Improving biodiversity in rubber plantations: A low input strategy to mitigate drought and sustain soil health

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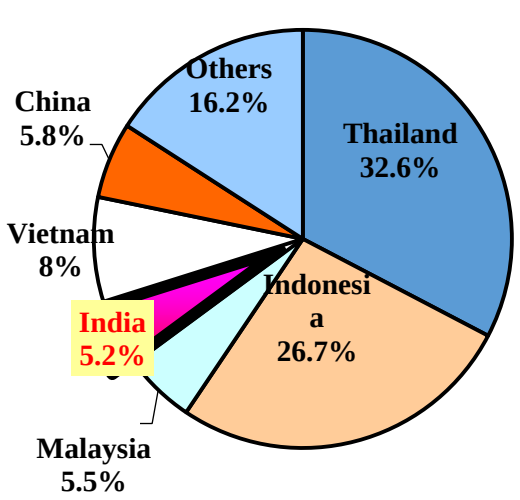
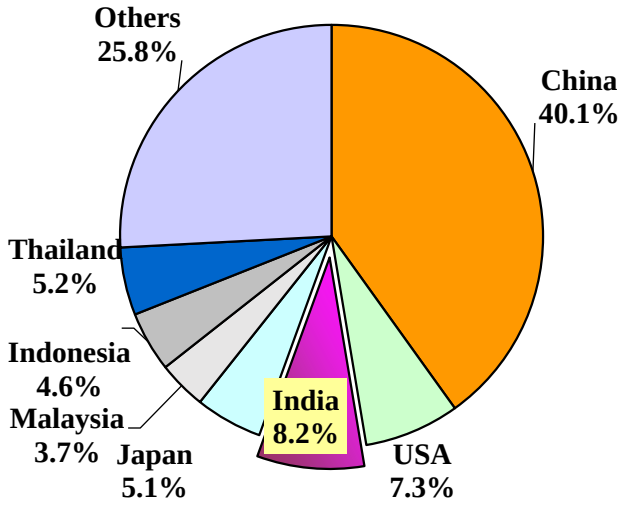
Introduction

India in the global scenario





India accounts for 4.8% of the global supply and 8.2 % of global consumption (ANRPC, 2019)

Contents

Natural rubber cultivation in India

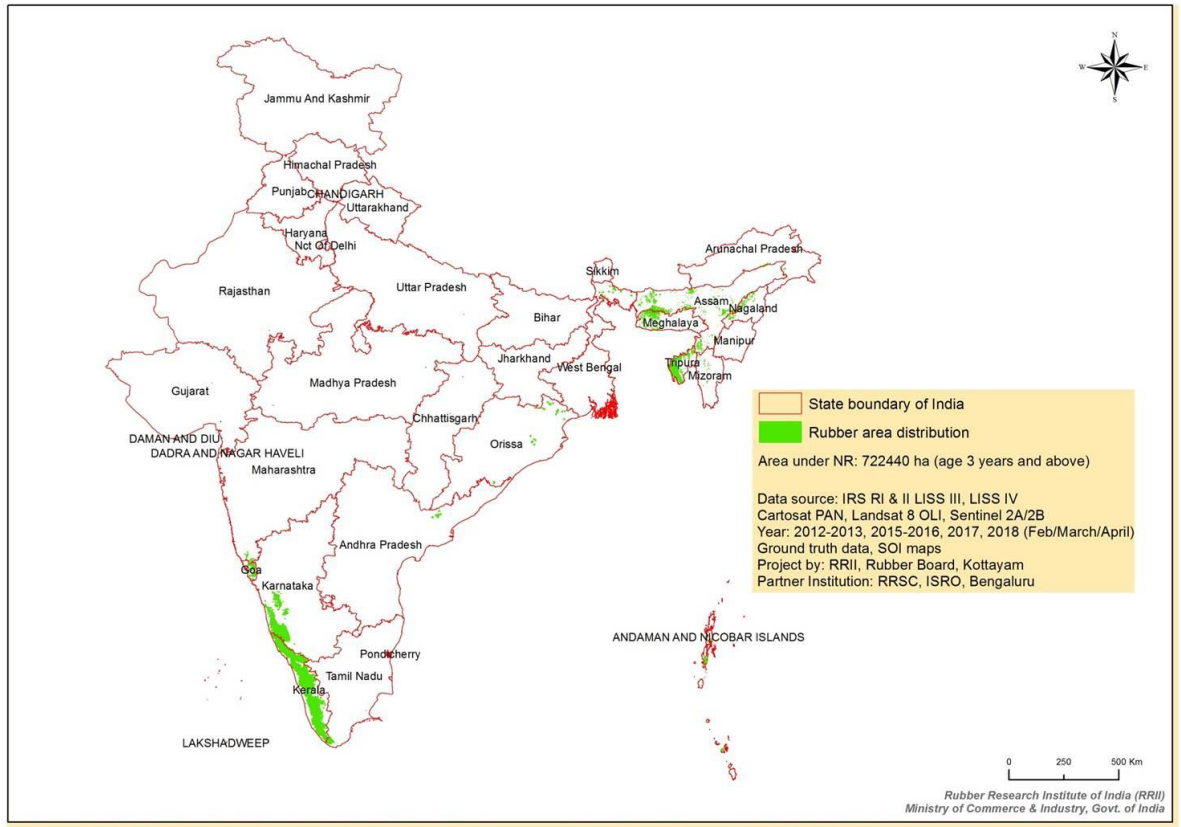
Area under cultivation – 8.2 lakh ha

Production 6.51 lakh t

South India- 70 % area and 79 % production

North East India- 23% area and 13 % production

Distribution of Natural rubber in India



Climate change and NR sector

Climate uncertainty – Scheduling of farm operations

Extreme weather events

Rising temperature

Frequent dry spells

Drought

Higher disease incidence

Livelihood security of rubber growers

Biodiversity in rubber plantations-possibilities

Luxuriant vegetation can be grown in association with rubber

- **Annual and short term crops**
- **Perennial crops**
- **Medicinal and ornamental plants**
- **Cover crops**
- **Natural flora**

Annual and short term intercrops

Banana

Pineapple

Vegetables with rubber

Leguminous cover crops

Pueraria phaseoloides

Mucuna bracteata

Rubber and cocoa

Medicinal plants with rubber

Alpinia calcarata

Strobilanthes cuspida

Ornamental plants with rubber

Dracaena massangeana

Heliconia

Natural flora

Mucuna bracteata

Natural flora

Mitigation of drought in rubber plantations

Irrigation – Water scarcity, cost

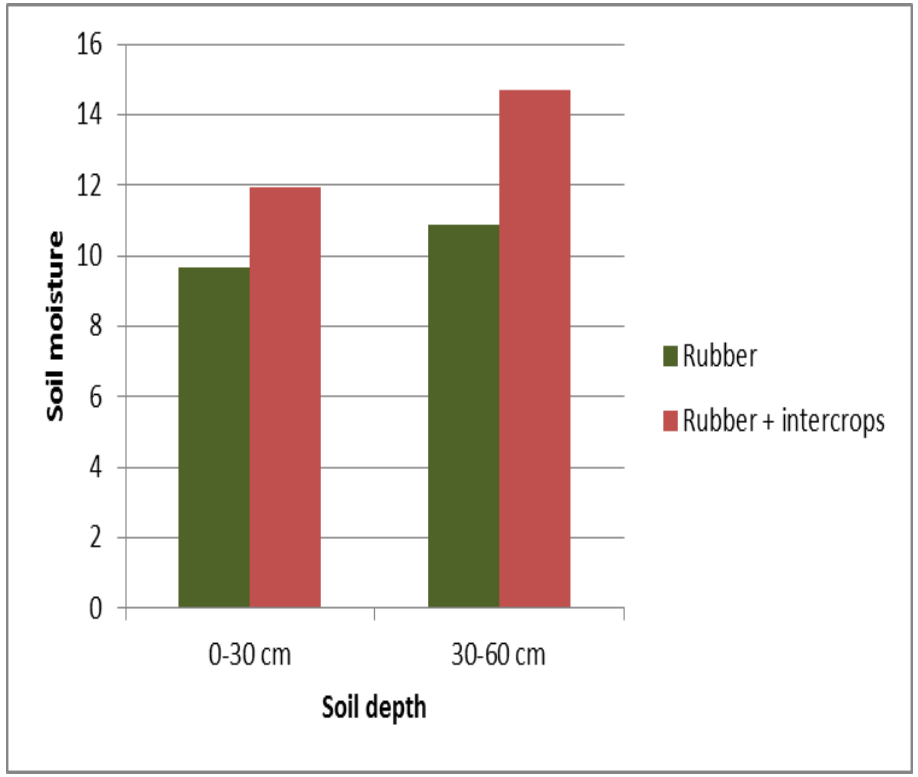
***In situ* conservation *of* soil moisture**

Improving soil fertility

Conserving soil moisture

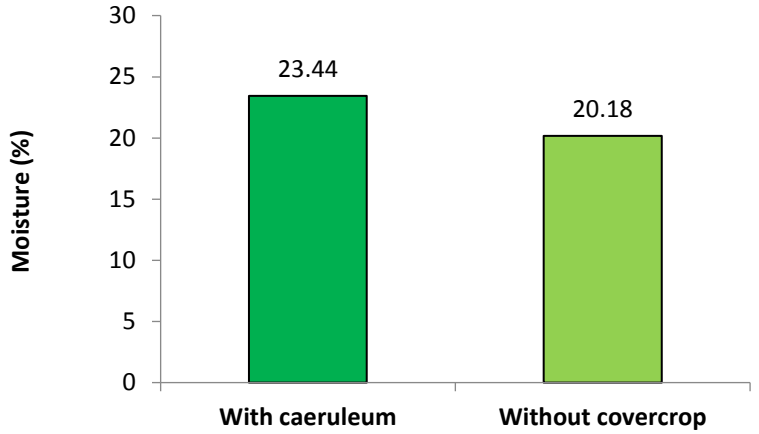
Crop diversification conserved soil moisture apart from generating additional income

Rubber and coffee

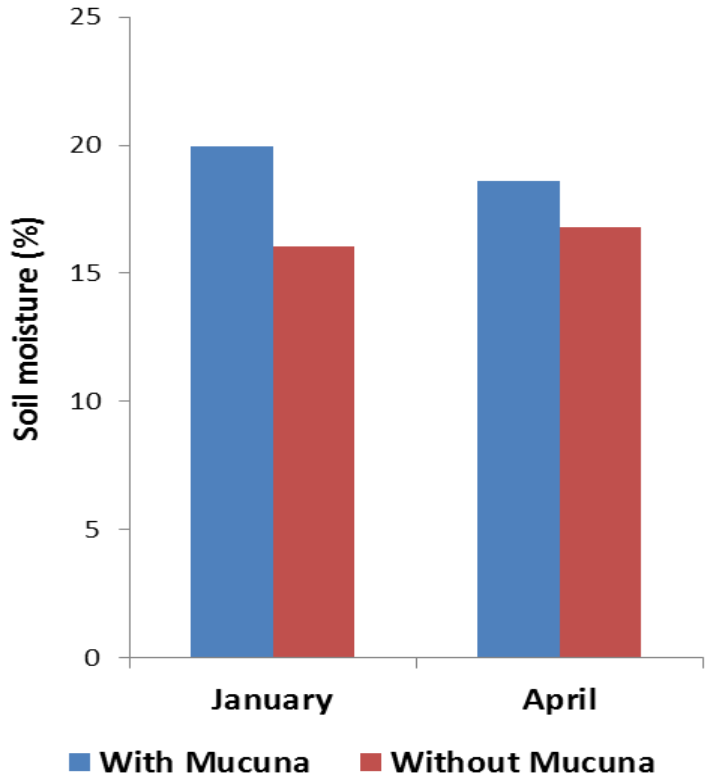


Soil moisture status (%)

Soil moisture in summer was higher in *C. caeruleum, a leguminous cover crop* established field

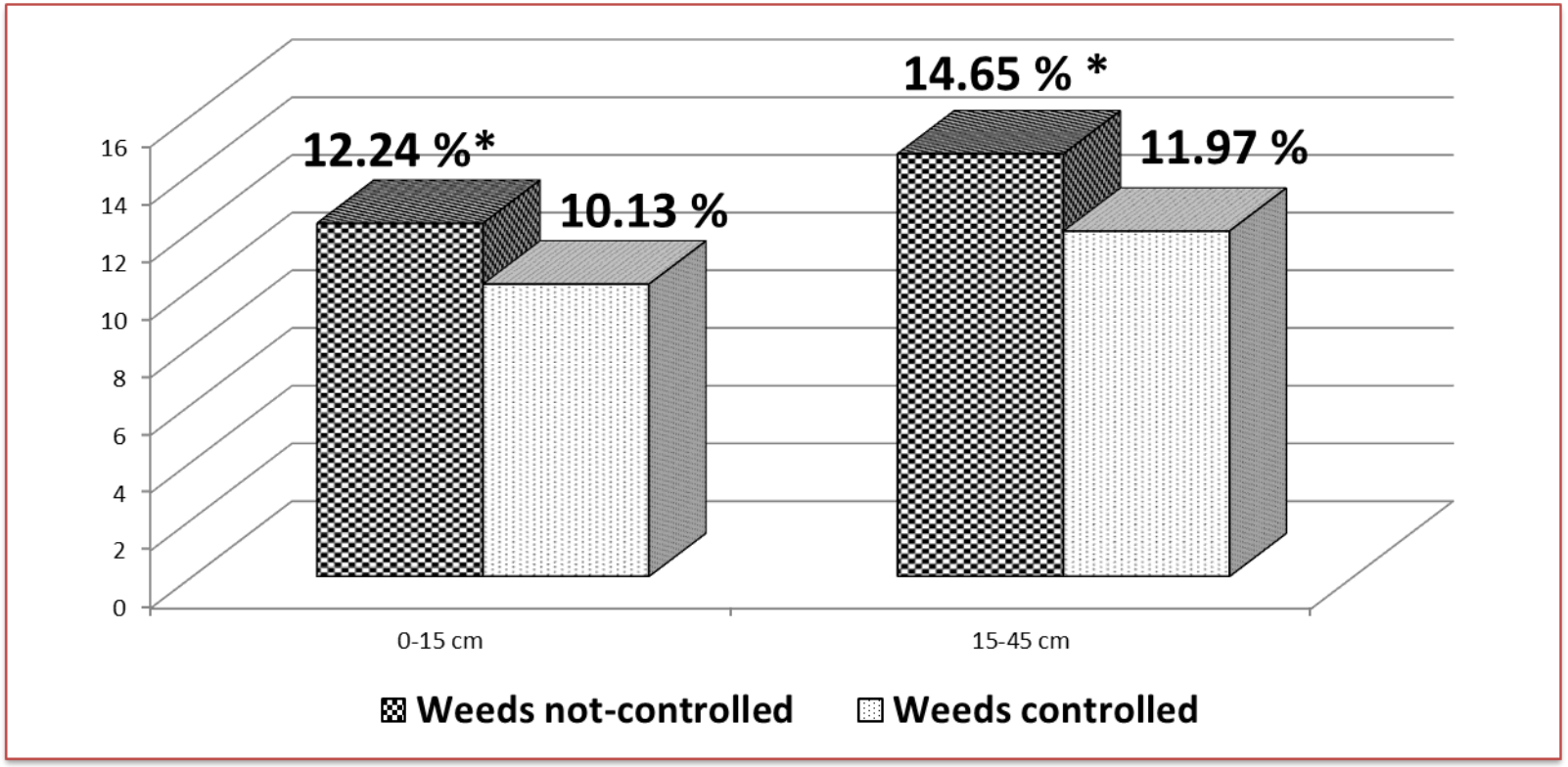


Phillip, 2020 (unpublished data)



Undergrowth of vegetation protects rubber soil and conserved soil moisture

Soil moisture was higher when weeds were retained in plantation



Abraham and Joseph, 2015

Retaining any vegetation,

crops, natural flora or leguminous cover crops

conserves soil moisture and mitigates drought

in rubber plantations

Sustaining fertility of rubber growing soils

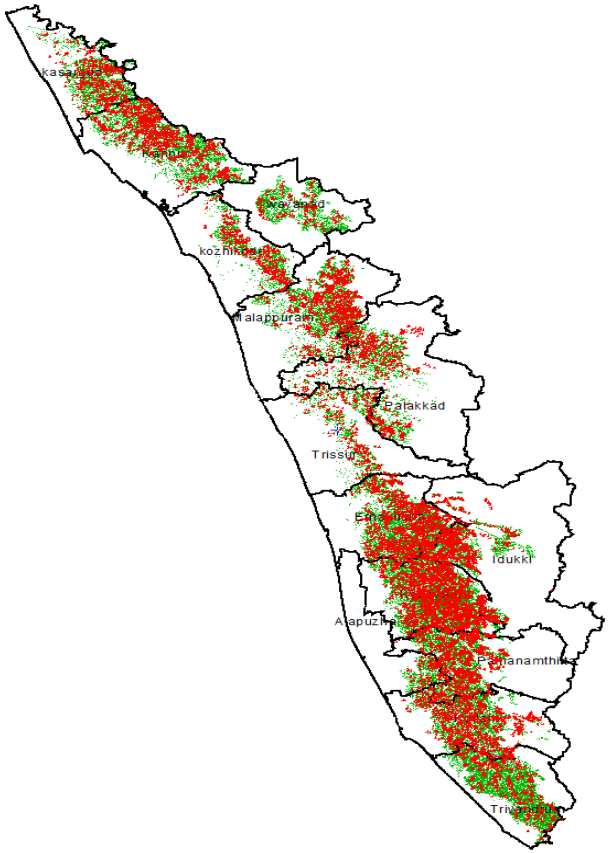
Identifying soil fertility constraints

Soil fertility management

Identification of fertility constraints

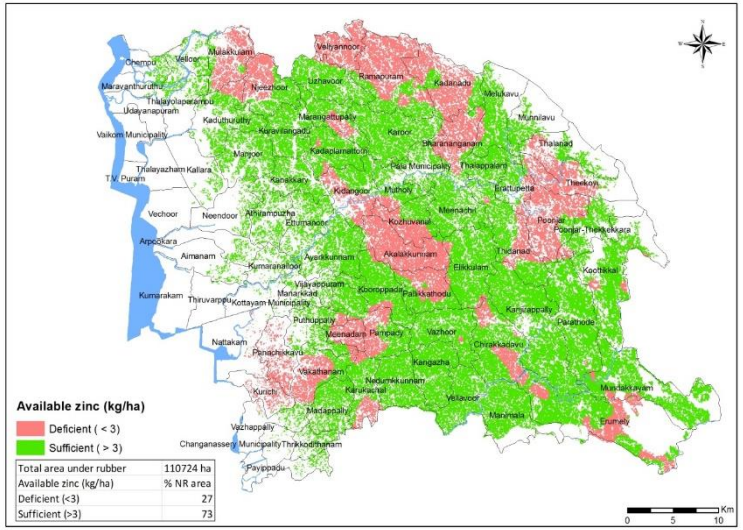
District wise soil fertility maps generated for rubber growing regions through extensive soil survey and geostatistical techniques

Kerala: No. of soil samples: 11000 (50 ha grid)



NR area
Soil samples
Kerala boundary

Spatial variability in soil ava. Zn status in rubber growing regions of Kottayam was delineated



Major Fertility constraints

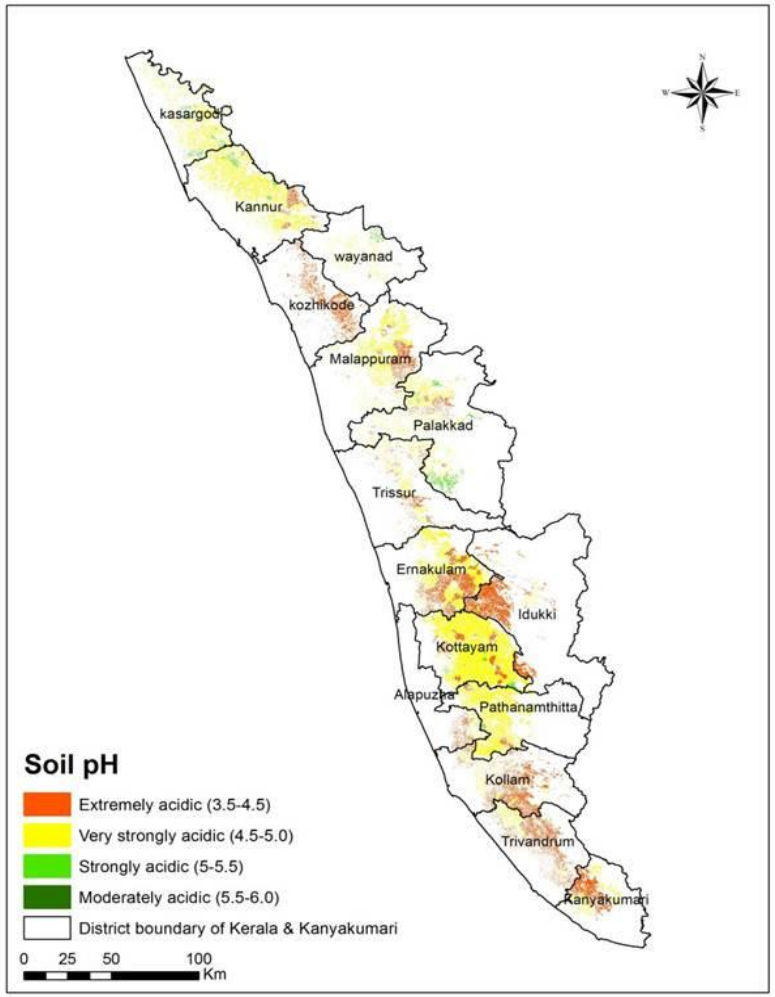
Soil acidity

Declining cation contents in soil

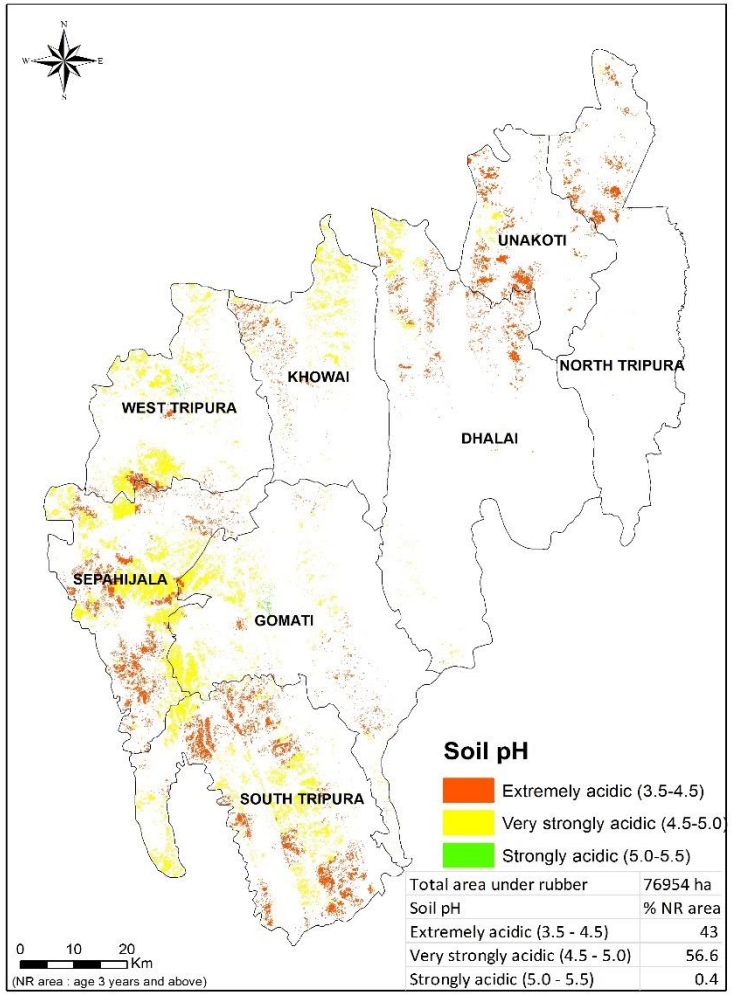
Low status of micronutrients like Zn and B

Majority of rubber growing regions of India are extremely/very strongly acidic

South India- Kerala and Tamil Nadu

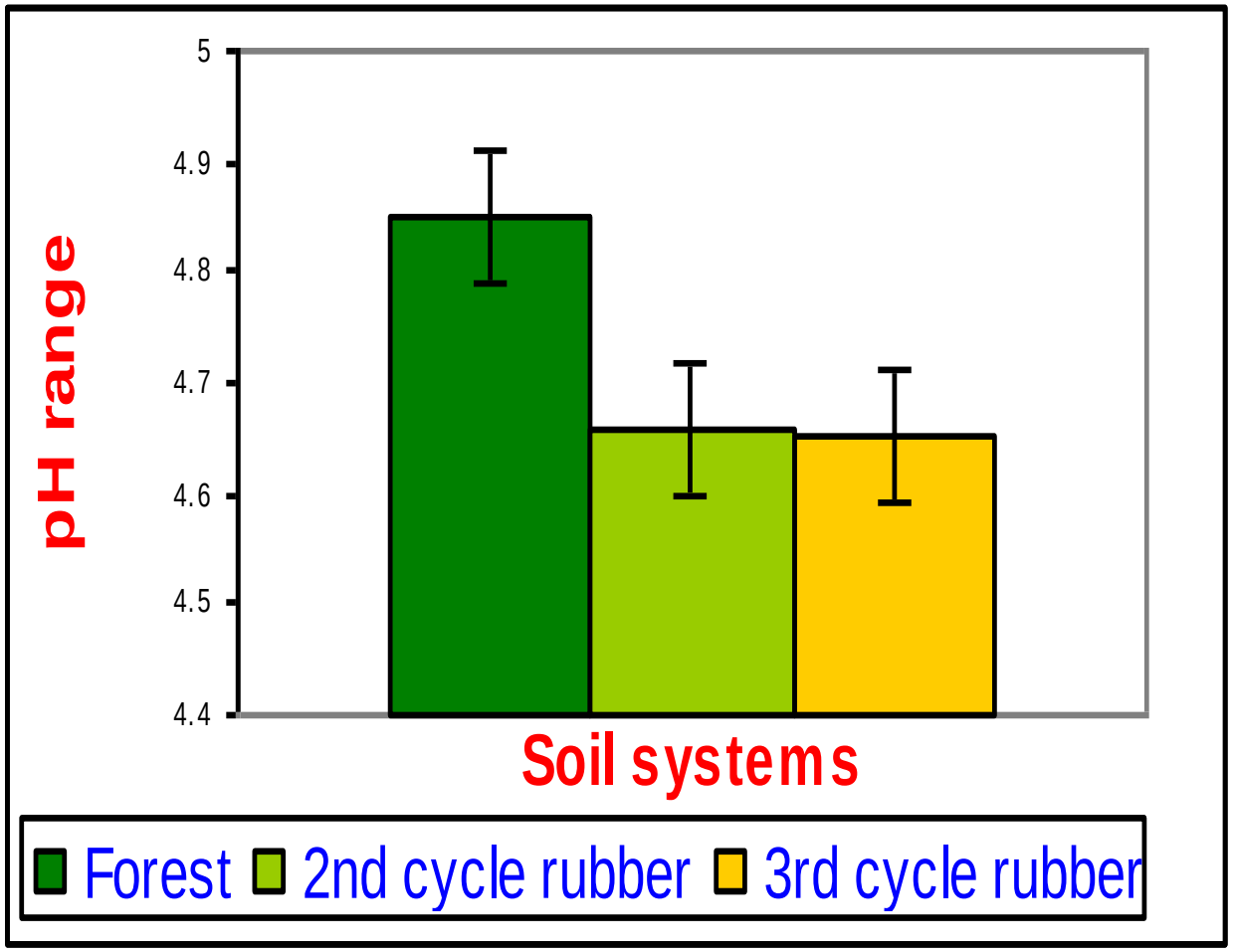


Tripura



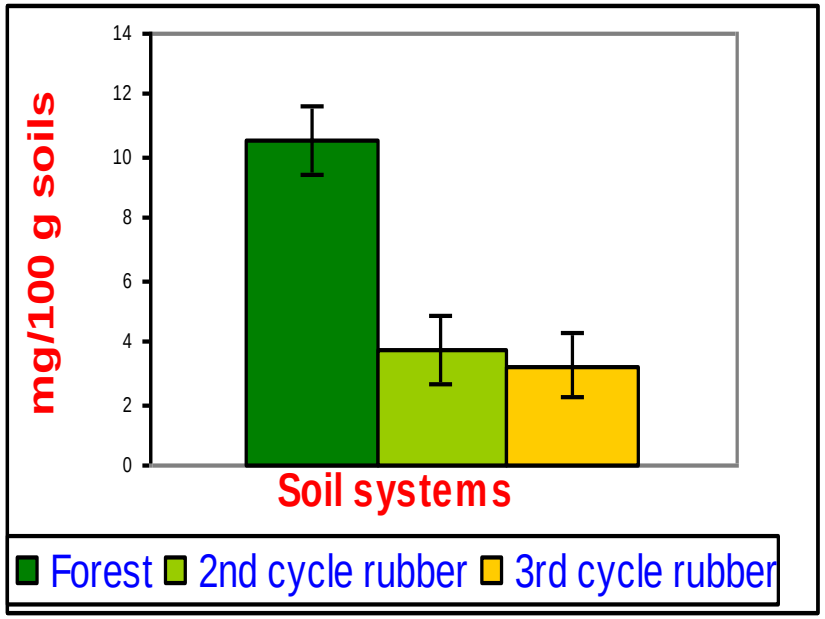
Total area under rubber	76954 ha
Soil pH	% NR area
Extremely acidic (3.5 - 4.5)	43
Very strongly acidic (4.5 - 5.0)	56.6
Strongly acidic (5.0 - 5.5)	0.4

Soil pH (0-30 cm) is significantly low in rubber plantations as compared to forests (South India)

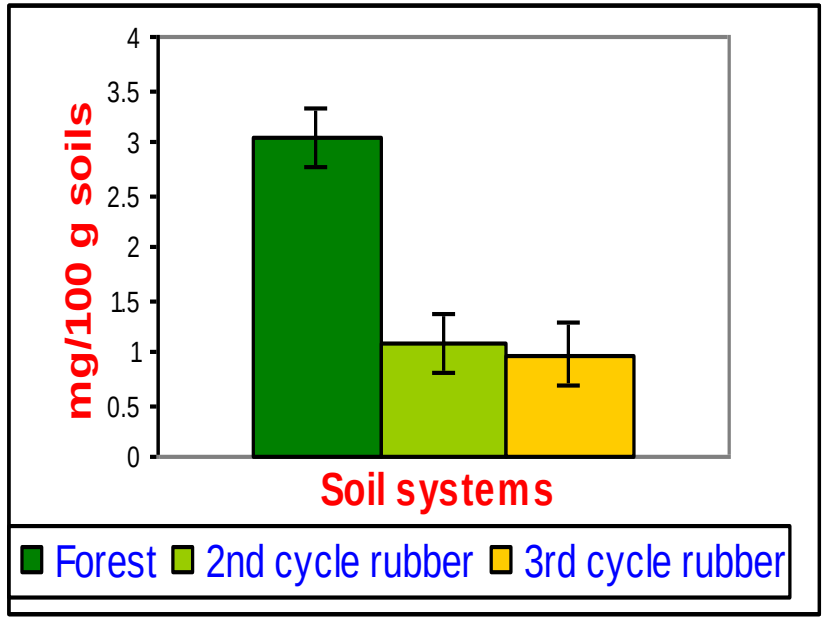


Ulaganathan et al., 2010

Significant decline in cations in rubber plantations compared to forest



Available calcium (0-30 cm)



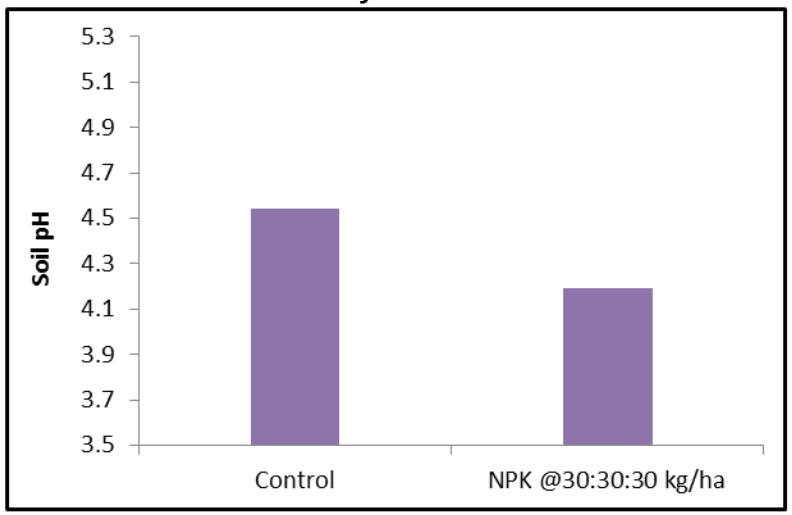
Available magnesium (0-30 cm)

Ulaganathan et al., 2010

Soil pH is influenced by management practices

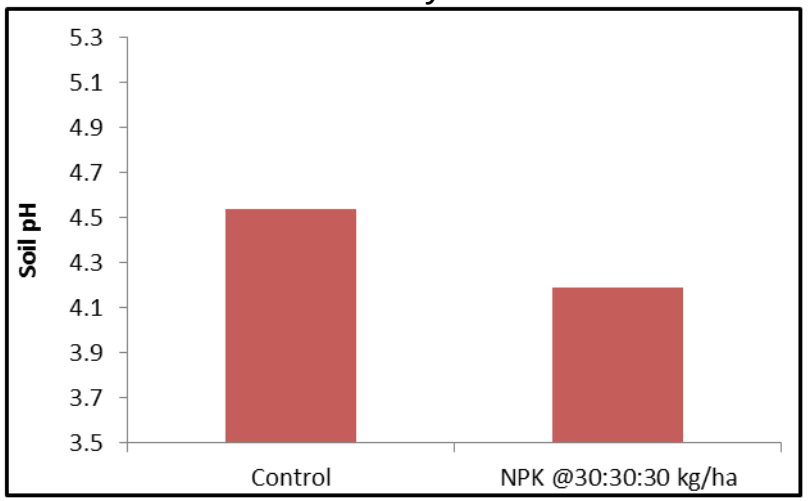
Continuous fertilizer application reduced soil pH

9 years



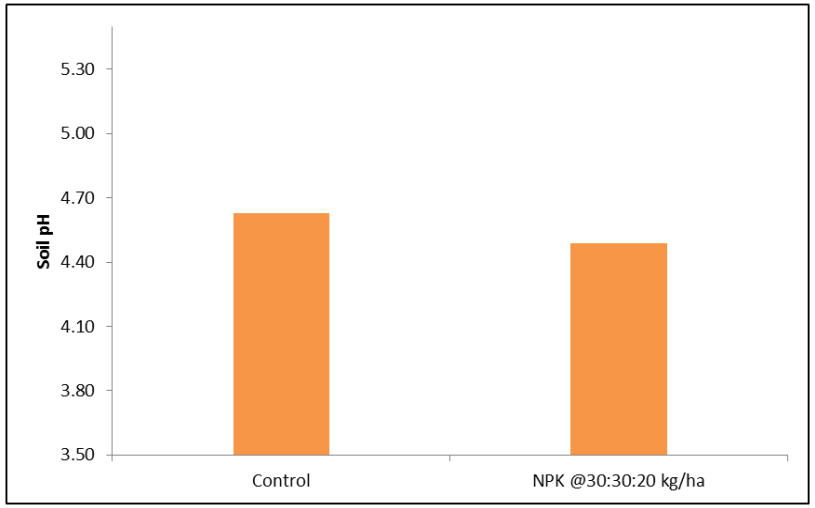
George 2012

14 years



Philip et al., 2012

17 years



Jessy and Joseph 2012

Amelioration of soil acidity

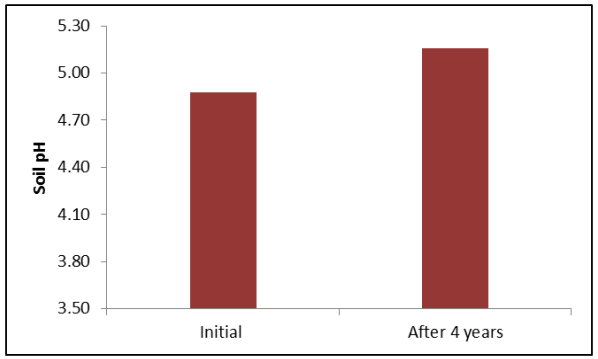
Liming- Increase cost of cultivation

***In situ* management of vegetation to exploit the natural processes**

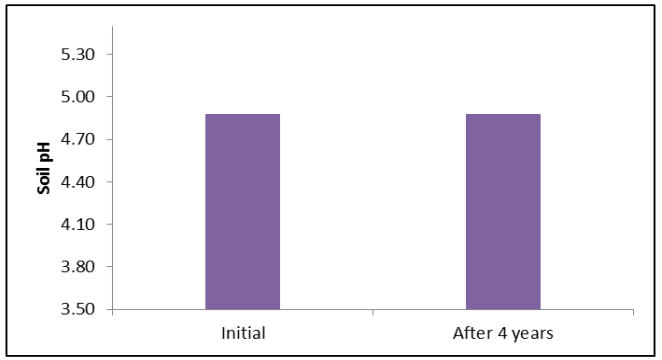
Need based fertilizer application

Vegetation influenced soil pH differently

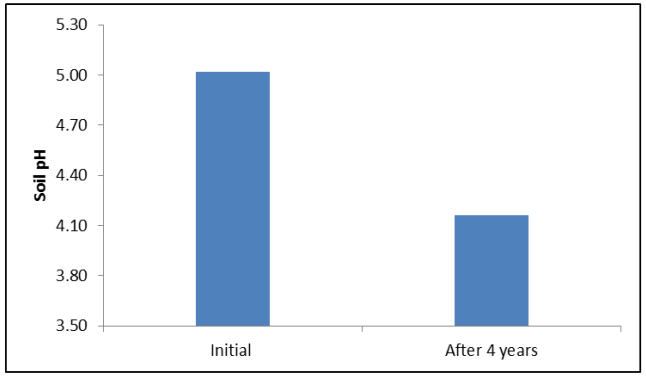
Natural cover increased soil pH significantly



***Pueraria* did not change soil pH significantly**

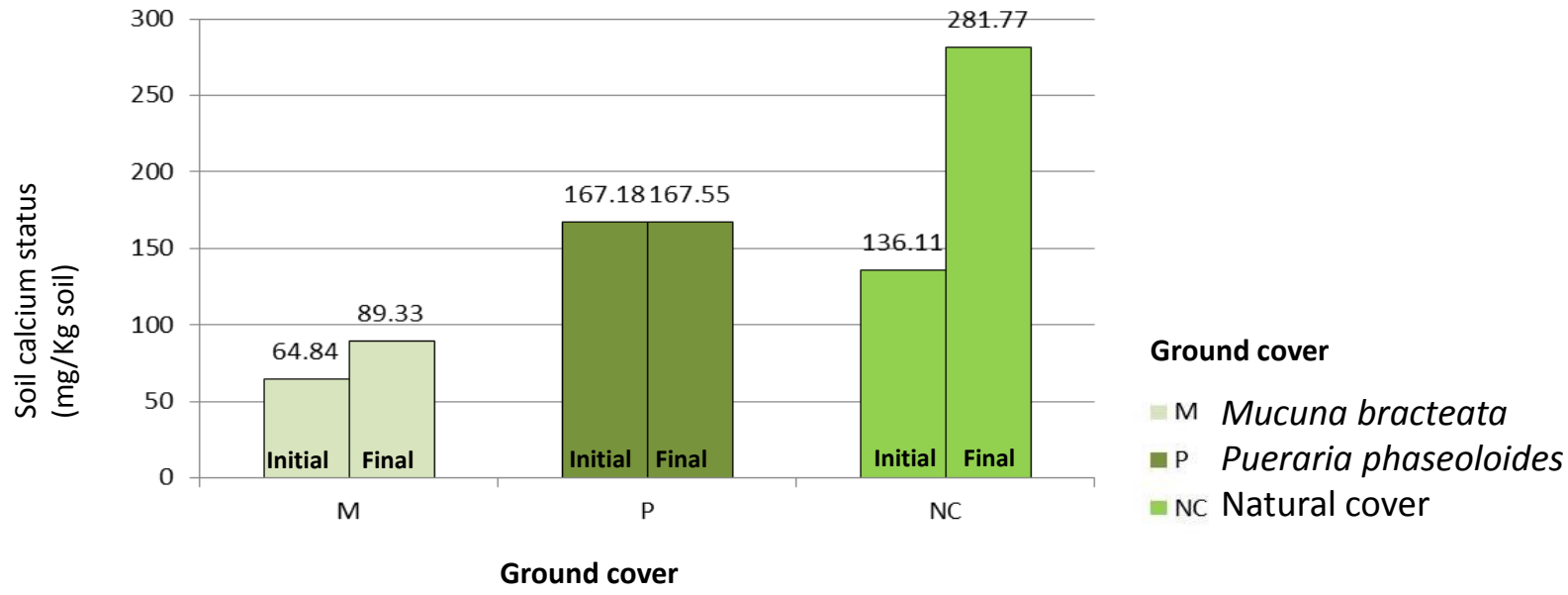


***Mucuna* decreased soil pH significantly**



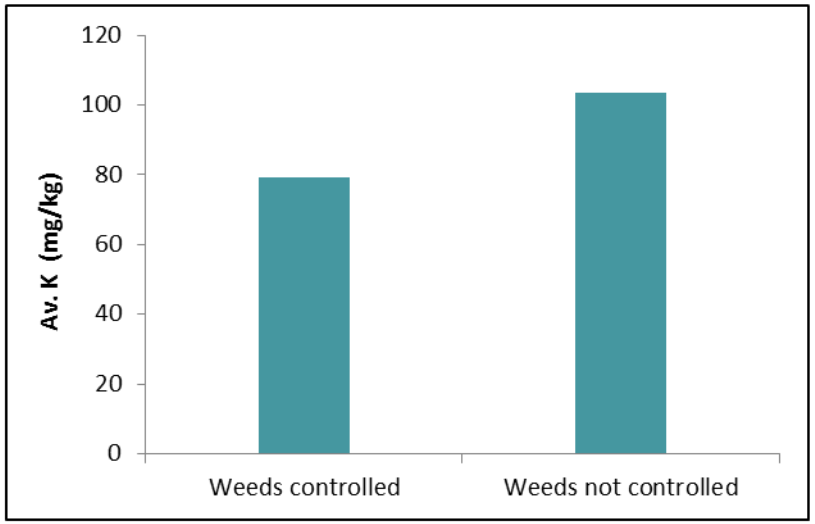
Jessy et al., 2013

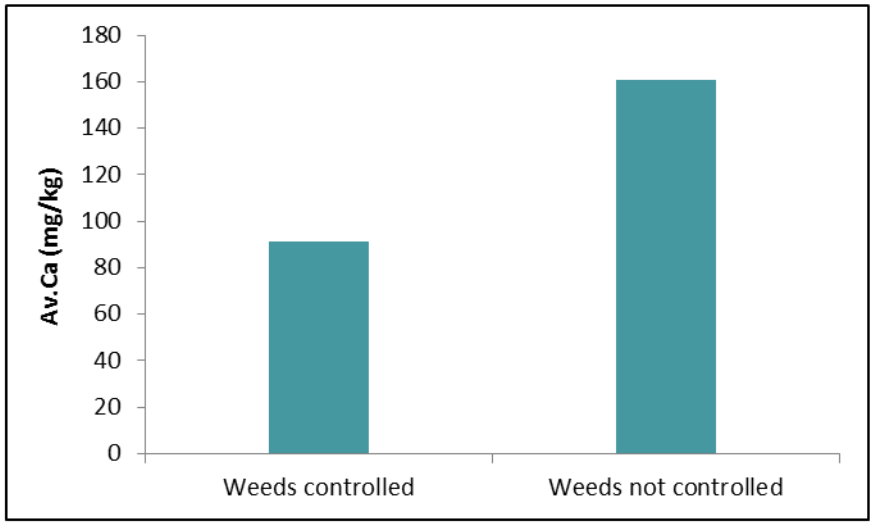
Vegetation influenced soil calcium status differently

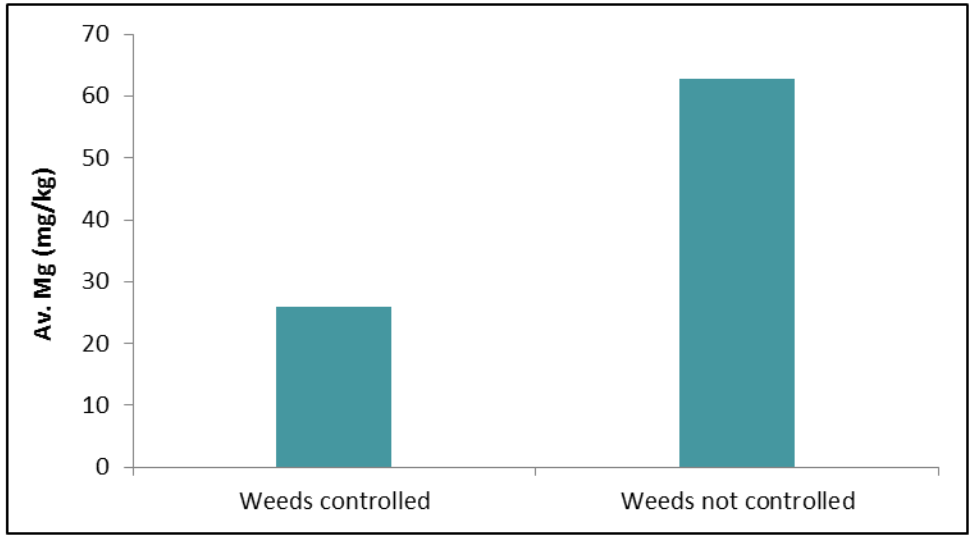


Maintaining natural cover in rubber plantations will decrease the decline in Ca status, which is a concern

Status of base cations (0-15 cm) was significantly high when natural flora was retained

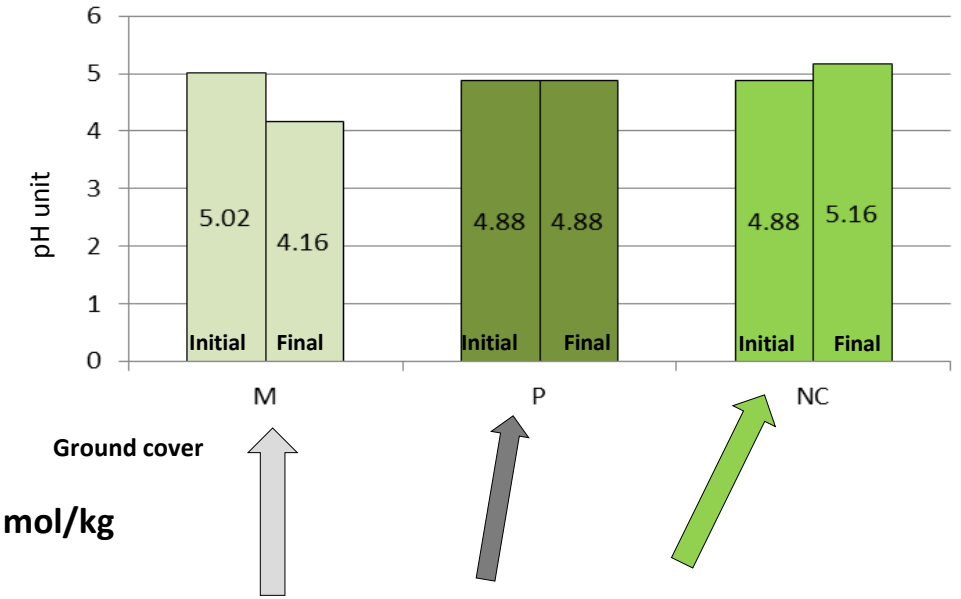




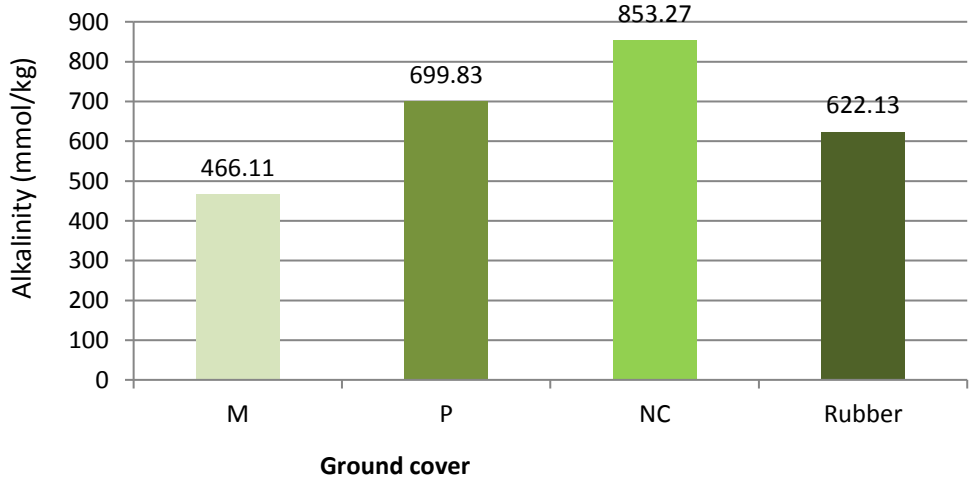


Abraham and Joseph ., 2015

Change in soil pH 4 years after establishment of various ground covers



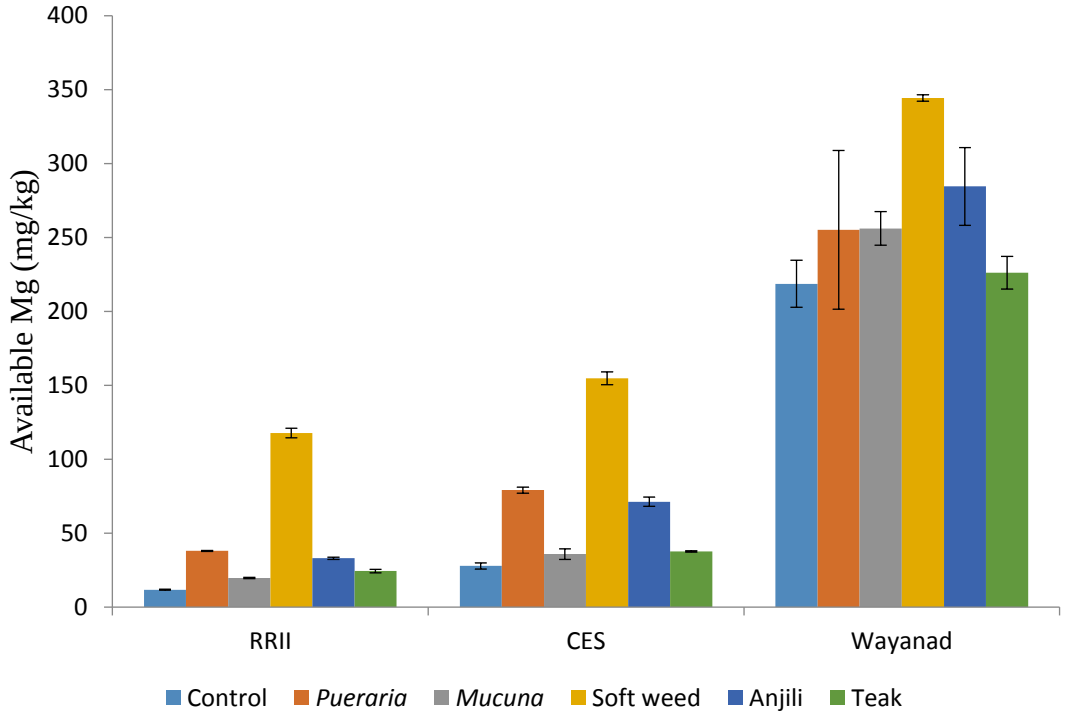
Alkalinity of the litter m mol/kg



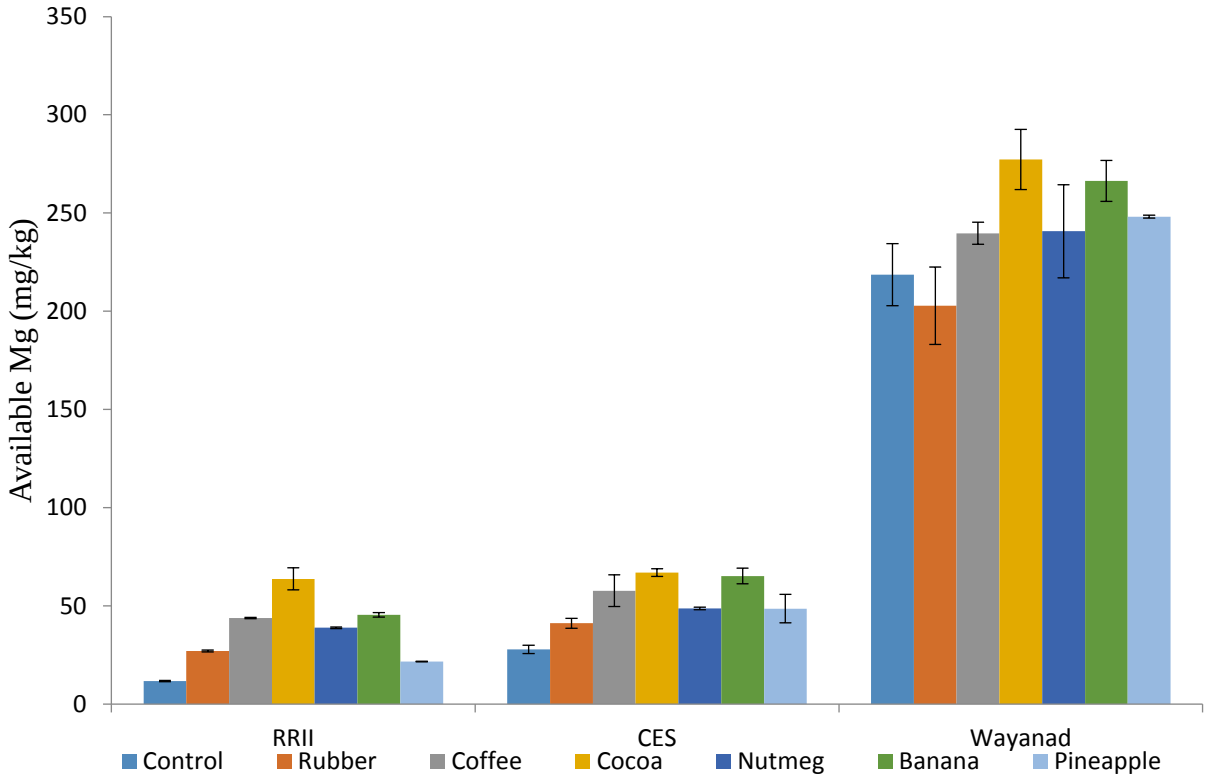
Ground cover

- M *Mucuna bracteata*
- P *Pueraria phaseoloides*
- NC Natural cover
- **Rubber**

Diverse litter of cover crops/soft weeds/timber trees affected soil available Mg status differently



Different crop residues influenced soil available Mg status differently

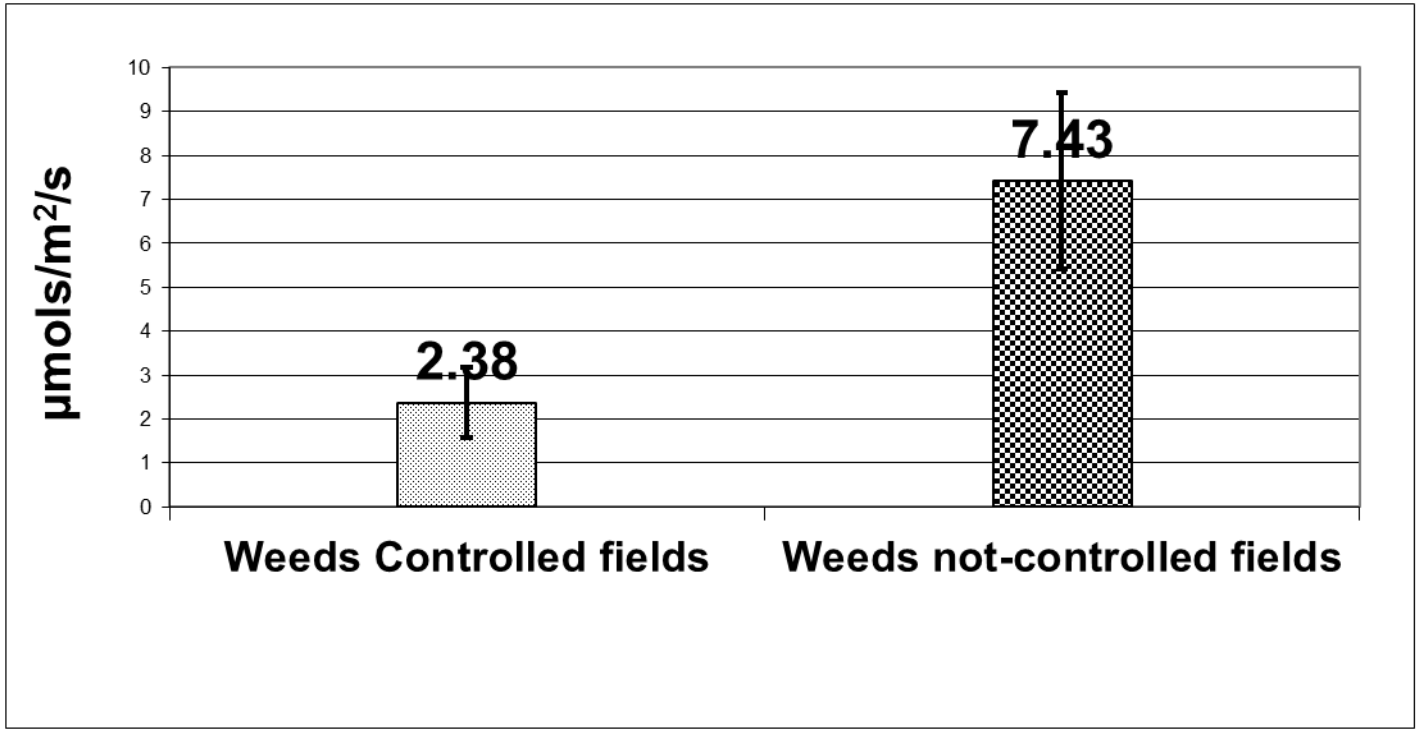


Stock of OC, TN and available nutrients was higher when natural flora was retained in the field

Systems	OC tons/ha	TN t/ha	P kg/ha	K kg/ha	Ca kg/ha	Mg kg/ha
Natural flora Controlled	70.26	5.53	12.12	223.57	275.01	80.92
Natural flora retained	76.52	6.34	3.41	262.86	305.93	144.56
Sig	*	**	NS	*	NS	**

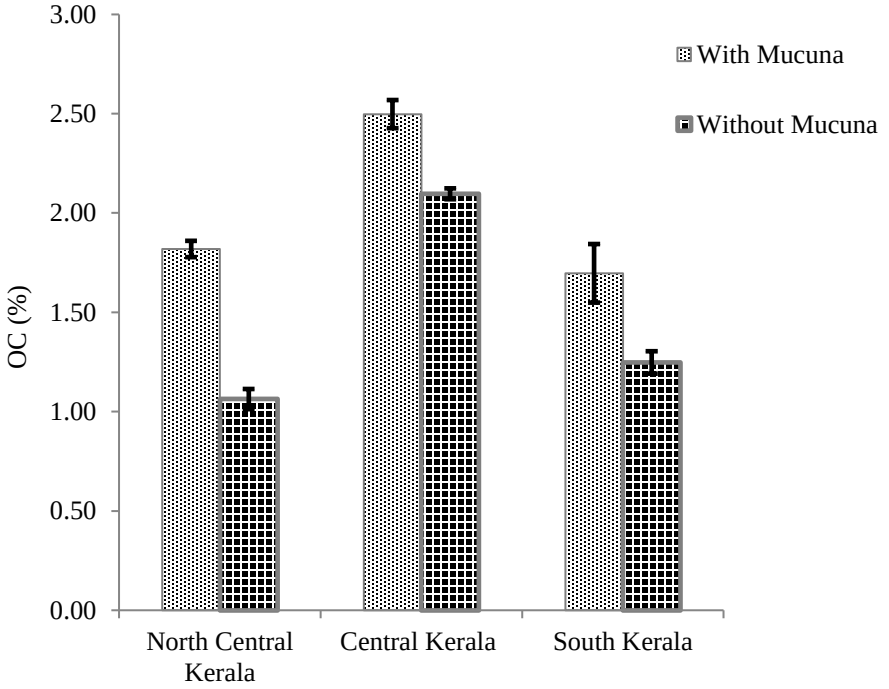
Abraham and Joseph, 2015

Soil respiration – soil CO_2 efflux (µmols/m^2/s) was higher when natural flora is retained



Abraham and Joseph, 2015

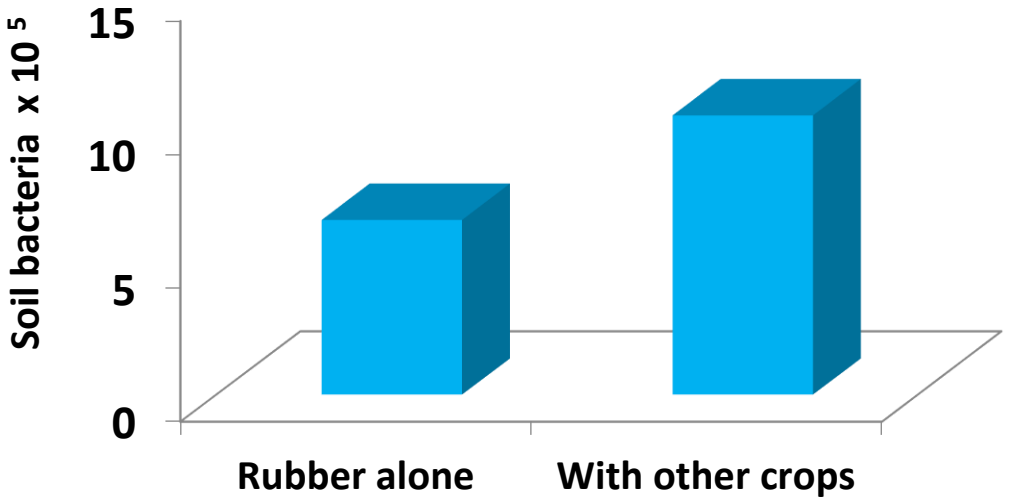
Mucuna bracteata improved soil organic carbon status in mature rubber plantations



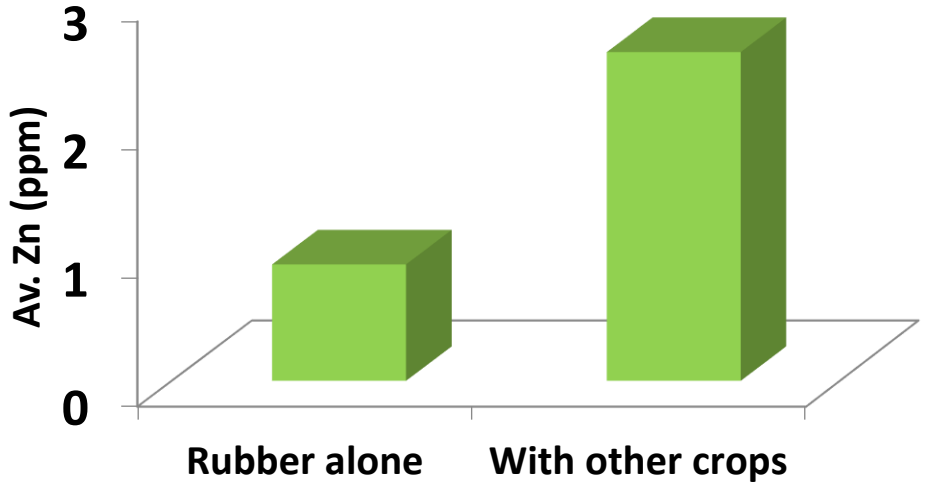
Philip (unpublished data)

Judicious crop mixing improved soil health

Soil microbial population significantly improved under crop diversification



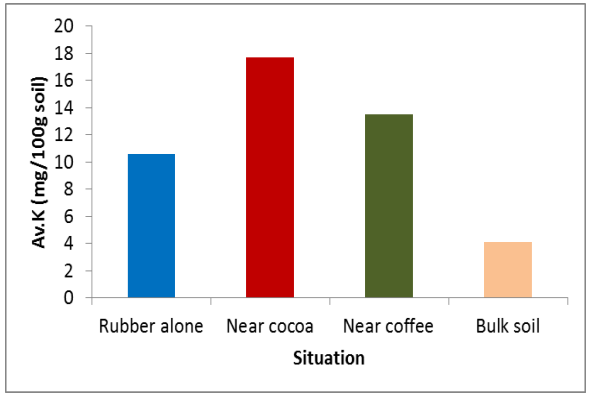
Soil available Zn status improved under crop diversification

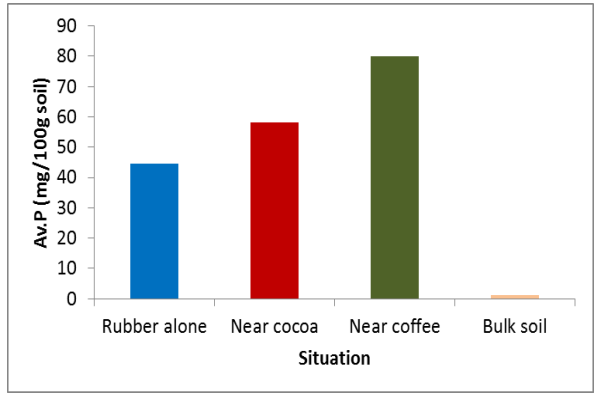


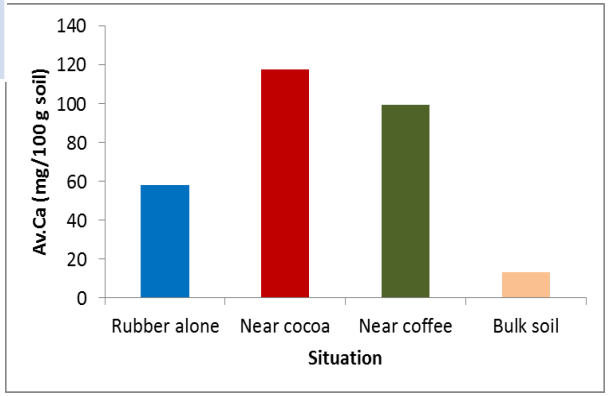
Earth worm castings are rich in plant nutrients

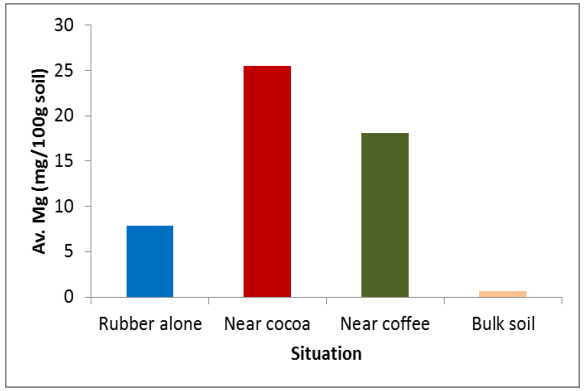
More earthworm castings under mixed cropping

Situation	Number
Near coffee	20.54
Near cocoa	30.42
Rubber alone	18.53









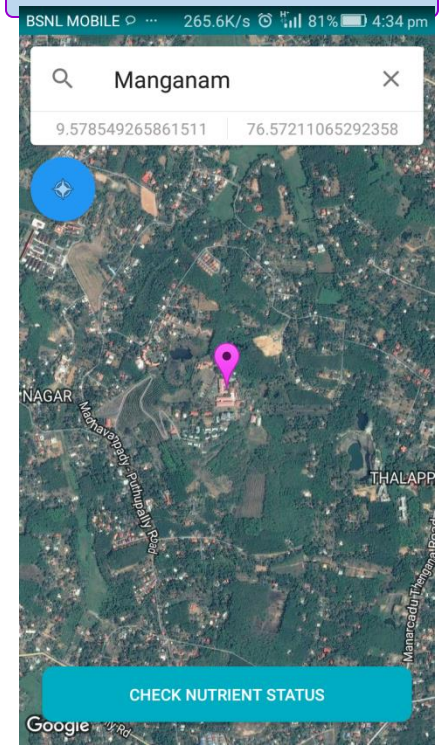
Judicious crop mixing and exploiting the natural processes

improves soil health

Need based fertilizer application

combining Principles of Soil Science and Agronomy with Geospatial Technology and Information and Communication Technology

Mobile App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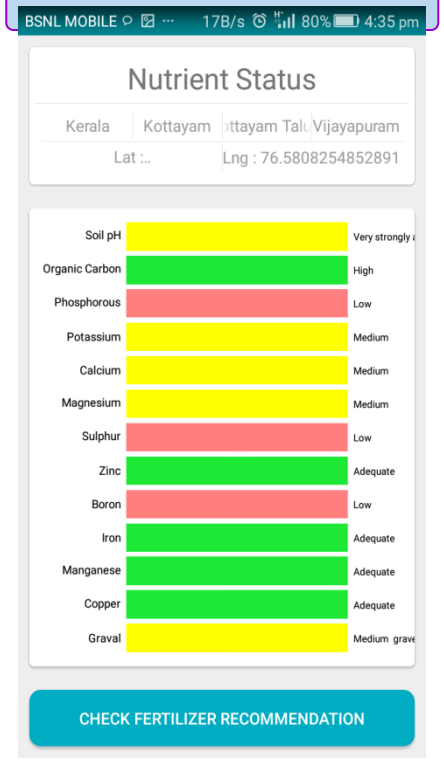
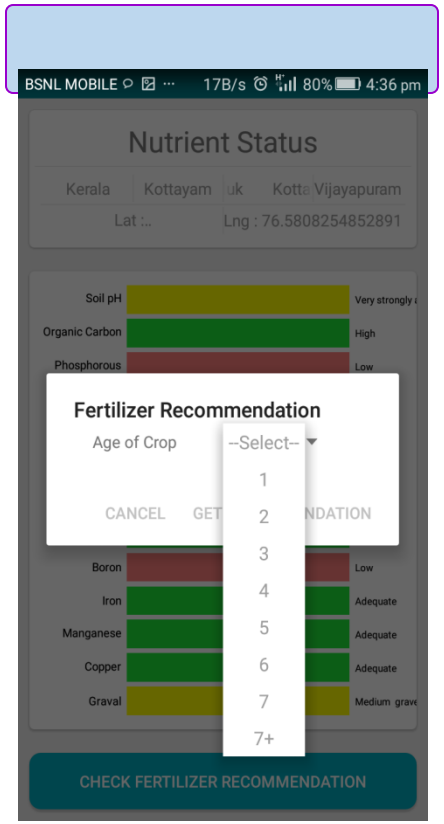
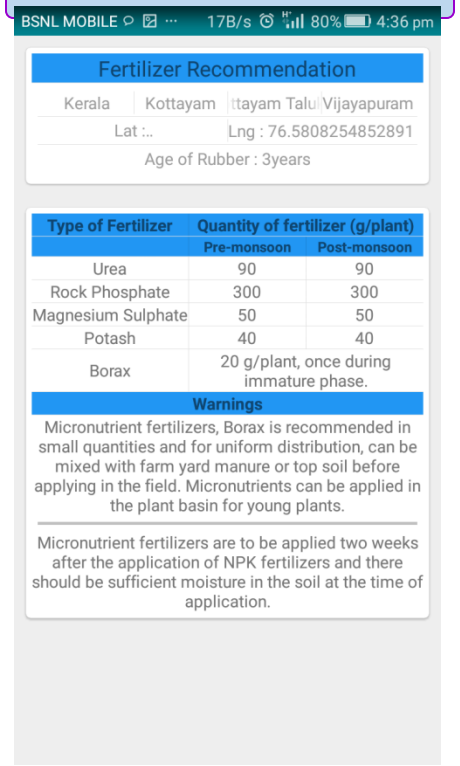
Manganam
9.578549265861511
76.57211065292358
CHECK NUTRIENT STATUS
Google


BSNL MOBILE 17B/s 80% 4:35 pm
Nutrient Status
Kerala
Kottayam
Vijayapuram
Lat :..
Lng : 76.5808254852891
Soil pH
Organic Carbon
Phosphorous
Potassium
Calcium
Magnesium
Sulphur
Zinc
Boron
Iron
Manganese
Copper
Graval
High
Low
Medium
Adequate
CHECK FERTILIZER RECOMMENDATION


BSNL MOBILE 17B/s 80% 4:36 pm
Nutrient Status
Fertilizer Recommendation
Age of Crop
--Select--
1
2
3
4
5
6
7
7+
CANCEL
CHECK FERTILIZER RECOMMENDATION


BSNL MOBILE 17B/s 80% 4:36 pm
Fertilizer Recommendation
Kerala
Kottayam
Vijayapuram
Lat :..
Lng : 76.5808254852891
Age of Rubber : 3years
Type of Fertilizer
Quantity of fertilizer (g/plant)
Pre-monsoon
Post-monsoon
Urea 90 90
Rock Phosphate 300 300
Magnesium Sulphate 50 50
Potash 40 40
Borax 20 g/plant, once during immature phase.
Warnings
Micronutrient fertilizers, Borax is recommended in small quantities and for uniform distribution, can be mixed with farm yard manure or top soil before applying in the field. Micronutrients can be applied in the plant basin for young plants.
Micronutrient fertilizers are to be applied two weeks after the application of NPK fertilizers and there should be sufficient moisture in the soil at the time of application.

RubSiS

Rubber Soil Information System

- Cost effective, efficient and easy to adopt e-governance tool for fertilizer advisory services.
- Ensures need based fertilizer application and sustain soil health

Need based fertilizer application

prevent soil degradation

reduce cost

and enhance growth and yield of rubber

Conclusions

- **Price volatility, increasing cost of cultivation and climate change are some of the serious challenges faced by global rubber plantation sector.**
- **Current pandemic is also affecting the sector in multiple ways.**
- **Low input sustainable strategies are to be evolved for addressing the challenges.**
- **Natural processes also should be exploited for the continued sustainability of the sector.**
- **Improving biodiversity in rubber plantations mitigates drought and sustain soil health.**

Consolidation of data and appropriate policy frameworks are needed for the sustainable development of the sector.

Thank You