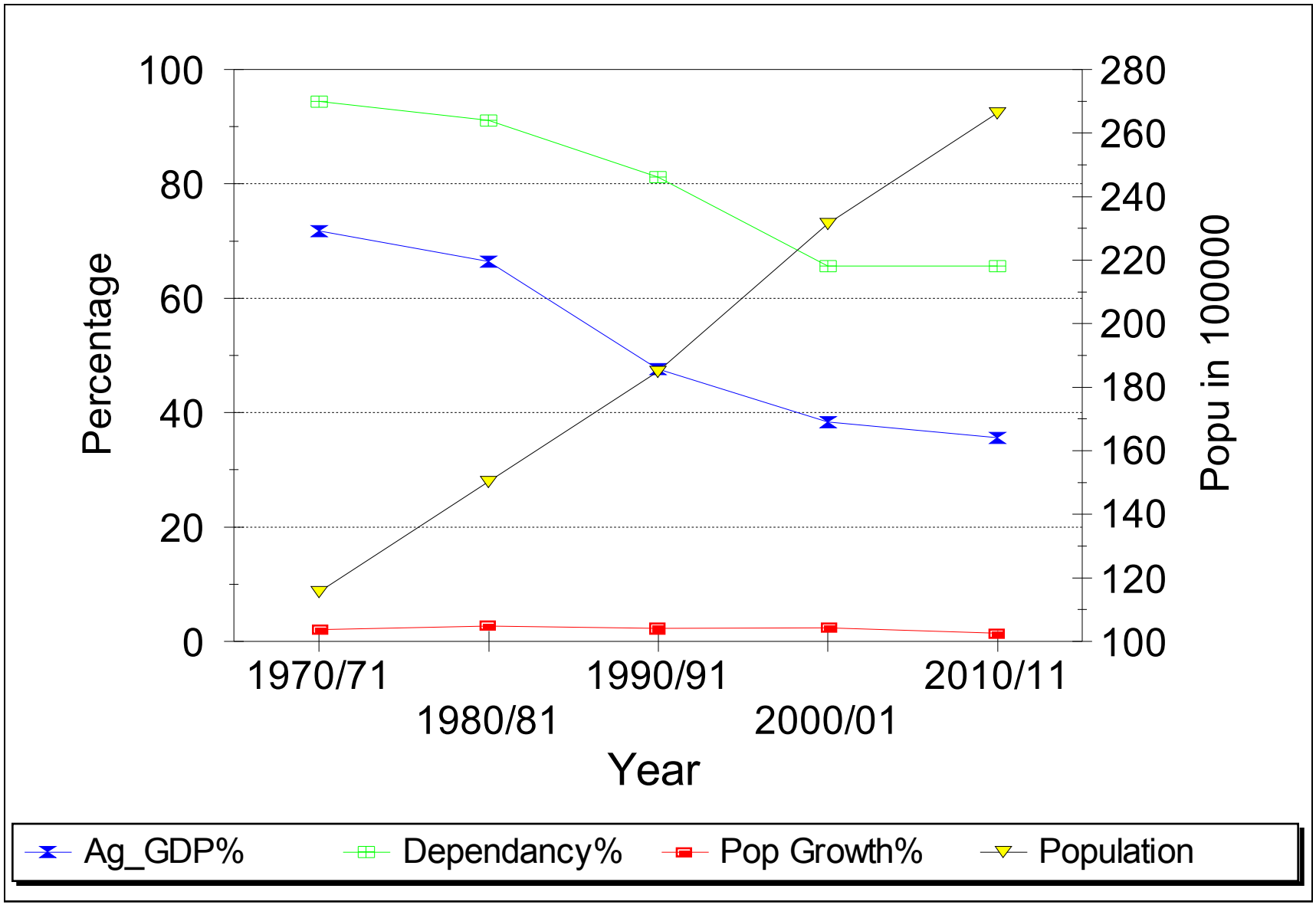



**Among the cultivated land only 40 % land got irrigation facility**


Crop Coverage in Nepal
Horticultural
Hill crops
Legumes
Cash crops
Wheat
Maize
Rice
5
7
7
10
16
20
35
0
10
20
30
40
Area in %

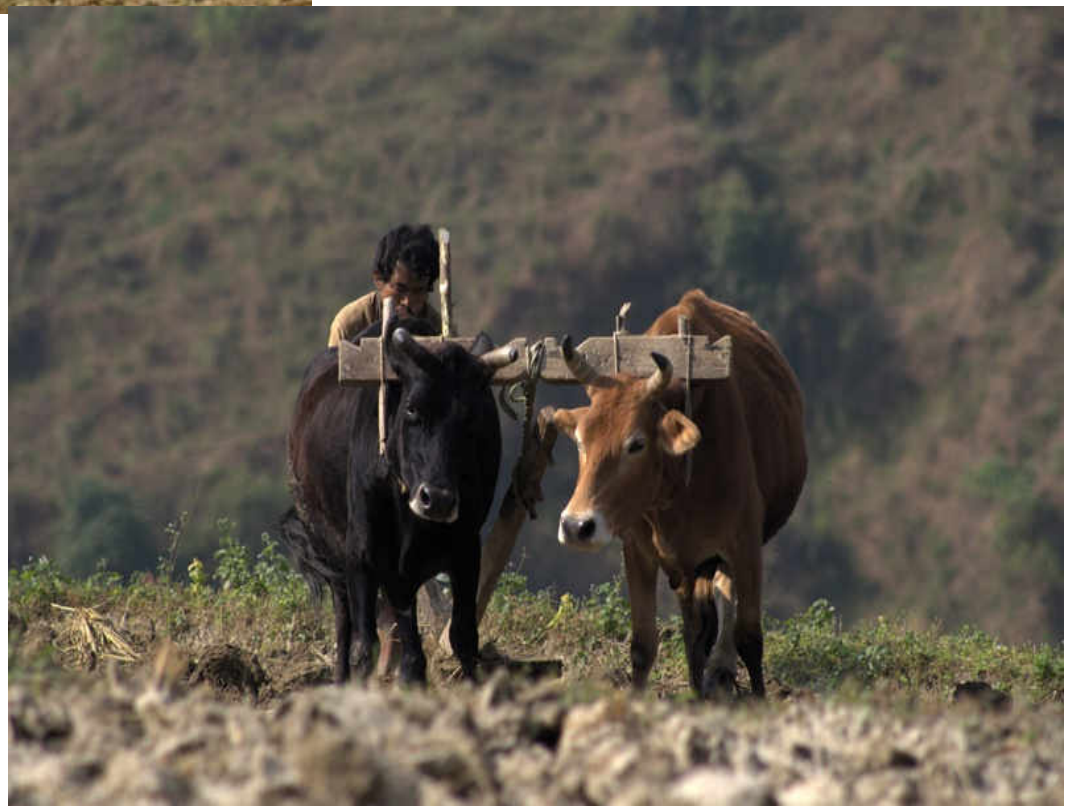

Food Balance (Mt)
Rice, Maize, Wheat, Barley, Finger millet, Buckwheat
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
-200,000
-400,000
-600,000
Food Balance (Mt)
1985
1990
1995
2000
2005
2010
2015
2020
Year

# Status of Population Growth, Dependency on Agriculture and share of Ag in GDP in Nepal

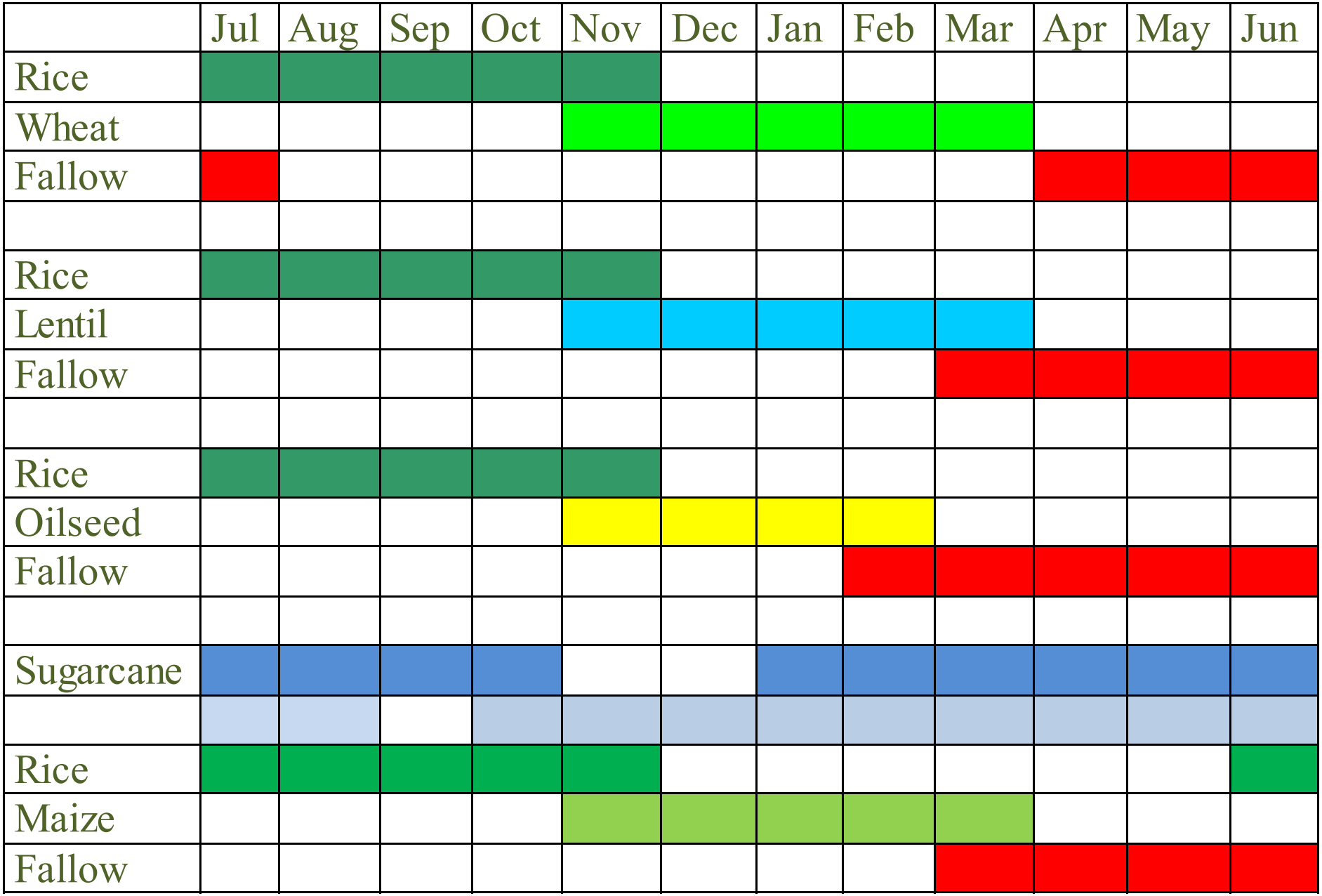


# Status of Import and Export of Agricultural Commodities

| Commodity | Export (Million NRs) | Import (Million NRs) | Export/ Import ratio |
|---|---|---|---|
| Live animals & their products | **22.76** | **1684.13** | **1: 9** |
| Plant products | **9353.46** | **17379.40** | **1: 2** |
| Animal & Plant based fats & oil | **314.34** | **12203.46** | **1: 38** |
| Processed Plant products | **3837.23** | **13163.42** | **1: 3.4** |
| **Total** | **13717.80** | **44430.17** | **1: 3.2** |



# Rice based Major Cropping Pattern:



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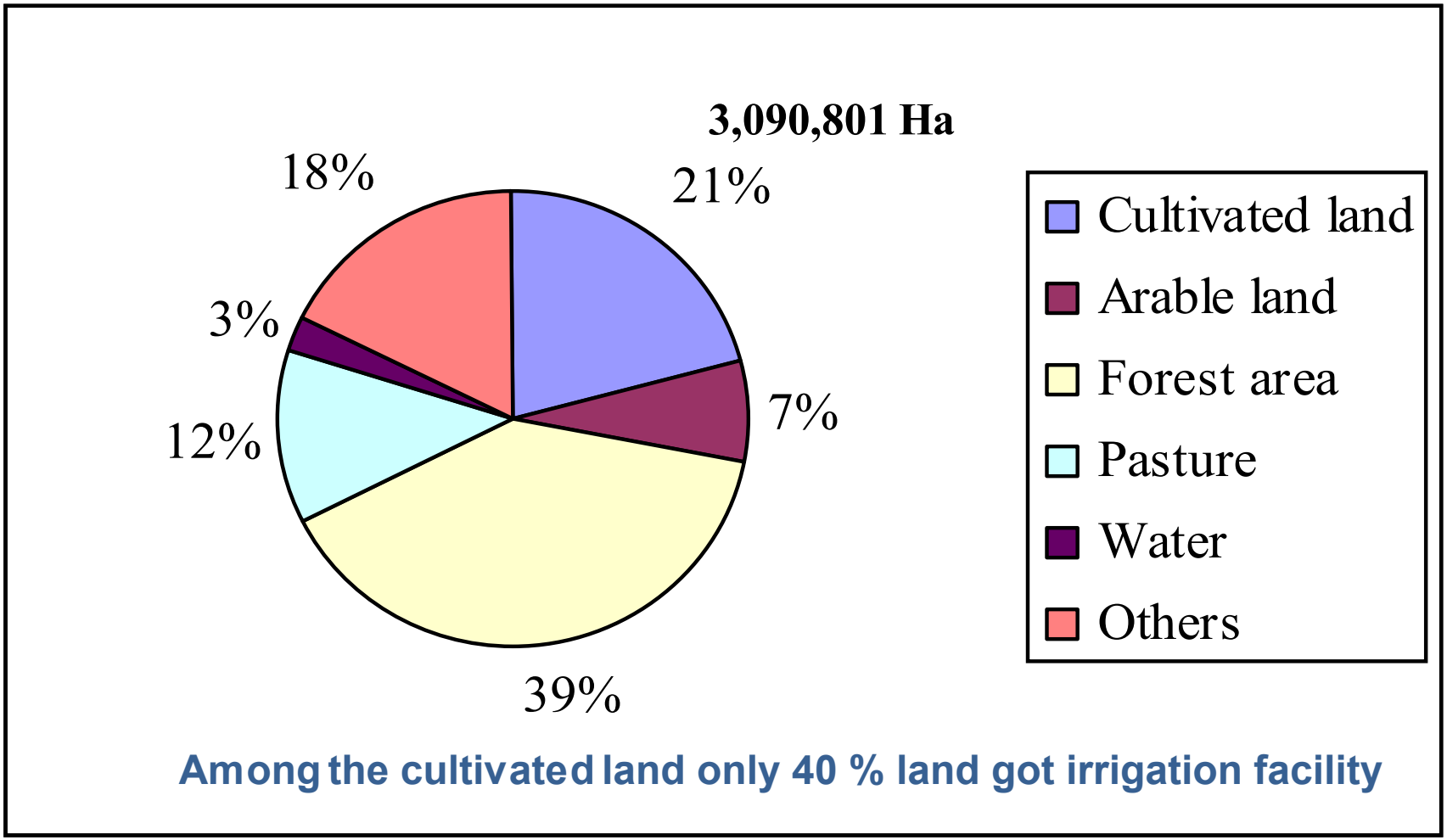
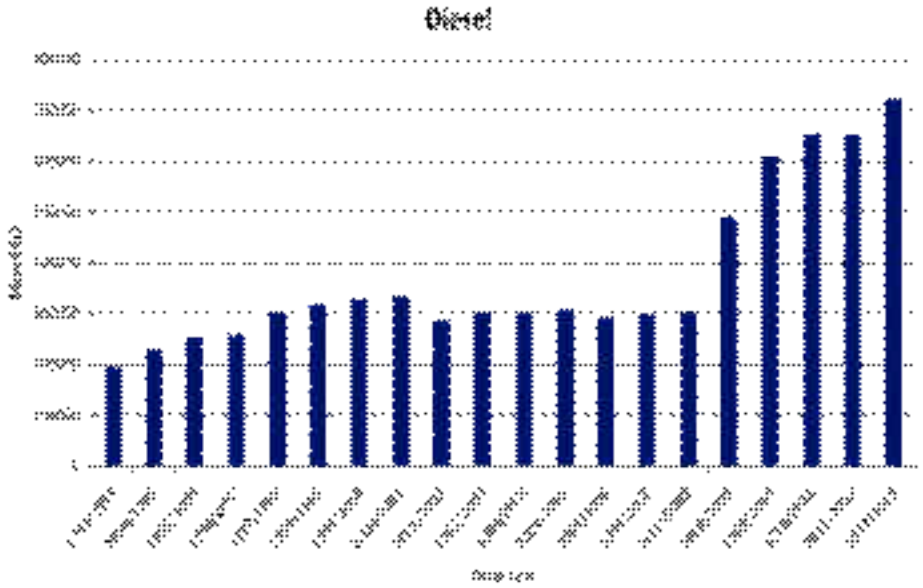
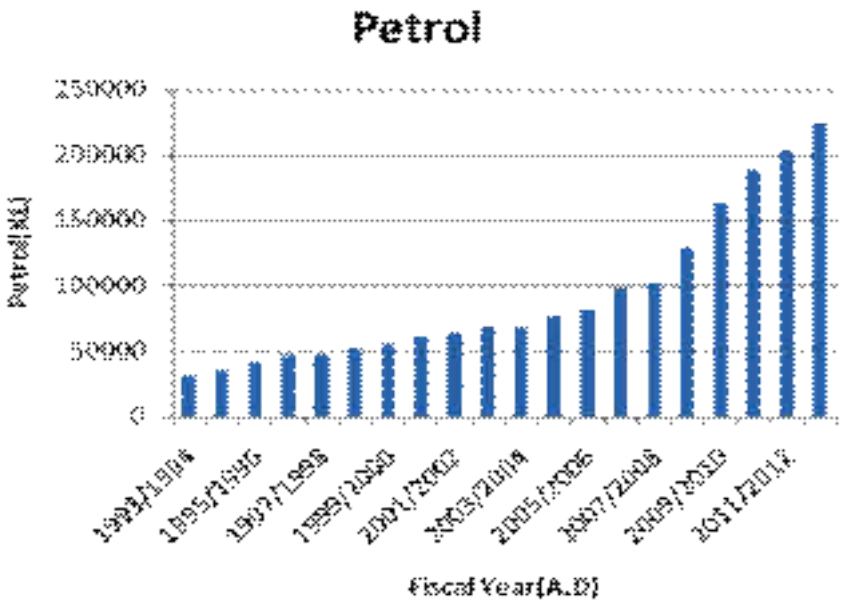
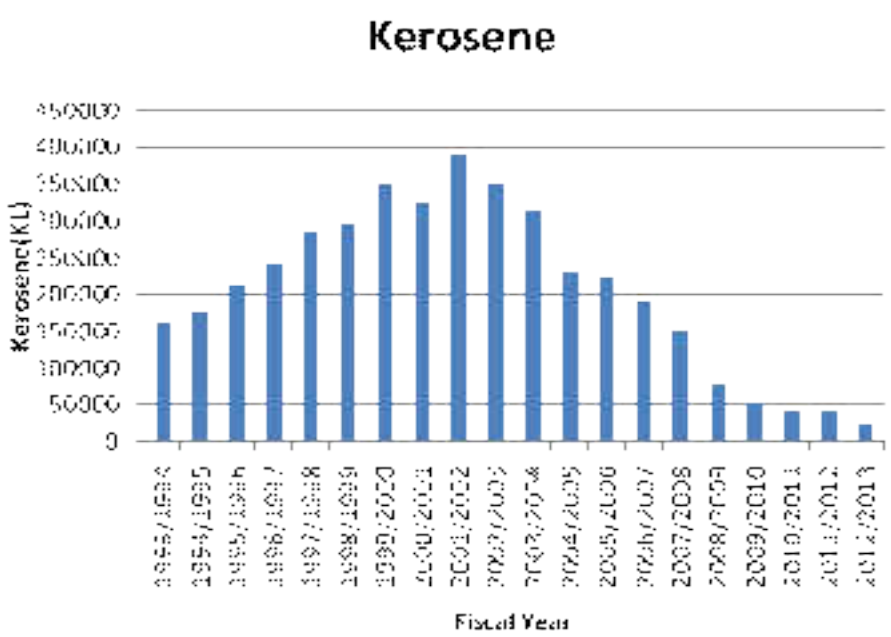


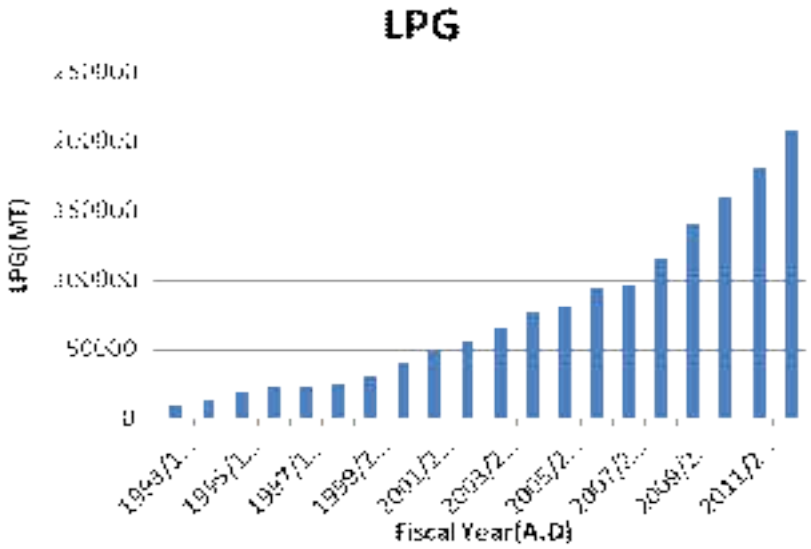

**Among the cultivated land only 40 % land got irrigation facility**

- Nepal depends on imported fuel from India and sells petrol, diesel and kerosene at highly subsidized rates, at huge financial cost to the government's Nepal Oil Corporation (NOC).


Diesel


Petrol
Petrol(KL)
Fiscal Year(A.D)


Kerosene
Kerosene(KL)
Fiscal Year


LPG
LPG(MT)
Fiscal Year(A.D)

Public protesting and firing belongings of Nepal Oil Corporation due to rise in price of fuels

**Police injured by public during security process for stopping protesting and firing of belongings of Nepal Oil Corporation due to rise in price of fuels**


LKO

More fuel will be demanded by the next generation: public can not travel on roof of the bus or aero plane. This can not be a much better transport option!

# Load-shedding

Load shedding per day:

- 6-8 hours (wet season) i.e. 2190-2920 hours/ 92-122 days per year (wet season)

- 12-16 hours (dry season) i.e. 4380- 5840 hours/ 183-243 days per year (dry season)

# Garbage can be converted to bio-fuel

- So, there is a urgent need to solve this fuel crisis

## Main Sources of Alternative Energy in Nepal

1. **Biogas**
2. **Micro-Hydro Power**
3. **Biomass Energy**
4. **Solar Energy**
5. **Wind Energy**

## Alternative fuel for Vehicle engines

1. **Compressed natural gas (CNG)**
2. **Liquefied petroleum gas (LPG)**
3. **Alcohol fuels such as methanol (methyl alcohol) and denatured ethanol (ethyl alcohol)**
4. **Bio-diesel**
5. **Electricity (stored in batteries)**
6. **Hydrogen (fuel-cell)**
7. **Solar**

# Status of Sweet potato in Terai

- **Bio-fuel will be one of the most prominent solution.**
- **In Nepal, for bio-fuel production, Jatropha seeds have been tried, however not been commercialized.**
- **Other possible commodities are algae, rape seed, sugarcane, sweet potato etc.**

# Objectives

- To find and improve suitable bio-fuel crop
- To improve soil moisture and fertility for growing bio-fuel crops
- To reduce GHGs
- To preserve ecosystems benefits
- To reduce import of fuels and save national foreign exchange
- To improve national economy

# Available resources

- **Sugarcane:**
  - Biotechnology Division
  - National Sugarcane Research Program
  - NARC setups

- **Sweet potato:**
  - Biotechnology Division
  - National Potato Research Program
  - NARC setups

# Future plan

Sugarcane:

- Evaluation and selection of mutants having capacity to efficiently utilize soil moisture and fertility for producing higher yield
- Evaluation for higher sugar content and ethanol output

**Sweet potato:**

- Collection of available germplasm
- Survey on distribution and cultivation
- Mutagenesis of desirable cultivar

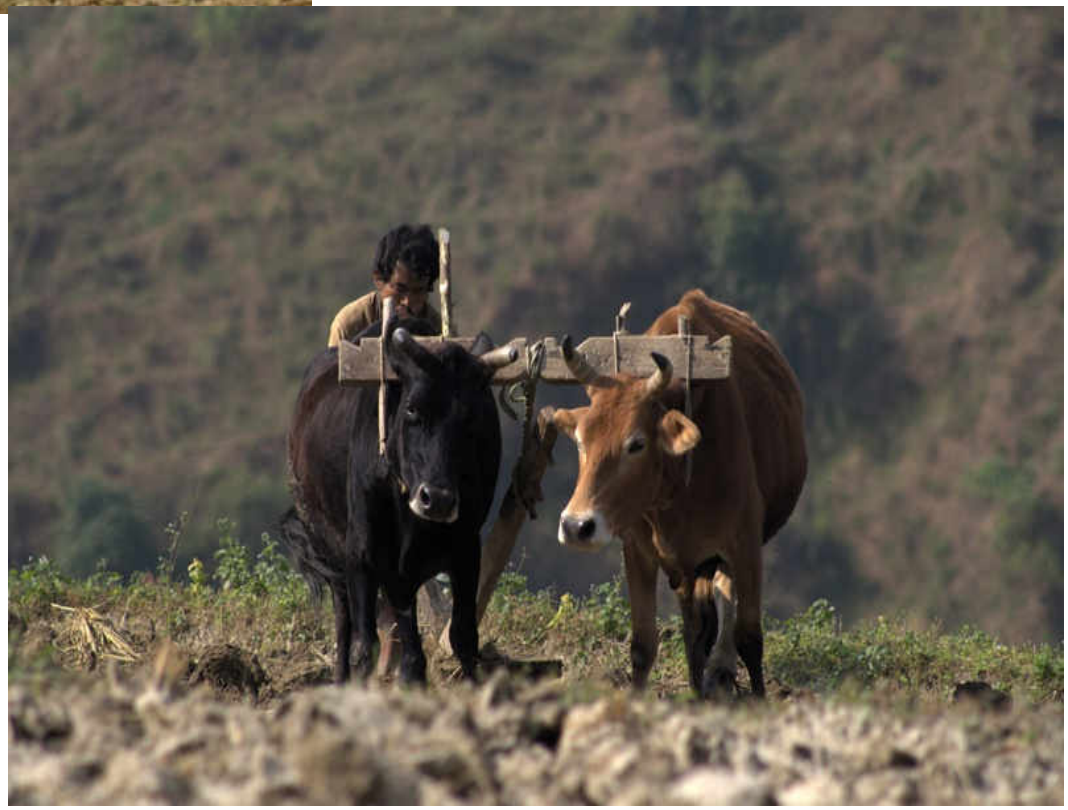
**Both:**

- Strengthening scientific capacity

# Request for assistance

- Facilitate in mutagenesis
- Facilitate for germplasm and scientific exchange
- Support in enhancing scientific capacity

# River basin and Mid-hill area



# Mid-hills

# Multi-purpose crops: food + feed + fuel

- Country is facing energy crises
- has great plant diversity that is potential for developing energy source
- plants producing oil and some plants that producing carbohydrate that can be converted to bio-ethanol
- huge amount of unproductive land: called as *"marginal land"* that cannot be used to grow food crops
- improved agricultural technologies like mutation breeding and nutrient and water management practices can be applied

- productivity of those marginal lands might be improved, especially by growing bio-energy crops

- Bio-energy crops, which will be developed for the marginal areas, therefore have the potential to improve the environment, increase rural incomes and offer a more robust crop

- Through developing potential bio-energy crops with application of nuclear techniques (mutation breeding; N-15 or C-13 isotopic techniques):

  ✓expected that crops' productivity will increase and, in turn, it will help to:

  - ❖ increase land productivity,
  - ❖ protect environment,
  - ❖ enhance ecosystem balance, and
  - ❖ improve farmers welfare in the region

# Objective

- Develop bio-fuel crop for fuel production in marginal and fallow land

# Activity

- Collect bio-fuel local commodities and irradiate seeds and plant parts
- Select genotypes with high fuel content
- Motivate for utilization of marginal land for bio-fuel production

# Meetings and Outcomes:

The workshop was held from 23 to 27 March 2015 in Vienna, Austria and 16 countries participated.

Outcomes were:

- Fine-tune of Regional project work plan with specific time frames and host countries identified
- National work plans developed and national work team identified
- National priorities on mutation breeding and soil and water management identified
- Current country status on mutation breeding of bio-energy crops presented
- Crops and target traits identified to breed for marginal lands
- IAEA's resources to provide technical support recognized

Outcomes of the meeting during March 2016:

**Crop: SUGARCANE**

**Members: Bangladesh/Nepal/Philippines/Thailand**

1. Background of marginal land problem in the region including soil, water and nutrient stats, current agricultural practices to restore marginal land
2. Field studies to address improving land nutrient and water management in marginal: objectives and outputs
3. Experimental design (treatments as well as number of replications), type of crops (*i.e.* Sugarcane, Cassava, sweet potato, Kepu, Candle nut, Kenaf, rapeseed, sorghum, *etc*.)

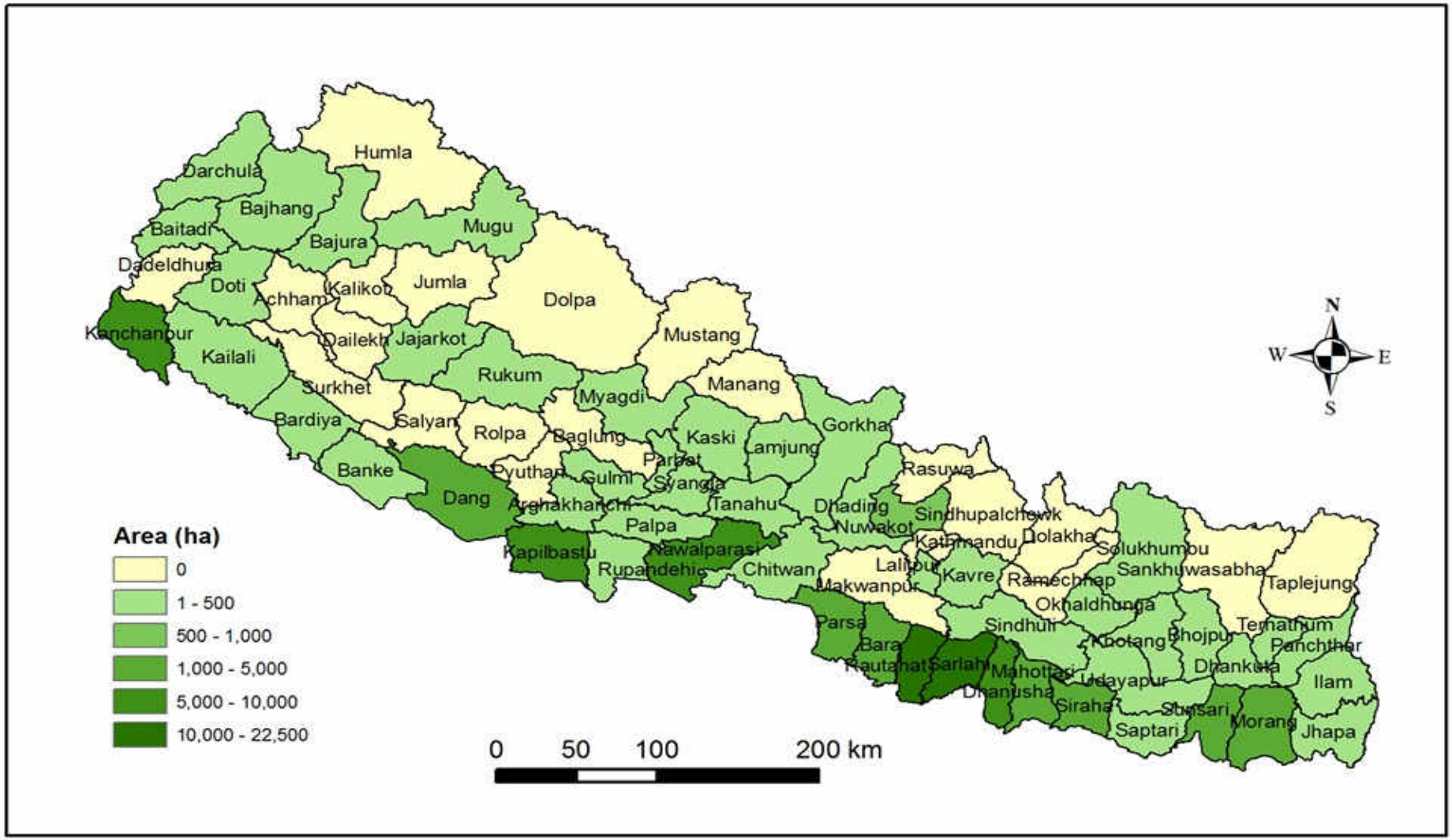
4. Soil, plant and water parameters to be collected and analyzed during the course of the study

5. Duration of the field trials along with starting date

6. Use of Nuclear Techniques such as $^{15}N$ to assess nutrient use efficiency, $^{13}C$ to asses soil quality, moisture neutron probe to monitor soil water and $^{2}H$ and $^{18}O$ to quantify evapo-transpiration if any?

7. Team (Soil plus plant breeding) need to be formed

# Distribution of sugarcane crop in Nepal



# Commercial Sugar Production in Nepal

Details of Sugar Factory, their Crushing Capacity and Sugar Production in Nepal during 2015/16

| SN | Name of sugar factory | Address | Cane Crushing Capacity (tons/day) | Total Cane Crushed (tons) | Sugar Production (tons) | Sugar Recovery % |
|---|---|---|---|---|---|---|
| 1 | Eastern Sugar Mills Ltd. | Amahibelha, Sunsari | 2,500 | 134,150 | 12,341.9 | 9.20 |
| 2 | Everest Sugar and chemicals | Ramnagar, Mahottari | 5,000 | 346,282 | 33,589.4 | 9.70 |
| 3 | Indu Shankar Chini Udhyog Ltd. | Hariwan, Sarlahi | 5,000 | 312,080.5 | 30,620.9 | 9.81 |
| 4 | Annapurna Sugar Mill | Dhankauta, Sarlahi | 2,500 | 114,950 | 10,690.4 | 9.30 |
| 5 | Shri Ram Sugar Mill | Garuda, Rautahat | 2,500 | 89,809.1 | 8,181.7 | 9.11 |
| 6 | Reliance Sugar Industry | Shripur, Bara | 2,500 | 181,000 | 17,611.2 | 9.73 |
| 7 | Mohini Sugar Industry | Nawalparasi | 50 | - | - | - |
| 8 | Indira Sugar and Agro Industry | Nawalparasi | 500 | 36,800 | 3,128.1 | 8.50 |
| 9 | Bagmati Chini Mill Ltd. | Kuriya, Nawalparasi | 1,200 | 66,389.8 | 6,194.2 | 9.33 |
| 10 | Lumbini Chini Udhyog Pvt. Ltd. | Sunwal, Nawaparasi | 1,000 | 34,800 | 2,784.0 | 8.00 |
| 11 | Mahalaxmi Sugar Mill Ltd. | Jawvari, Kapilvastu | 2,000 | 71,700 | 6,811.7 | 9.50 |
| 12 | Mahakali Sugar Mills | Kanchanpur | 500 | 98,300 | 9,142.0 | 9.30 |
| 13 | Bhageswori Chini Udhyog | Kalika, Kanchanpur | 1,000 | 65,800 | 6,053.7 | 9.20 |
| 14 | Himalayan Sugar and Chemicals | Panwari, Siraha | 2,500 | 16,600 | - | - |
| | **Total** | | | **1,568,661.4** | **147,149.2** | |
| | **Ave rage** | | | | | **9.22** |

# Sugar Status

## Global

**171 million metric tons** **174 million metric tons**

(Source: USDA, 2016)

Sugar Production

Sugar requirement

**Deficit**
**1.15 %**

## National

**Prod=147,149 mt**

**Req=212,966 mt**

**@ 30g of sugar/day/person**

**Deficit**
**30.6%**

**(Source: MoAD, 2015, Indushankar sugar mill, 2015)**

- To fulfill the domestic requirements and export promotion of sugars, we must attain at least 70-80 mt/ha national productivity with >11% sugar recovery

- **Improved sugarcane varieties and Improved production technologies** play an important role in boosting cane productivity.

# Major Constraints in sugarcane varieties development in Nepal

- **Since 2004 none of the varieties have been released in Nepal**

Why ???

- **Sugarcane seed fuzz could not be produced**

**No Congenial environment for natural breeding**

- Landraces of sugarcane found in Nepal are not suitable for commercial cultivation
- The landraces are low in sugar content and low productive.
- No any valid external sources of sugarcane germplasm
- Lack of Bilateral and multilateral agreements for germplasm exchange with other countries

# Major Constraints in sugarcane production

- **No seed set**

- **Biotic stresses**
  - **Red Rot**
  - Smut
  - Wilt
  - *Pyrilla*
  - Root and Shoot Borers
  - Whitefly

- **Abiotic Stresses**
  - **Drought**
  - Flooding/ Waterlogging
  - **Nutrient disorder**

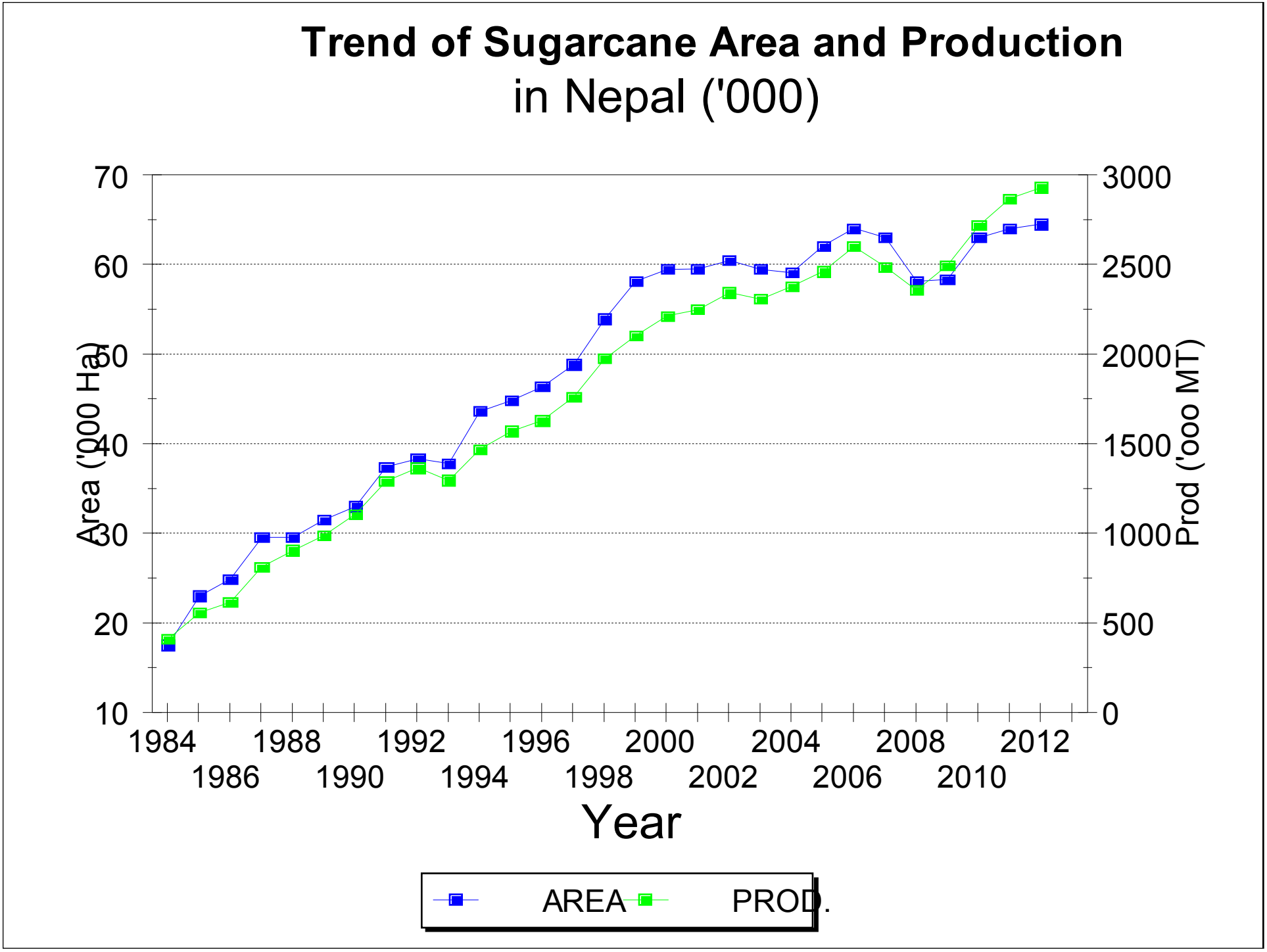
(deficiency and toxicity)

**Red Rot**

**Smut**

**Drought Stress**

**Flooding**


Trend of Sugarcane Area and Production
in Nepal ('000)
Area ('000 Ha)
Prod ('000 MT)
70
60
50
40
30
20
10
3000
2500
2000
1500
1000
500
0
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Year
AREA
PROD.

# Mutation Breeding in Sugarcane using EMS

Source sugarcane plant in field for ex-plant

Meristem

Callus

EMS treatment

Shaker

Regeneration

Hardening

Plantlets in earthen pot

Plant transferred to field evaluation

# Field Design

Observation nursery

- Plot size: two rows & two meter length with 90cm spacing
- Seed setts: three budded 12 setts per meter length
- Setts treatment: dipping 15 minutes in fungicides carbenzim@1 gm/litre
- Fertilizer recommended: 150:60:40 kg N:P:K/ha
- Other intercultural operations were done as per crop requirement

- Mutant Sugarcane Genotypes:

  UP 9742, CoP 97182, CoSe 98255 and CoSe 92423

37 Mutant lines grown in the field of SRP, Jeetpur, Bara (Photo at their vegetative stage): variations are clearly visible

# Sugarcane cont….

- As a first lot, a total of 36 putative mutant lines of sugarcane, derived from CoSe 92423, had been planted in NSRP, Jitpur for field evaluation.

- Further, five elite sugarcane germplasms, viz. BO-139, BO-141, CO-0233, COJ-85 and COLK-94184 were collected from NSRP, Jeetpur for in-vitro mutagenesis.

# Initial Evaluation Experiments:

- Design: RCBD
- Replication: three
- Plot size: 90 cm spaced 4 row with 4 m length
- Fertilizer: 150:60:40 kg/ha NPK
- Seed setts: three budded 12 setts per meter length
- Setts treatment: dipping 15 minutes in fungicides carbenzim@1gm/litre
- Other intercultural operation was done as per crop requirement

Table1: Cane yield and yield attributing characters of various genotypes in Initial Evaluation Trial (IET) during 2072/73

| Genotypes | Yield (mt/ha) | Millable canes/ha | Stalk length (m) | Cane diameter (cm) | Single cane weight (kg) |
|---|---|---|---|---|---|
| BO 139 | 116.48 | 121750 | 2.61 | 2.01 | 0.84 |
| CoSe 1434 | 79.25 | 106250 | 2.60 | 2.99 | 0.86 |
| CoSe 98231 | 87.20 | 105000 | 2.31 | 2.19 | 0.96 |
| Co 0232 | 75.58 | 122500 | 2.24 | 2.06 | 0.76 |
| Co 97016 | 57.67 | 76875 | 2.52 | 2.13 | 0.94 |
| BO 147 | 58.75 | 70625 | 2.51 | 2.15 | 1.07 |
| CoS 88230 | 57.42 | 82500 | 2.34 | 2.17 | 0.93 |
| CoS 8432 | 46.11 | 70625 | 1.59 | 2.21 | 0.71 |
| BO 146 | 109.05 | 101250 | 2.71 | 2.11 | 0.99 |
| Co 07250 | 88.92 | 95000 | 2.28 | 2.08 | 0.86 |
| CoSe 98259 | 78.02 | 95625 | 2.26 | 2.30 | 0.95 |
| CoLk 94184 | 106.26 | 126250 | 2.48 | 1.93 | 0.84 |
| CoJ 64 | 52.16 | 62500 | 2.23 | 2.01 | 0.80 |
| Co 0233 | 82.58 | 100000 | 2.48 | 2.06 | 1.02 |
| BO 141 | 80.56 | 99375 | 2.60 | 1.91 | 0.84 |
| CoSe 03234 | 77.56 | 100625 | 2.44 | 2.06 | 0.94 |
| Co 98014 | 18.50 | 33125 | 2.12 | 2.21 | 0.95 |
| UP 0098 | 67.32 | 78125 | 2.56 | 3.26 | 0.94 |
| BO 110 | 83.09 | 126250 | 2.63 | 1.82 | 0.77 |
| Co 0239 | 112.91 | 131875 | 1.78 | 2.30 | 0.83 |
| CoS 96268 | 82.70 | 87500 | 2.47 | 2.20 | 0.98 |
| BO 120 | 63.77 | 125625 | 2.35 | 2.00 | 0.76 |
| CoJ 88 | 83.13 | 91250 | 2.81 | 2.11 | 1.06 |
| UP 0097 | 64.10 | 111875 | 2.16 | 2.01 | 0.73 |
| CoSe 96275 | 82.84 | 96875 | 2.42 | 1.81 | 0.75 |
| BO 150 | 88.13 | 133750 | 2.64 | 2.08 | 1.04 |
| CoP 97182 BD 2 | 36.16 | 88750 | 2.58 | 2.08 | 0.92 |
| UP 9742 BD 10 | 88.49 | 123125 | 2.56 | 1.83 | 0.89 |
| CV% | 10.05 | 12.80 | 3.53 | 5.74 | 11.39 |
| LSD | 12.48** | 20557** | 0.14** | 0.19** | 0.17** |

- Among them, two BD lines UP 9742 BD 10 from UP 9742 genotype and CoP 97182 BD 2 from CoP 97182 genotype were selected for Initial Evaluation trial based on
  - ✓ cane yield,
  - ✓ tiller numbers,
  - ✓ stalk thickness
  - ✓ stalk length.

- Comparatively, only UP 9742 BD 10 lines performed well and selected for further advanced varietal selection trial from Initial Evaluation Trial.

- But, CoP 97182 BD 2 line was rejected for further field experiment due to low yield, low sugar recovery, thin cane diameter and susceptible to red rot disease.

# Evaluation of Selected mutant genotypes under different stress conditions

UP 9742 BD 10

- **Evaluation in waterlogged conditions with check**
- **Evaluation in Drought condition with check**

Photo taken at RARS,Parwanipur

Photo taken at NSRP, Jitpur

Photo taken at farmer's field in Rautahat District

- Likewise, sixty four mutagenic lines of sugarcane genotype CoSe 98255 was provided for field evaluation in NSRP in 2015 and planted in field for further evaluation.

- From this observation field trial, only 15 lines were selected from primary evaluation for further Initial Evaluation Experiments. The selected lines were

CoSe 98255 BD 2,
CoSe 98255 BD 3,
CoSe 98255 BD 6,
CoSe 98255 BD 15,
CoSe 98255 BD 24,
CoSe 98255 BD 28
CoSe 98255 BD 29,
CoSe 98255 BD 35,
CoSe 98255 BD 38,
CoSe 98255 BD 39,
CoSe 98255 BD 49,
CoSe 98255 BD 52,
CoSe 98255 BD 55,
CoSe 98255 BD 57,
CoSe 98255 BD 58.

Delivering mutant lines to Sugarcane Research Program:

- Among those, genotypes found superior than others in initial evaluation field trials are:

| | Mutant line | Yield (mt/ha) |
|---|---|---|
| 1 | CoSe 98255 BD15 | 101.11 |
| 2 | CoSe 98255 BD 52 | 92.00 |
| 3 | CoSe 98255 BD 38 | 89.58 |

* But more aerial roots emerged from stalk nodes

- Similarly, new 56 mutagenic lines of sugarcane genotype CoSe 92423 were generated and delivered to NSRP in 2016. These lines were planted for primary observation evaluation for further selection and experiment.

- The protocol of chemical *in-vitro* mutagenesis in sugarcane has been standardized.
- Till date, 174 putative mutants of sugarcane were induced and delivered to NSRP, Jitpur.
- Identification of the desirable mutation among these lines in sugarcane need to be regenerated more number of mutants.

# Current Research Activities

- Varietal improvement research going on in SRP, Jitpur:

  - Collection of Local and Exotic germplasm
  - Disease and Pest screening
  - Selection and characterization (maturity group, different domain)
  - Stability analysis under different environmental condition (GxE interaction study)

# Current Research Activities

➢ Varietal improvement research related with mutation:

- Evaluation of mutant putative genotypes



## Crop: Sweet potato

- It grows on well-drained soils with good aeration and is well adapted to marginal soils with low nutrient content. In heavy soils, root formation is reduced.

# Sweet potato

- Sweet potato seedlings are raised in nursery beds and transplanted in marginal lands in hilly area during June-July which is harvested in Oct-Nov., while
- Cuttings are transplanted in Terai areas
- Only grown in river basins soils covered by flood soil, sands, dry areas where no other commodities can be grown
- No any kind of efforts packages of practices are made during the season (irrigation, nutrition, weeding etc.) – only harvesting
- Not even considered as a food security crop

## Crop: Sweet potato

2016: Collection of germplasm: 47

2016: Multiplication

2017: Evaluation of germplasm in the field

2018: Irradiation of superior and desirable germplasm

2018: Descending followed by selection

2019: Multiplication of superior mutant

2020: Recommendation

# Sweet potato in observation nursery showed distinct variation

# How to irradiate?

## Other candidates:

- Castor (*Ricinus communis)* is commonly called as ‘adir’ in Nepal.
- Castor *beans subjected for the extraction of oil-contained 48% of yield.*
- *The refined oil contained 0.8% free fatty acid (FFA) and 76.258mg KOH/g saponification value which showed that oil was very suitable for bio-diesel production.*


*Jatropha curcas* L.

# Summary:

- Only Two meetings (Vienna and Malaysia) were attended
- Only one personnel is being trained

## Suggestion:

- Fallow land should be utilized for bio-fuel crop commodities
- NPC should be timely informed for the arrangement of any training
- Team members need to be trained urgently for conducting activities

# Sugarcane Researches in Nepal

Coordination meeting to review the
**Progress of the Field Trials:**

Soil and Water Use Efficiency Part

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# Import and consumption of Fertilizer in Nepal

In 2014/15 (in Mt)

| Fertilizers | Import | Consumption |
|---|---|---|
| Nitrogen | 83200 | 71314 |
| Phosphorus | 27600 | 31320 |
| Potassium | 4500 | 2807 |
| Total | 115300 | 105441 |
| | | |
| urea | 140000 | 128384 |
| DAP | 60000 | 68088 |
| Potash | 7500 | 4678 |

# Fertilizer users

Cereal Crops: >50-70%

Vegetable Crops: 30-40%

Industrial Crops: < 8%

other minor crops: <2%

# Current Research Activities

- Agronomical research:
  - Weed management
  - Integrated Nutrient management
  - Response on spacing on different varieties
  - Ratoonability on different shaving dates
  - Intercropping in sugarcane
  - Plant protection research


# Research in nutrient managements

Activity 1. Identify the nitrogen requirements for various sugarcane genotypes during 2014/15

Factor A: Nitrogen

1. 75% RDN*
2. 100% RDN
3. 125% RDN
4. 150% RDN

Factor B: Sugarcane Genotypes

| |
|---|
| **CoLk 94184** |
| **BO 147** |
| **Co 0233** |
| **BO 141** |

* RDN = Recommended Dose of fertilizers

=150:60:40 kg/ha NPK ) for plants

=200:60:40 kg/ha NPK for ratoon crops

Table 1: Yield attributes and cane yield of promising sugarcane genotypes plant cane under different nitrogen levels at NSRP in **2014/15**.

| Treatments | No of Millable canes /ha | Stalk length (m) | Single cane weight (kg) | Cane yield (mt/ha) |
|---|---|---|---|---|
| **Level of Nitrogen (kg N/ha)** | | | | |
| **75% RDN (112.5)** | 98207.92 c | 2.54 | 0.92 | 71.74 c |
| **100% RDN (150)** | 102156.19 bc | 2.49 | 0.97 | 82.09 b |
| **125% RDN (187.5)** | 107602.96 b | 2.57 | 1.00 | 88.48 a |
| **150% RDN (225)** | **115548.43 a** | **2.56** | **0.98** | **90.57 a** |
| **LSD** | 6758.93** | NS | NS | 5.12** |
| **Sugarcane genotypes** | | | | |
| **CoLk94184** | 124831.06a | 2.38 b | 0.79 b | 75.91 b |
| **BO 147** | 68643.88 c | 2.56 a | 1.03 a | 69.79 c |
| **Co 0233** | 112583.31 b | 2.56 a | 1.06 a | 93.18 a |
| **BO 141** | **117457.24 ab** | **2.65 a** | **0.98 a** | **94.01 a** |
| **LSD** | 8933.78** | 0.101** | 0.177** | 3.94** |
| **CV** | 8.2 | 6.5 | 15.1 | 5.9 |
| **Grand mean** | 105878.9 | 2.54 | 0.97 | 83.22 |

Table 2: Yield attributes and cane yield of promising sugarcane genotypes ratoon crop under different nitrogen levels at NSRP in **2016**

| Treatments | No of Millable canes /ha | Stalk length (m) | Single cane weight (kg) | Cane yield (mt/ha) |
|---|---|---|---|---|
| **Level of Nitrogen (kg N/ha)** | | | | |
| 75% RDN (150) | 83110b | 1.87 b | 0.65 b | 59.78b |
| 100% RDN (200) | 86640b | 1.93 ab | 0.76 a | 65.87ab |
| 125% RDN (250) | 89050b | 1.97 a | 0.74 a | 69.57a |
| **150% RDN (300)** | **100700a** | **2.0 a** | **0.76 a** | **72.37 a** |
| LSD | 9950.94 * | 0.08 * | 0.047 ** | 8.22* |
| **Sugarcane genotypes** | | | | |
| CoLk 94184 | 107400a | 1.91 | 0.60 b | 64.16 b |
| BO 147 | 60480 c | 1.95 | 0.81 a | 45.81 c |
| Co 0233 | 96220 ab | 1.96 | 0.77 a | 81.72 a |
| BO 141 | 95390 b | 1.95 | 0.74 a | 75.89 a |
| LSD | 11219.9** | NS | 0.104 ** | 8.81** |
| CV | 12.95 | 4.1 | 6.4 | 12.3 |
| Grand mean | 89879.61 | 1.94 | 0.73 | 66.89 |

# Conclusion

- Genotypes Co 0233 and BO141
- Higher than recommended dose (150 kg N/ha for plant and 200 kg N/ha for ratoon crops)

# Integrated nutrient management:

## Activity 3: Integration of chemical fertilizers with Press mud in Sugarcane

- Design: RCBD
- Plot size: 90 cm spaced 5 row with 5 m length
- Fertilizer: 150:60:40 kg/ha NPK
- Seed setts: three budded 12 setts per meter length
- Setts treatment: dipping 15 minutes in fungicides carbenzim@1gm/litre
- Other intercultural operation was done as per crop requirement
- Genotypes: BO 141

| Treatments | Combinations |
|---|---|
| $T_1$ | 120kg N/ha ($\frac{1}{2}$ at basal and $\frac{1}{2}$ in two split doses at 60 and 90 DAP) |
| $T_2$ | 150kg N/ha ($\frac{1}{2}$ at basal and $\frac{1}{2}$ in two split doses at 60 and 90 DAP) |
| $T_3$ | 200kgN/ha($\frac{1}{2}$ at basal and $\frac{1}{2}$ in two split doses at 60 and 90 DAP) |
| $T_4$ | 120kg N supplied by Press-mud |
| $T_5$ | 150kg N supplied by Press-mud |
| $T_6$ | 200kg N supplied by Press-mud |
| $T_7$ | 120kg N/ha ( 50% supplied by urea and 50% by Press-mud) |
| $T_8$ | 150kg N/ha ( 50% supplied by urea and 50% by Press-mud) |
| $T_9$ | 200kg N/ha ( 50% supplied by urea and 50% by Press-mud) |
| $T_{10}$ | 0kg N/ha |

| Treatments | Cane Yield(mt /ha) | No. of millable canes/h a | Stalk length(m ) | Stalk diame ter (cm) | Single cane weight (kg) |
|---|---|---|---|---|---|
| 120kg N/ha ($\frac{1}{2}$ at basal and $\frac{1}{2}$ in two split doses at 60 and 90 DAP) | 65.04 | 79667 | 1.84 | 1.77 | 0.95 |
| 150kg N/ha ($\frac{1}{2}$ at basal and $\frac{1}{2}$ in two split doses at 60 and 90 DAP) | 59.17 | 87000 | 1.79 | 1.90 | 0.90 |
| 200kgN/ha($\frac{1}{2}$ at basal and $\frac{1}{2}$ in two split doses at 60 and 90 DAP) | 61.25 | 89000 | 1.77 | 1.95 | 0.99 |
| 120kg N supplied by Press-mud | 55.76 | 84667 | 1.72 | 1.84 | 1.00 |
| 150kg N supplied by Press-mud | 63.77 | 87000 | 1.59 | 1.85 | 0.95 |
| 200kg N supplied by Press-mud | 63.42 | 86000 | 1.68 | 1.91 | 0.91 |
| 120kg N/ha ( 50% supplied by urea and 50% by Press-mud) | 72.96 | 85000 | 1.85 | 1.99 | 1.033 |
| 150kg N/ha ( 50% supplied by urea and 50% by Press-mud) | 60.32 | 84333 | 1.67 | 1.72 | 1.030 |
| 200kg N/ha ( 50% supplied by urea and 50% by Press-mud) | 60.00 | 83000 | 1.67 | 1.75 | 0.96 |
| 0kg N/ha | 44.25 | 65667 | 1.33 | 1.45 | 0.75 |
| GM | 60.596 | 83133 | 1.695 | 1.81 | 0.946 |
| CV% | 4.98 | 8.26 | 9.61 | 3.2 | 12.39 |
| FSD(0.05) | ** | ** | ** | ** | * |

# Conclusion

- 120 kg N/ha supplied in combination with 50% (i.e. 60 kg N/ha) urea and 50% (i.e. 60 kg N/ha) from Press mud

# Future Plan

- Nutrient trial will be conducted on sugarcane selected mutant lines along with checks in marginal land from next season starting Sept-Oct 2017
- If N-15 urea is available before planting season, It will be included in the experiment.

- Training on Isotopic techniques is required


Thank you