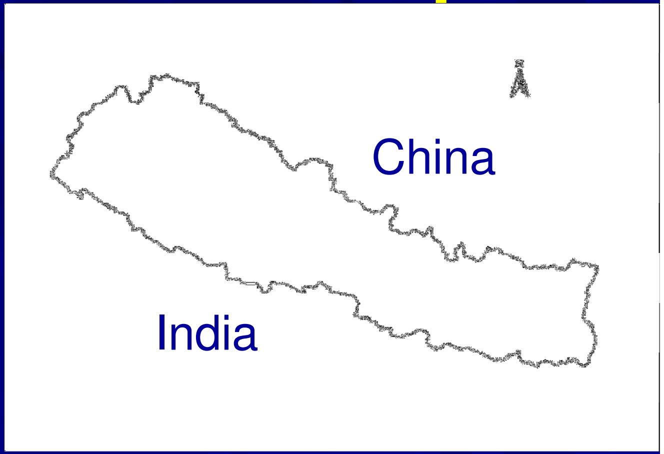
Soil Acidification and Fertility Status of Nepal

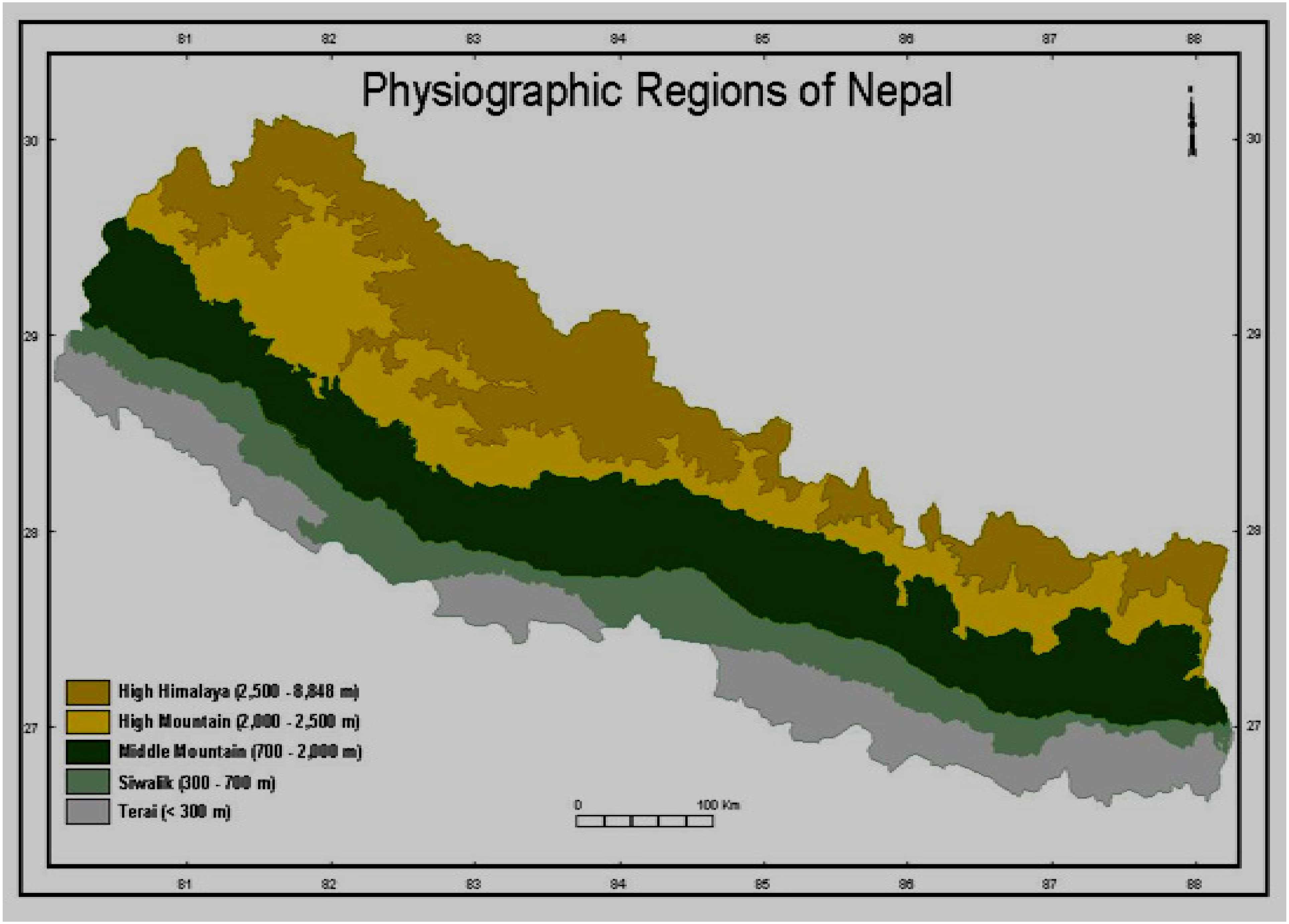


Background

- Nepal - 80^0 4'' and 88^0 12'' E longitude & 26^0 22'' and 30^0 27'' N latitude.
- China in North and India in the East, South and West
- Total land area 147, 181 km^2
- East to West - 885 kms and North to South 145 - 248 kms

Five Physiographic regions

- Terai (flat and fertile land <300m)
- Siwaliks Mountain (low river valleys and dunes forest 300-700m)
- Middle Mountain (Green forest and long slopes leading to fertile valleys: 700-2,000m)
- High Himalayas (huge peaks >2,500 m),
- Mount Everest: [8,848 m]



Physiographic Regions of Nepal
81
82
83
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27
High Himalaya (2,500 - 8,848 m)
High Mountain (2,000 - 2,500 m)
Middle Mountain (700 - 2,000 m)
Siwalik (300 - 700 m)
Terai (< 300 m)
0
100 Km

Contd….

- Nepal - mountainous country, diverse and extreme relief features.
- Most common environment problem - land degradation, waste disposal, Inland water pollution, air pollution, Population growth, land acidification, and low agricultural production.
- Water is the most important natural resource
- Nepal - the second richest country in the world, possessing about 2.27 % of the world's water resources.
- Major sources of water - glaciers, snowmelt from the Himalayas, rainfall and ground water.
- Nepal - one of the world's least developed countries.
- More than 90 % of the total population still live in rural areas, under minimum physical facilities necessary to fulfill their basic needs, underdeveloped areas.

Challenge to eliminate poverty from these rural areas and provide every one with minimum basic needs - is tremendous.

Status and Trend in Natural Resource Management

- Forest resources being seriously depleted every year.
- Steep topography - sensitive to erosion, acidification and causing soil fertility depletion.
- Hill Agriculture system is complex;
  - Scarcity of arable land due to high population density
  - Few employment opportunities
  - Market problems and week institutional support
  - Annual food shortage in hilly districts.
  - Encroachment upon forest lands, pasture, steep hill slops and river fans (marginal lands).
- Mountainous regions - potential for livestock and horticulture production.

Soils of the Middle Mountain Regions

- The region occupies about 30 % of the total land of the country, homeland of 61 % of the total population (approximately 26 million based on the 2006 population census).
- Very complex topography, elevation, geology and vegetation. Soils are also diversed
- River valleys (grain basket) have alluvial soils of different texture and depth classes.
- Terraces (Tars), - formed by erosional deposition
  - Mostly neutral to acidic
  - Cultivated with upland crops; maize, millet, upland rice etc.
- In general, soils derived from granite are sandy, from shale, silty and from limestone, clayey.
- Soils are generally slightly acidic in reaction
- OM content – medium range, N and available P are low to medium, and available K medium to high.

Soil Acidification and Its Impact on Nutrient Deficiency

- Optimum soil pH for the majority of agricultural crops is between 5.5 and 6.5.
- Recent soil survey and experiments reveals - soils pH of middle mountain ranges from 3.3 and 7.5 with mean value 5.8.

Reasons for the acidification of soils

- Dominant bedrock - sandy stone, siltstone and quartzite, all of which produce acidic soil materials.
- Cultivation practices - introduction of double and triple annual crop production, improper use of chemical fertilizer mainly ammonium sulphate and urea fertilizers
- Less use of organic manure and no lime application

Rating of pH in the Soil Samples analysis from the Western Hills

	Very strongly acidic	Strongly acidic	Medium acidic	Slightly acidic	Neutral	Slightly alkaline
pH	≤ 5.0	> 5.0-5.5	> 5.5-6.0	52> 6.0-	> 6.5-7.3	> 7.3-7.8
#	30	73	73	6.5	32	1

Note: Soil extraction was prepared as soil: water ratio 1:2.5 and determined with pH meter.; Total Soil Samples - **261**

Source: Thripathi, 1999.

Threats to Soil Acidification in Middle Mountain

- Chir pine (*Pinus roxburghii*) are native to the middle mountain.
- Pine and pine litter have a tendency to acidify the soils.
- Little research has been done to determine the effect of pine litter management on the overall soil fertility.
- Soil might be buffered by using compost and FYM but it will not be maintained with the addition of pine litter.
- Exchangeable Mg and Ca in soils decreased over time due to leaching and erosion.

Effect of N, P, K and Lime on Grain Yield of Maize at Three Ecological Sites

	Deurali			Chambas			Bhakimli		
Trt.	2001	2002	Mean	2001	2002	Mean	2001	2002	Mean
Farmers' Practice	2630	3588	3109	2950	2899	2925	3540	3430	3485
100: N kg/ha	3780	4564	4172	4830	2865	3848	3990	3908	3949
100:100 N: P_2O_5 kg/ ha	4010	5030	4520	5530	5258	5394	4020	4697	4359
100:100 N: K_2O kg/ ha	3940	4899	4420	5290	3539	4415	4190	4641	4416
100:100:100 N: P_2O_5 : K_2O kg/ ha	3960	5316	4638	5410	5728	5569	4140	4239	4190
100:100:100 N: P_2O_5 :K_2O kg ha^{-1}+5 t lime ha^{-1}	**4730**	**5552**	**5141**	**5740**	**6253**	**5997**	**4220**	**5293**	**4757**
Mean P-value	3842 <0.001	4825 <0.001	4333	4958 <0.001	4424 <0.001	4691	4017 <0.001	4368 <0.001	4192

Source: NARC/CIMMYT, 2004

Application of Soil Amendments

- Lime requirement is determined through the procedure published by FAO (1970) using 0.04 N $Ca(OH)_2$.
- Lime can be used to raise the pH to 6.5 from the original pH of the soil
- Lime requirement calculated using the following equations;

$$Y = -5.063 + 1.56X \ldots\ldots M_1 \text{ soil}$$
$$Y = -5.524 + 1.743X \ldots\ldots M_2 \text{ soil}$$
$$Y = -4.7 + 2.5X \ldots\ldots\ldots\ldots M_3 \text{ soil}$$
$$Y = -4.738 + 2.79X \ldots\ldots M_4 \text{ soil}$$

Where: Y= desired pH of the soil
X= lime requirement (kg ha^{-1}) to attain desire pH
M_1, M_2, M_3, and M_4, indicates Forest soil, Lowland rice cultivated soil, Overgrazing soil, and Young alluvium soil respectively.

Source: Karki, K. B. 1986

Dry matter yield of *Vigna umbelata* (masyan) as affected by different management practices on highly degraded soil of mid - hill/Nepal

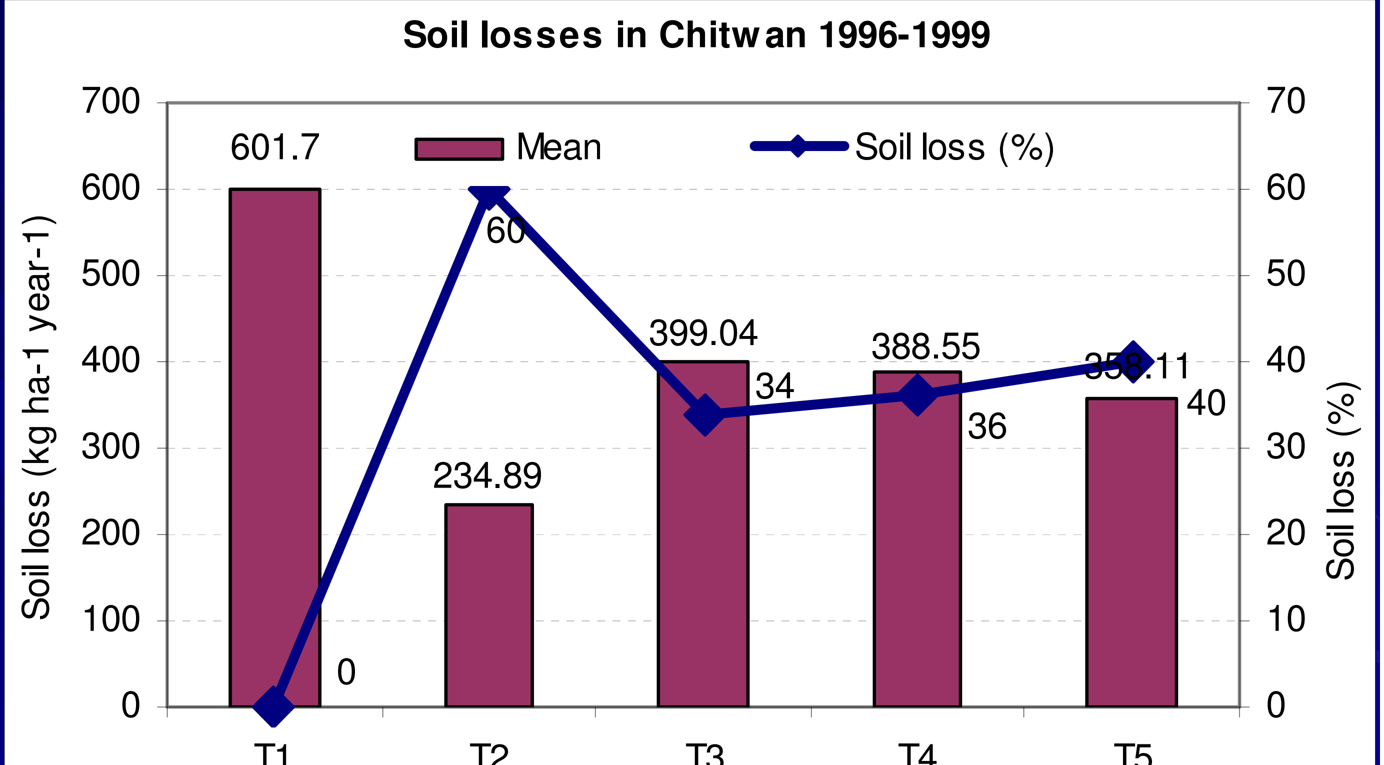
S. N.	Treatments	Means	Percent Increased in yield (g/pot)
1	1/3 FYM +1/3 GM + 1/3 RS + lime	**10.13** a	67.99
2	Green manure (GM) + lime	**9.73** ab	61.36
3	FYM + lime	9.70 abc	60.86
4	Farm yard manure (FYM)	9.57 abcd	58.71
5	1/3 FYM +1/3 GM + 1/3 RS	8.87abcde	47.1
6	Rice straw + lime	8.0 abcdef	32.67
7	Control	6.03 fg	-
8	Rice straw (RS)	5.67 fg	- 9.29
9	Chemical fertilizer (CF)	5.33 fg	- 11.61
10	Green manure (Gm)	4.9 g	- 18.74

Remediation of Soil Acidity

- Application of lime and manure - possible solution to avoiding further soil acidification.
- Combined application of lime and manure - @ 20 t. ha^{-1} of lime and 20 t. manure ha^{-1} to improve soil pH (0.2 pH units) (Schreier and Shah,1995).
- Planting of nitrogen fixing tree species and native grasses – on bare soils.
- Adoption of Sloping Agricultural Land Technology (SALT)
- Application of balanced fertilizers - instead of single urea and ammonium sulphate.
- Dissemination of IPNM technologies - extension workers and farmers

Results of SALT Experiment

Up to 60 % of soil erosion reduced by adopting the hedgerow system in sloping land under cultivation.



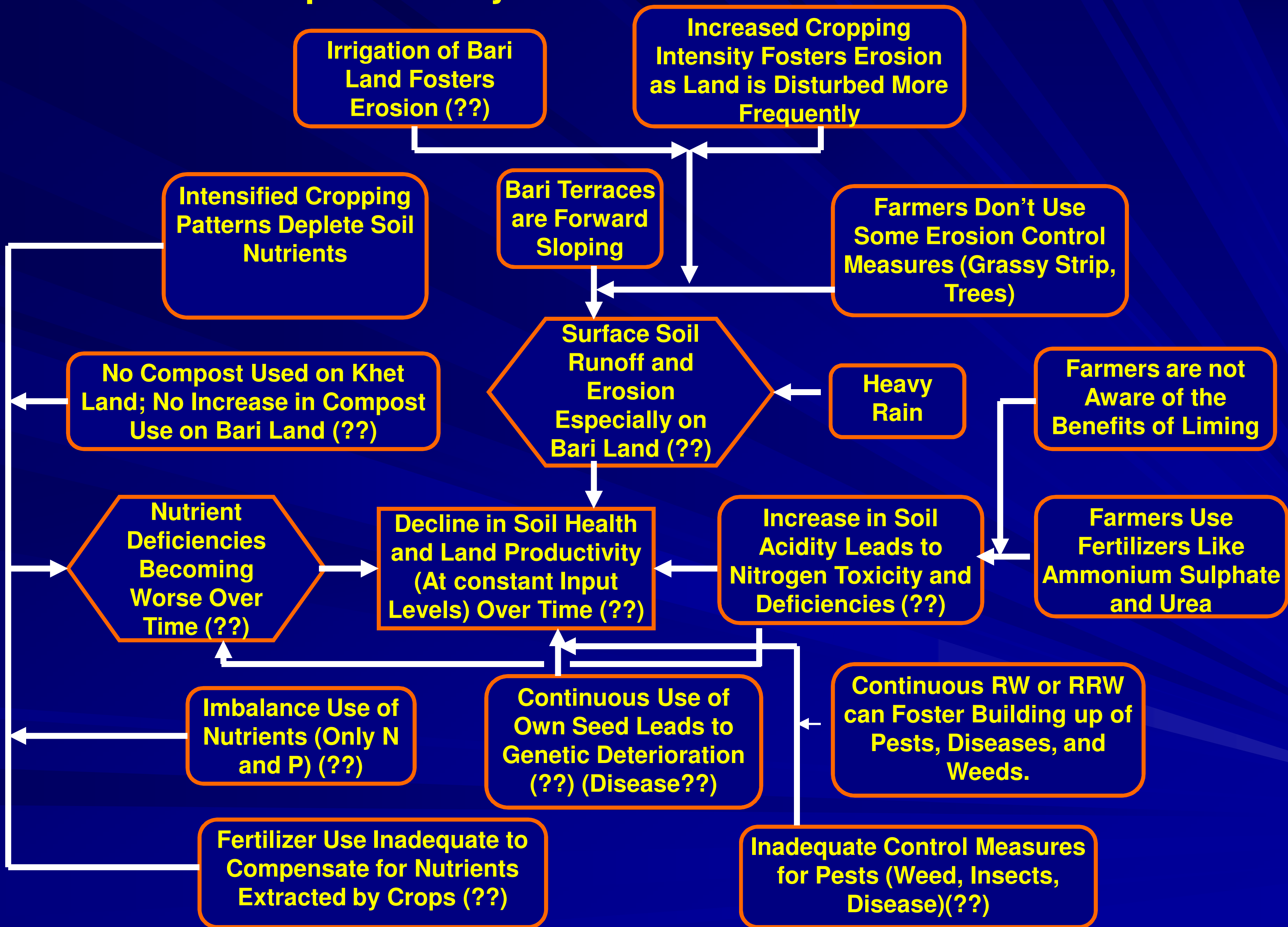
T1=Farmers' practice(FP) T2=FP + Hedgerow s(HR) (Dalbergia sissoo)
T3=HR and w ithout fertilizer T4=FP+HR (Desmodium rensonii)
T5=FP + HR + Fruit tree (Mango)

Soil Fertility Declination in Middle Mountain

Soil productivity declination by 20-30 % over the last 25 years.

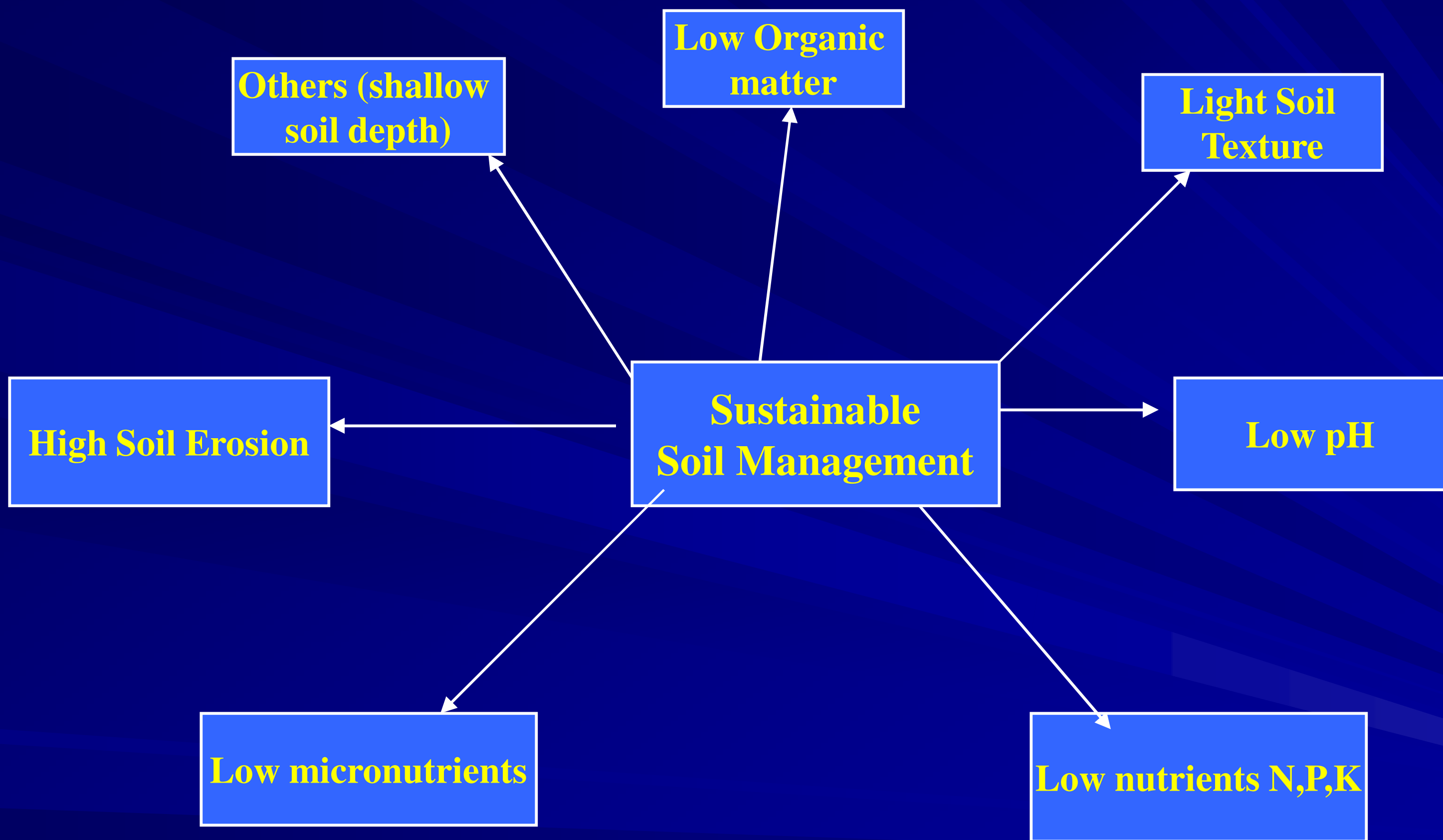
- ✓ Soil acidification
- ✓ Deforestation
- ✓ Decreasing livestock numbers
- ✓ Increasing cropping intensity
- ✓ Use of improved verities
- ✓ Lack of crop residue management
- ✓ Lack of organic manures
- ✓ Lack of awareness to correct soil acidification.

Problems and causes: declining soil health reduces crop yields and threatens future productivity



Key: Rectangles – Problems: Ovals – Causes: Hexagonal – "Primary" - Causes

Threats to Sustainable Soil Management in Nepal



Source: STS, 2002

Conclusion

- Application of lime and adoption of appropriate agronomical and soil management practices.
- Adoption of soil erosion control measures to minimize nutrient losses from the soil surface (Mg and Ca).
- Combined use of OM and inorganic fertilizers to maintain soil fertility in longer run.
- Best option - integrated plant nutrient management (IPNM) to improve physico-chemical properties for the sustainable agriculture productivity.


Thank You !!