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Cambodian Upland Soils Projects

Strengthening soil knowledge and capability in Cambodia to support upland agricultural development

Ngala kwop biddi.
Building a brighter future, together.

Australian Centre for International Agricultural Research

Australian Aid

Land Management Group
Professor Richard Bell

- Crop and plant nutrition
- Soil fertility and management
- Management of sands
- Conservation Agriculture
- Saline soils
- Cropping systems
- Revegetation of mine sites and minerals processing residues

Res Fellows	PhD/ MRT students
Ed Barrett-Lennard	Fariya Abubakari
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Luca De Prato	Winwin Pyone
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Noel Schoknecht	Afrin Mila Jahan
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Partner agencies		
ACIAR	CSIRO/ U Adelaide/ UQ/ USA	Brazil, UFV
GRDC	DPIRD/ UWA/ UTas/ANSTO	Bangladesh, BARI/ BRRI/ BAU
Soil CRC	NSWDPI/SCU/ CSU/ PIRSA	BARC/KU/ PSTU/ CASPA/ SRDI
WANTFA/ WMG/ Leibe	Laos, NAFRI	India, CSSRI/ BCKV
Facey Group/ CFIG/ BFS	Cambodia, GDA-DALRM/CARDI/RUA	Vietnam, ASISOV/IAS/ HUAF

Next 5 years- plans, opportunities, collaborations

- Soil CRC
  - sandy soils, multiple constraints, novel fertilisers, soil C
- GRDC
  - K nutrition, biofortification of grain, emerging deficiencies (Mg, B, Si, Ni)
- ACIAR
  - Bangladesh; Conservation Agriculture, nutrient management
  - Cambodia, Laos; Crop-Livestock, Soils in the Uplands
  - Ganges coastal zone; cropping intensification
- Alleviating subsoil constraints- chemical, physical, biological strategies

Outline

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Department of Primary Industries and Regional Development
GOVERNMENT OF WESTERN AUSTRALIA

- Overview of Cambodian Upland Soils Project
- Project highlights
- Objectives of the new project
- Highlight potential collaboration between SLAM/2022/103 and CROP/2022/110

CUSP Cambodia Upland Soils Project
ACIAR Project SMCN/2016/237

Overview

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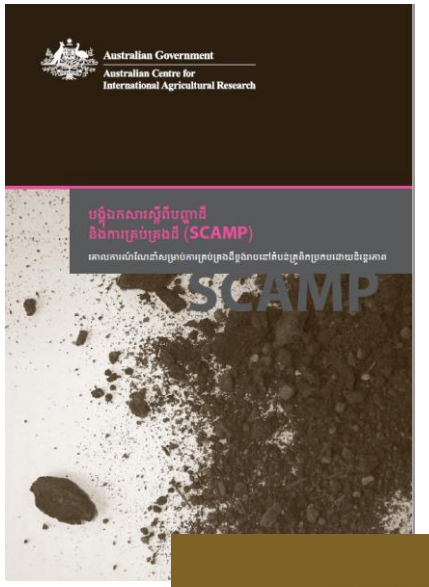
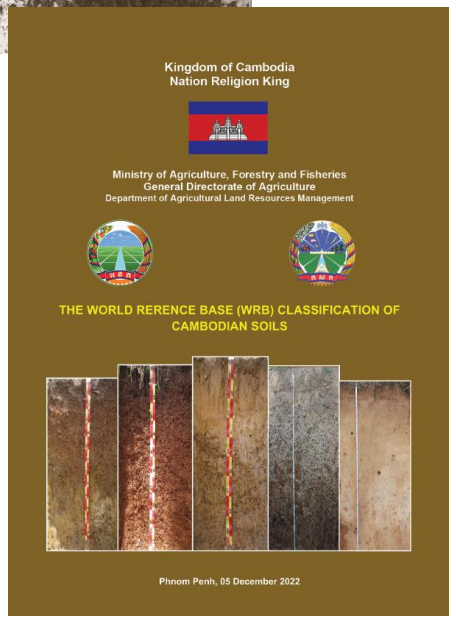
Soil degradation occurs at a rapid rate in upland areas of due to agricultural practices
Farmers do not recognize the value of investing in soil health
There is limited uptake of sustainable agricultural practices in upland farming systems
There is very limited soil information in easily accessible forms in Cambodia
Soil degradation is a recognized risk to food security and economic stability
Soil degradation is exacerbating the impacts of climate change and vis versa
Practice change in upland farming systems is constrained by access to knowledge and services
Soil research and extension capacity in Cambodia limited
There are multiple international development partners working in Cambodia uplands

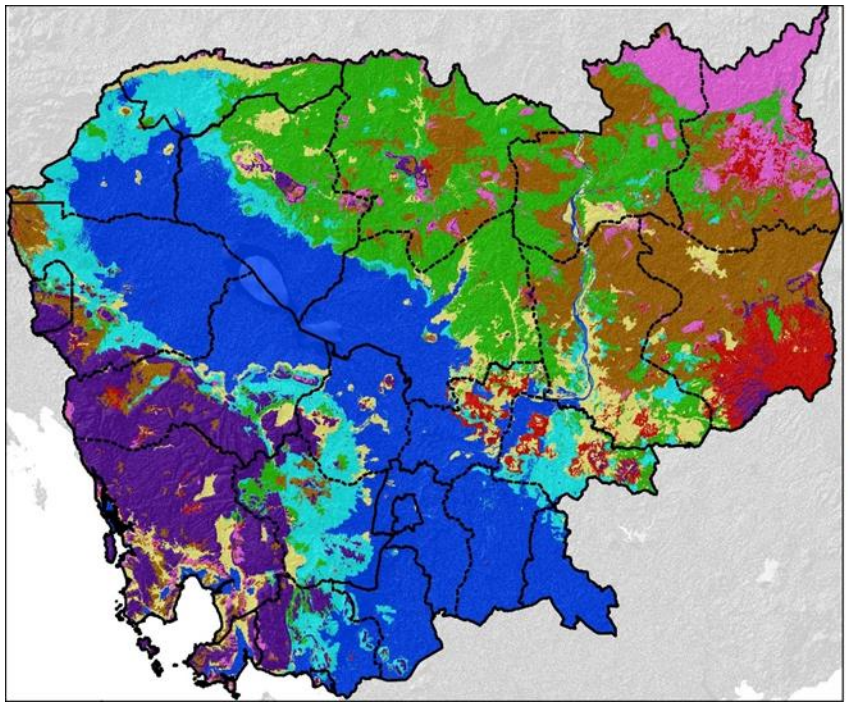
Introduce new methodologies for soil and land suitability assessment and identify main soil types and landscape patterns in representative upland regions.

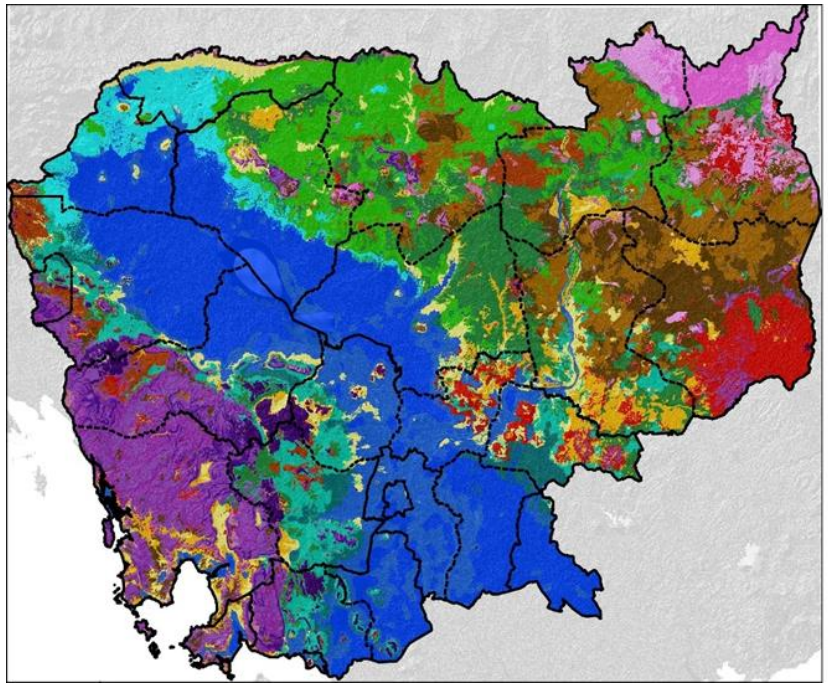
- Geographic framework of Cambodia – Framework for interpreting soil distribution in a landscape context. Spatial framework which separated Cambodia into zones for soil landscape interpretation.
- Soil surveys of two districts completed which identified 5 new upland soils not described previously.
- Cambodian Soils Practitioners Stakeholder group implemented – Workshop on soil survey, soil database and method harmonisation.
- Rapid Soil Analysis (MIR and ISE) techniques developed and calibrated for CARDI laboratory enhancing capacity for soil chemical and physical analysis.





Agricultural (Soil) Management Zones





DEM
- Slope
- Multi-resolution Valley Bottom Flatness
- Multi-Resolution Ridge Top Flatness
- Hillshade

LAND
- Geology
- Landforms

Climate
- Seasonal rainfall
- Aridity Index
- Surface water (Feb & Oct)

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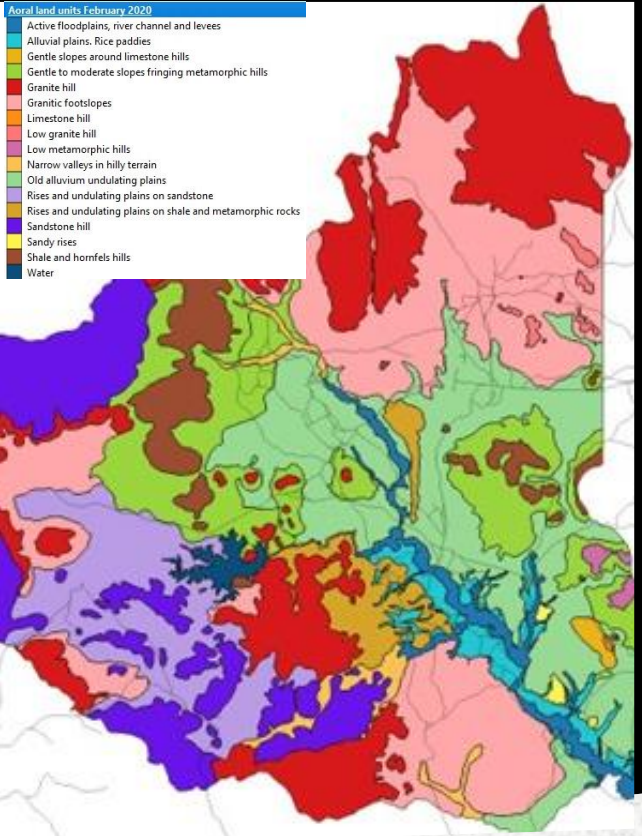
Department of Primary Industries and Regional Development
GOVERNMENT OF WESTERN AUSTRALIA

Karen Holmes, Noel Schoknecht & Paul Galloway





Identifying, characterising and mapping key agricultural upland soils

Establishing infrastructure and expertise in-country for Rapid Soil Analysis

Mid-Infrared spectroscopy

- Bruker MIR commissioned

- The MIR calibration was completed for soil parameters.
  - % clay, % sand, CEC, TOC analytical quality
  - pH(H_2O), DPTA Mn and Cu good quality estimates

- Calibration
  - Samples from the new collection sites from North and North East Cambodia were in set of samples considered to be outside the current calibration range.
  - Currently protocol under development on how to improve the current calibrations to include these new locations

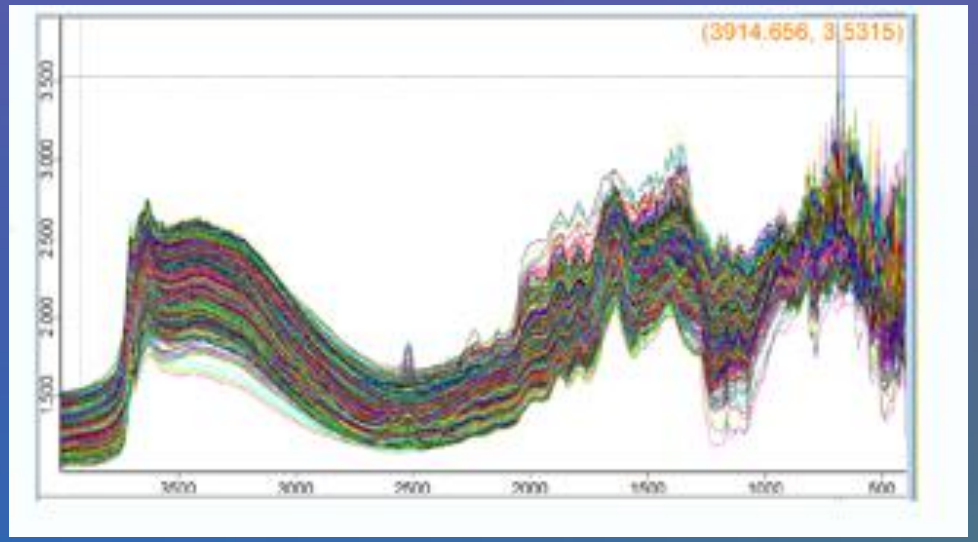
Near-Infrared spectroscopy

- Small activity started to complete Near-Infrared Spectroscopy on Cambodian samples in Australia.

Ion selective electrode

- Ion selective electrode method for measurement of K implemented.

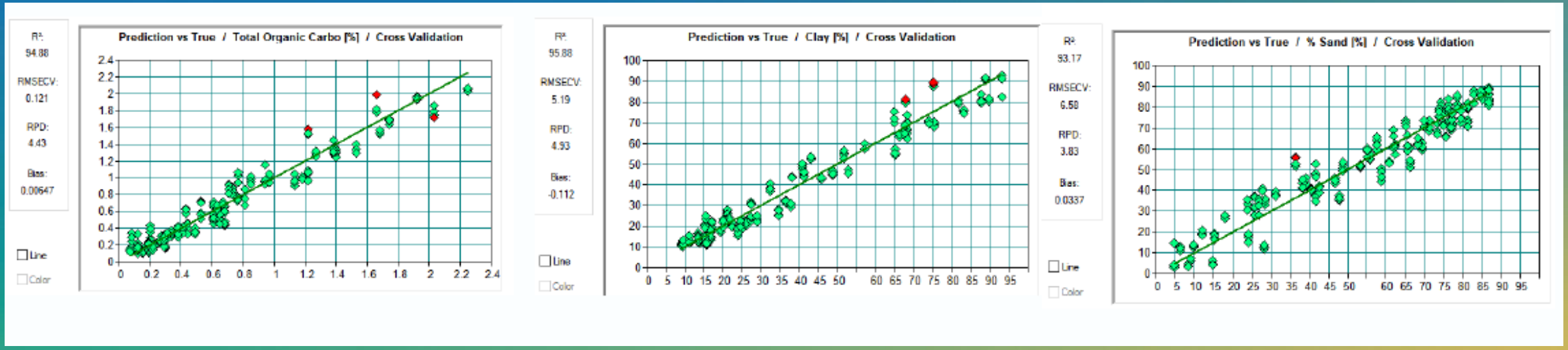
MIR Calibrations – Analytical quality estimates



TOTAL ORGANIC CARBON (%)

CLAY %

SAND %



Case for development for rapid soil analytical techniques

1. Requirement for soil information and inventory of natural resources
2. Assessment of soil properties for land suitability and management
3. Number of samples required for modern soil attribute mapping
4. Logistics of providing timely soil information at the local level

Rapid soil analysis – MIR Spectroscopy

- Allows estimation of soil properties at ALL sample sites
  - Not possible with conventional laboratory analysis because it is too expensive and time-consuming
- Each sample takes about 5 minutes to acquire MIR spectra
- MIR spectra can be used to estimate several soil properties
  - This requires a calibration for each soil property using laboratory analysis of a small subset of samples
- Cost ~AUD $ 40K

- Wet chemistry AUD$ 150 per sample
- Calibrate using ~100 samples = AUD $ 15000

Characterise the soil and land constraints to crop production and identify soil management technologies for these regions.

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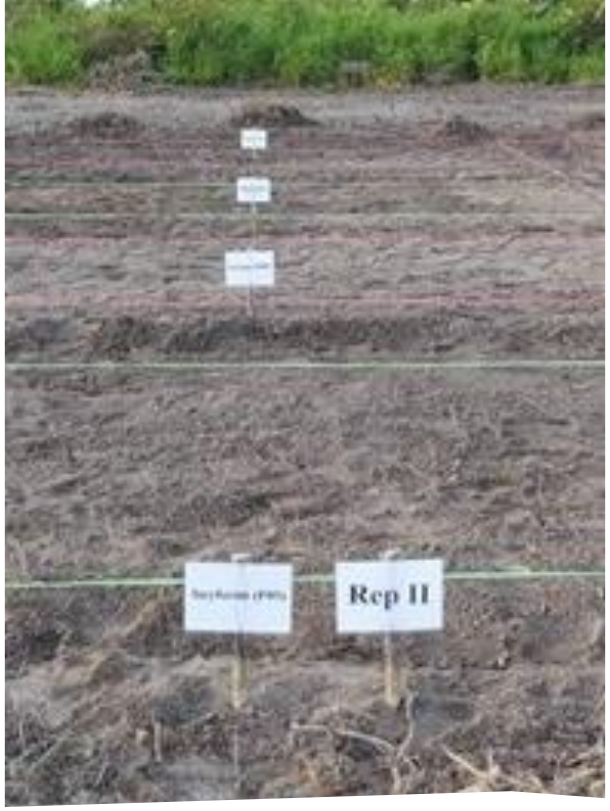
- On-farm satellite trials demonstrated crop response to P and K fertiliser additions compared to nil-fertiliser by farmer practice.
- Land suitability analysis of soil types within the study districts with a diagnostic tool developed.
- Field trials and pot trials identified the variability of response of crops and soils in the study region to amendments of fertiliser for nutrient improvement, or lime for managing low pH conditions.

Smallholder farmers in extensive areas of the Cambodian uplands are hampered by unreliable yields

The frequency of fertiliser use in upland regions can vary among famers and is low.

There are significant yield gaps between farmers' practice and improved agronomic practices.



Conducting pot and field trials to improve productivity of key soils

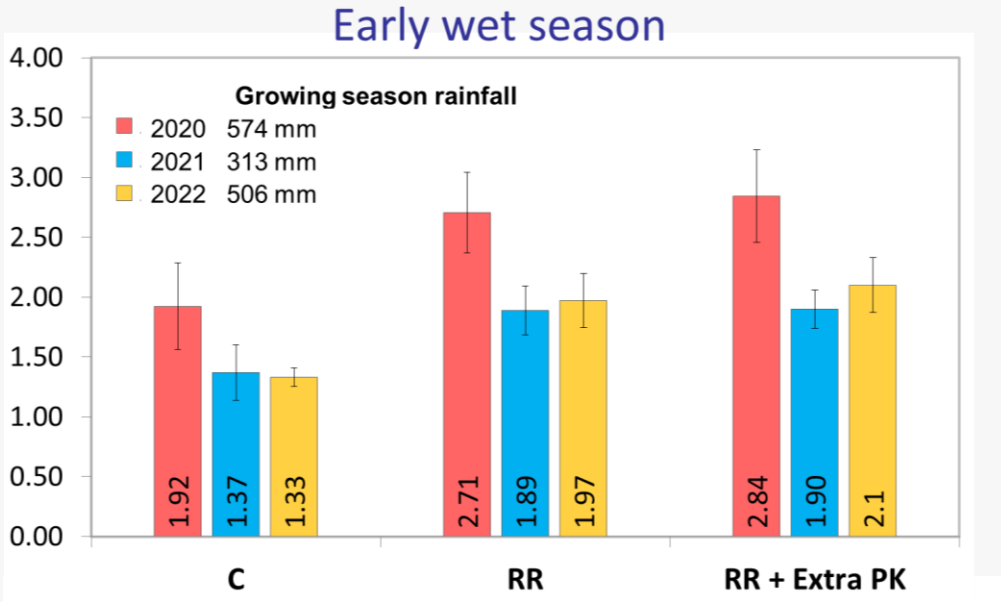
Crop selection and nutrient studies (K and P) on degraded

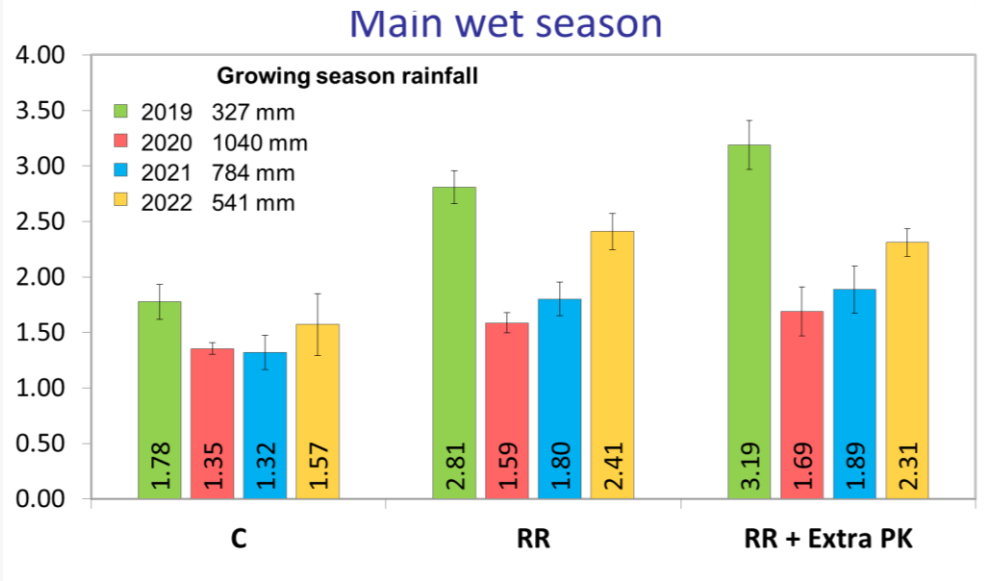
Lime amendment for soil acidity

Conducting Satellite trials for demonstrations

- **Satellite trials** : Assessment of Fertilizer Use Efficiency and Suitable Growing Seasons for Peanut in Cambodian Uplands (2019, 2020, 2021, 2022)

Dried kernal yield (t/ha)





Assess Rate of land degradation in the Aoral District of Cambodia (2020 - 2022)

Occurrences of soil and land degradation in the Aoral district reported after land clearing.

- Soil loss by erosion
- Fertility decline by loss of soil organic matter and plant nutrients, and soil acidification.

Aim

Determine the rate of soil and land degradation since clearing and to predict future land and soil conditions if current rates are not altered by better practices.

This complements work on soil surveys where samples were characterised by rapid soil analysis techniques, farmers' interviews and field experiments to manage soil pH and nutrient deficiencies.

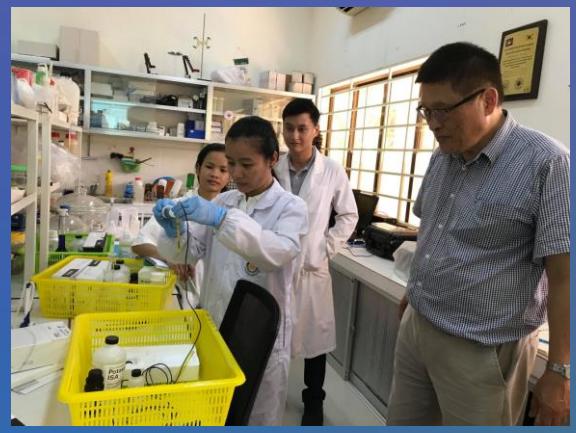
Conducting innovative extension exercises to maximise uptake of research findings in rural, subsistence communities

Community soils activities and on farm field activities

Farmers knowledge and perceptions – soil properties and soil fertility

Year	Topic	Aims
2019	Community soil baseline activity: Aoral & Dambae Districts	Determined farmers' perspective/understanding of: soil type, soil related constraints, suitable crops for particular soils and soil management practices.
2020	Gender awareness & analysis activities	Understand the demand of women and men farmers for adoption of soil management information, tools and technologies
2021/22	Soil fertility and fertiliser use study	Explore smallholder understanding of soil fertility; document the extent of fertiliser use; and investigate the constraints to fertiliser use.







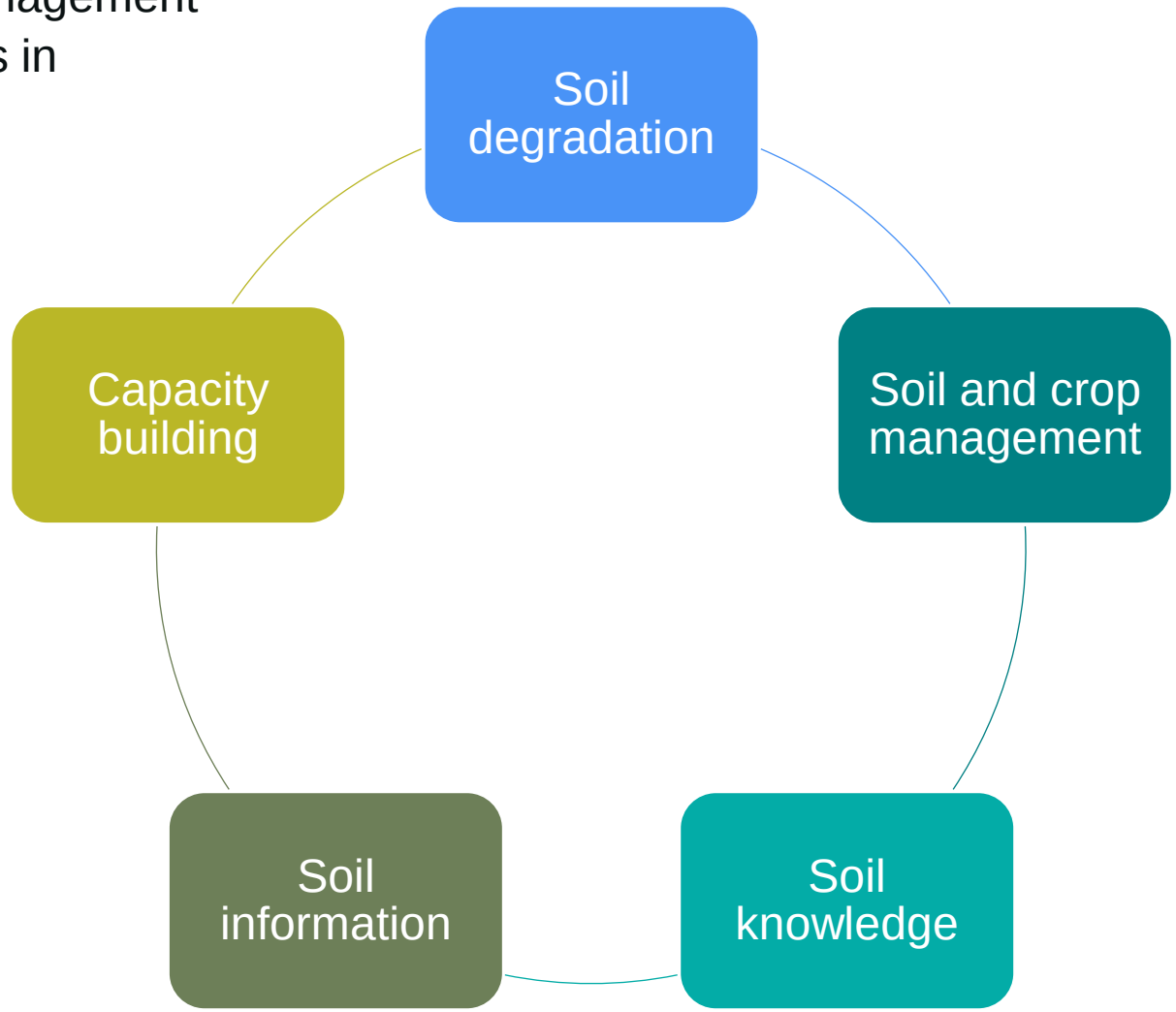


Samsung Quad camera

New Project - CUSP 2.0

The project aims to identify and develop sustainable soil management solutions to priority soil constraints and soil degradation risks in upland agro-ecological systems in Cambodia.

- Improved soil management practices in upland agriculture to limit soil degradation.
- Improved understanding of soil information needs and knowledge sharing pathways across diverse stakeholder groups to enable sustainable and profitable management of upland crops.
- Improved knowledge and capability for managing soil resources in Cambodian uplands among researchers, extension practitioners and farmers.



Collaborations

- Capacity building for characterisation of soil properties.
  - Purpose
  - Sampling strategy
  - Analysis (MIR, ISE, wet chemistry)
  - Reporting
- Soil constraints and management practices for cassava identified.
  - Nutrient budgets
  - Soil structure stability
  - Erosion, waterlogging
- Quantify soil degradation under cassava farming systems.

- Site characteristics added to soil database of Cambodia.
- Increased range of samples analysed by MIR → Improve calibration.
- Land suitability assessment criteria developed for Cassava.

Thank you

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Soil Preparation for MIR Analysis

Grinding soil sub sample

Representative soil

Store soil in plastic jar

Run soil sample

Calibrated 28 Soil Attributes

Particle size distributions:

- Coarse sand (200-2000 uM), Fine sand (20-200 uM), All sands
- Silt (2-20 uM)
- Clay (<2 uM)

Chemical attributes

- Organic C (Walkley and Black)
- pH in $CaCl_2$, pH in water
- Exchangeable acidity
- Exchangeable Al, $CaCl_2$-Al
- Base saturation, aluminium saturation
- CEC, ECEC
- PBI

Exchangeable base cations

- Ca, Mg, K, Na

Nutrients

- Olsen P, KCl-S, $CaCl_2$-B, DTPA Cu, Fe, Mn, Zn

- Electrical conductivity

Attribute	r2	RMSECV	Goodness of Calibration
CEC	97.6	1.26	Very good
Exch Ca	96.4	0.94	Very good
Clay	95.9	5.19	Very good
Organic C	94.9	0.121	Very Good
Exch Mg	94	0.74	Very Good
Sand	93.2	6.58	Very good
ECEC	87.9	2.55	Good
DTPA Cu	83.8	0.2	Good
DTPA Mn	82.1	20.5	Good
Sulphur	77.9	2.71	Good
DTPA Zn	77.2	0.26	
Boron	76	0.06	
pHCaCl2	75.8	0.4	Indicator
Exch Al	72	0.51	Indicator
PBI	67.6	353	Indicator
Conductivity	61	0.0125	Indicator
Base Sat	59.4	22.1	Indicator
DTPA Fe	54.9	10	Poor
Olsen P	43.7	3.9	Poor
Exch Na	18.9	0.46	Poor
Exch K			