Decision support for landscape specific fertilizer management

EIA 2030

Fertilizer Ethiopia Use Case

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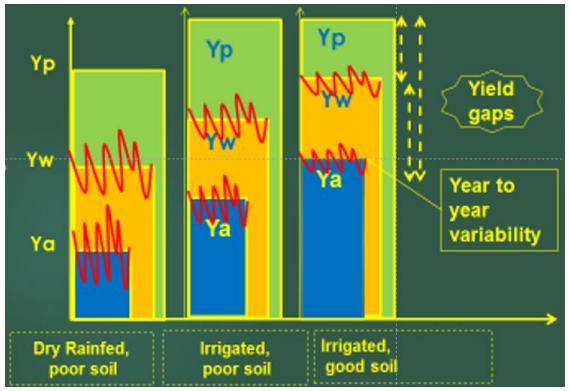
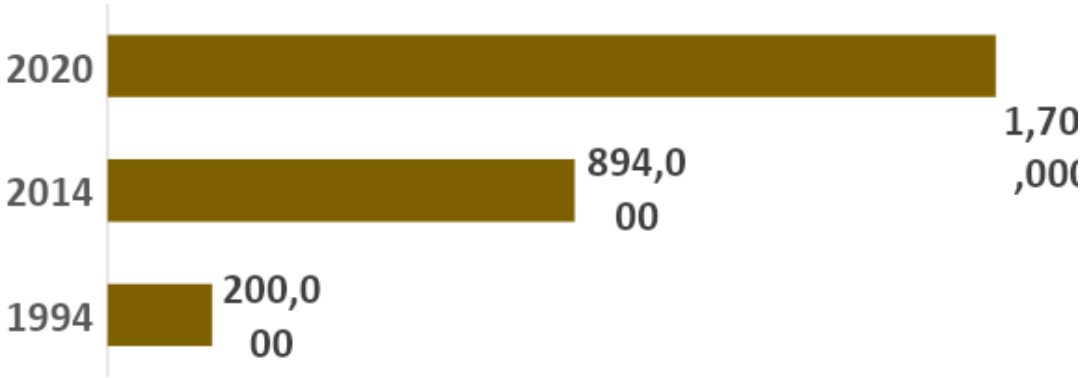
Outline

1. Background on fertilizer management in Ethiopia
2. Fertilizer trials and crop response dataset
3. Fertilizer Ethiopia Use Case
4. Decision Tools
5. Testing landscape targeted fertilizer recommendations
6. Potential scaling pathway
7. Conclusion

1. Challenges in fertilizer management

- Nutrient mining on farms in the **undulating and rugged landscapes has resulted in degraded soils** and 40% less yield than the global average
- **Potential yield gap** – yields at farmers fields are two to three times less
- **Environment variability** of farmer parcels and affordability to invest
- Despite the government invest in fertilizer usage (1.7 million metric tons in 2020) and developing soil information maps (EthioSIS), **targeting site specific crop response to fertilizer is the major concern**

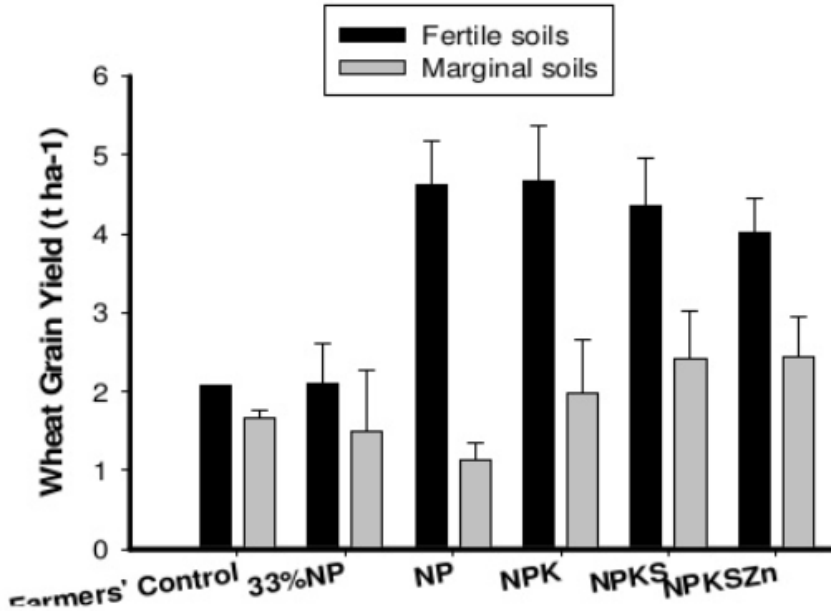




Blanket recommendation

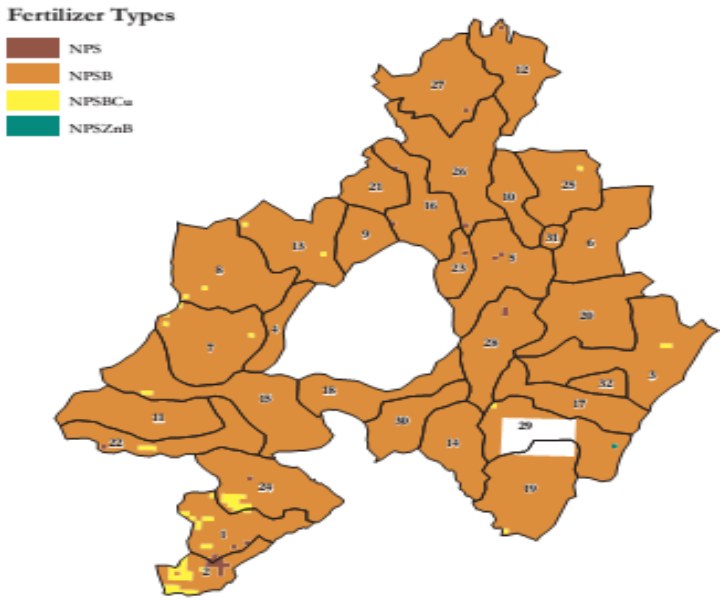
- Blanket recommendation - Fertilizer management is based on generalized crop response to fertilizer
- Since 2010s, soil test-based fertilizer trials and EthioSIS allow to employ combined approach

1. Crop response – Field experimentation



2. Soil test – EthioSIS

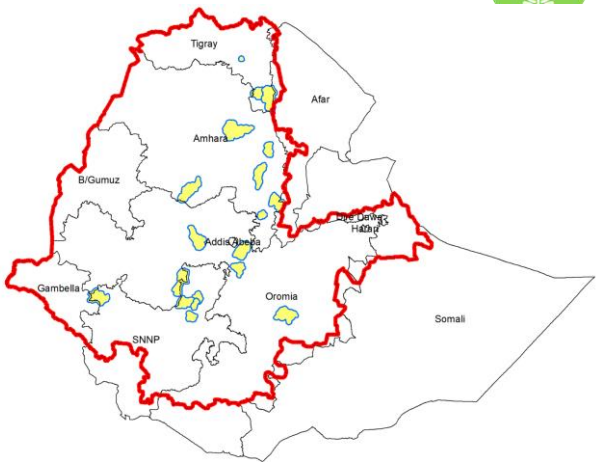
Critical levels and fertilizer sources

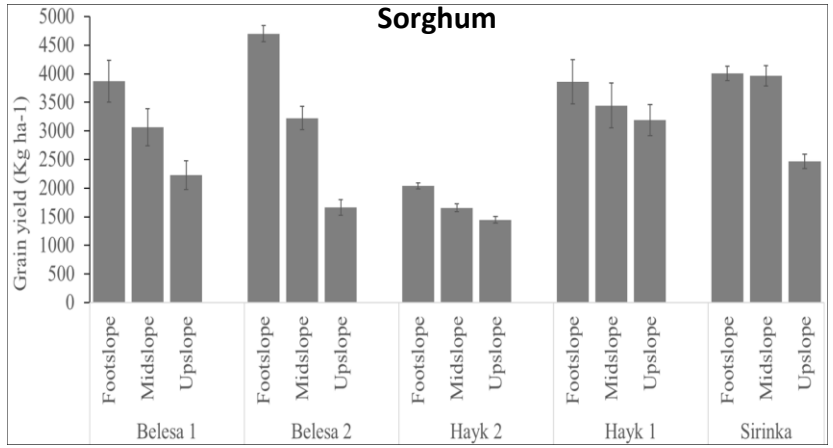


2. On-farm fertilizer trials and crop response data

ICRISAT and partners implemented fertilizer trials from 2014-2020 under different farming systems targeting landscape positions, soil fertility/soil type, cropping system, and rainfall regime.
Trials: omission, yield gap, agro-fortification trials

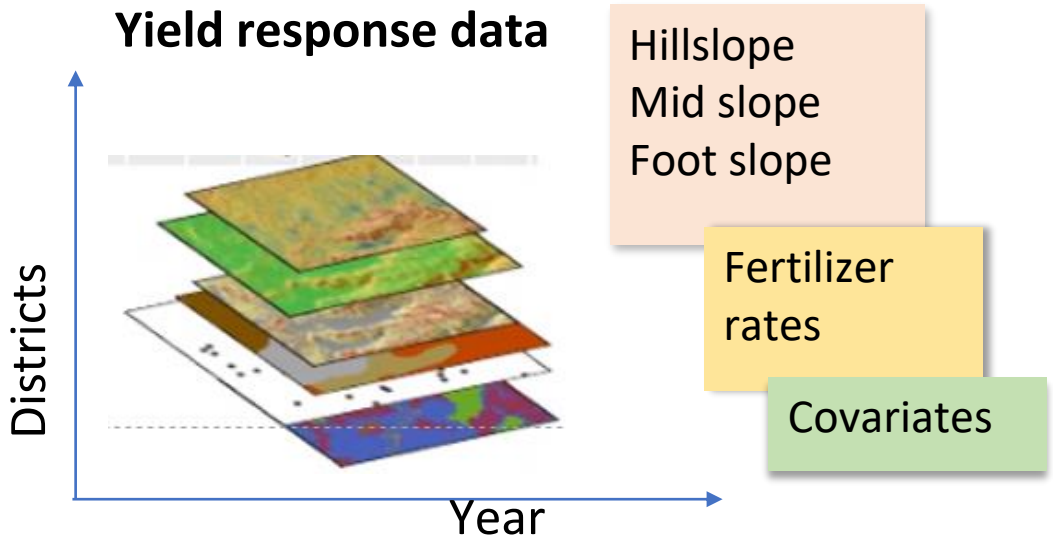
Yield Response = f(fertilizer rate, landscape position, fertility, etc.,)

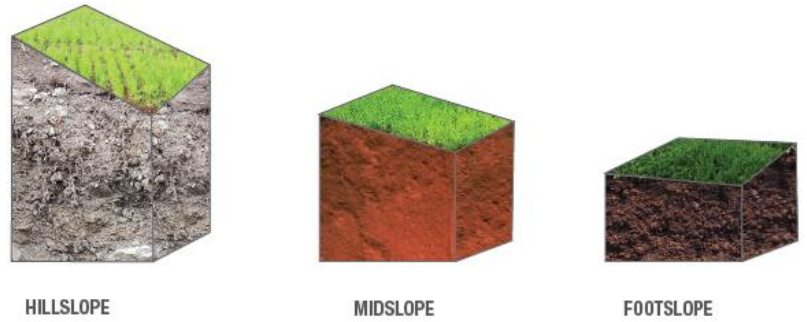




2. On-farm fertilizer trials and crop response data

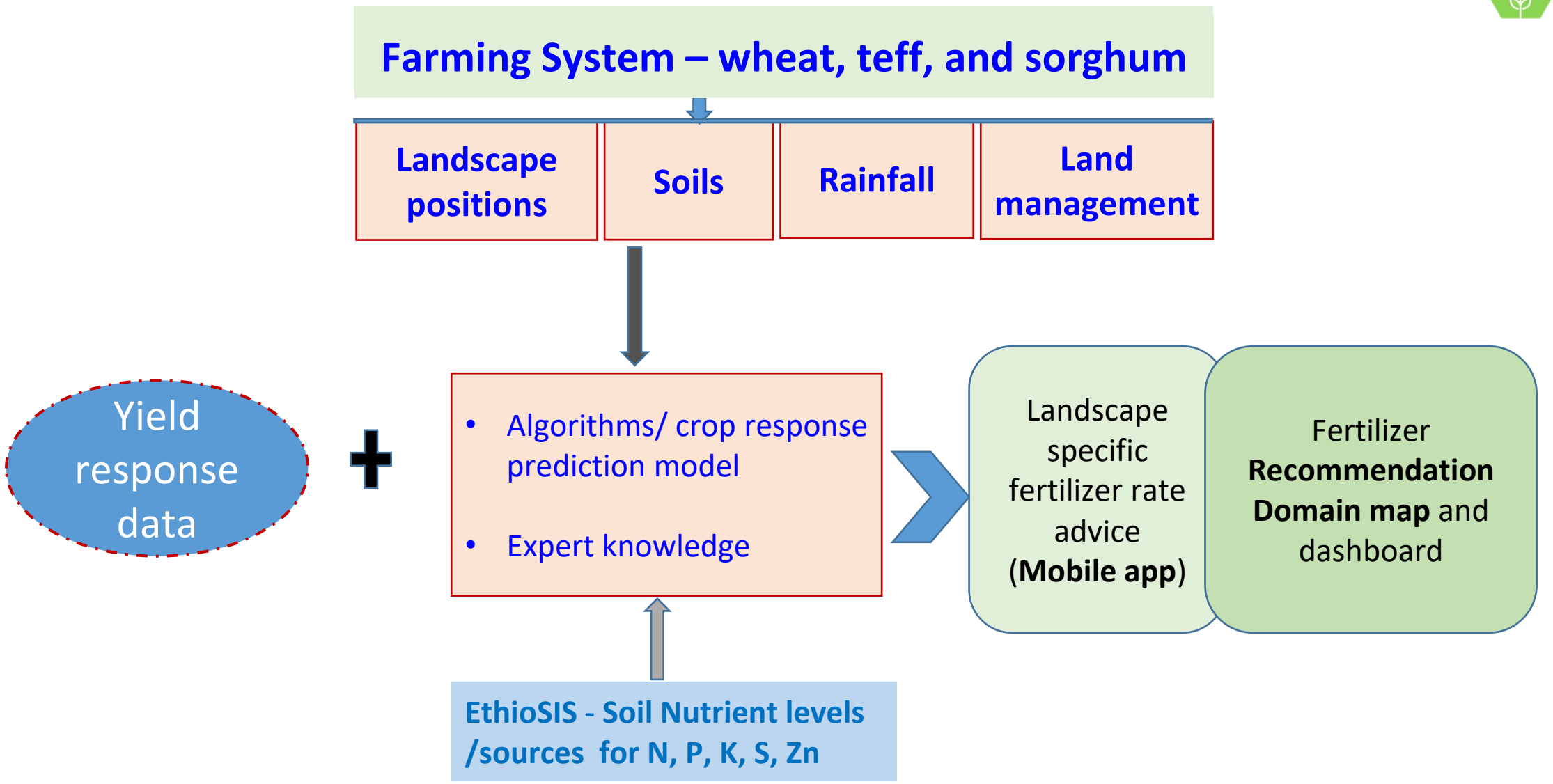
DATASET (Wheat, Teff, Sorghum)





- Based on extensive evidence generated from 10650+ on-farm plot experiments by ICRISAT and partners, dataset at three landscape specific fertilizer management zones are developed

3. Fertilizer decision support framework

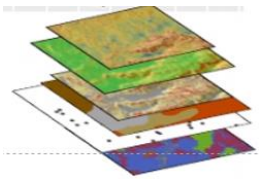


3. Fertilizer Ethiopia Use Case

- Two Minimum Viable Products (MVPs)
  - MVP 1 – calibrated and validated fertilizer response prediction tool (app) at landscape (hillslope, mid slope, foot slope)
  - MVP 2 - calibrated and validated district level fertilizer recommendation domain maps (dashboard)

Nutrient response algorithm-mobile app (MVP1)

Yield response data



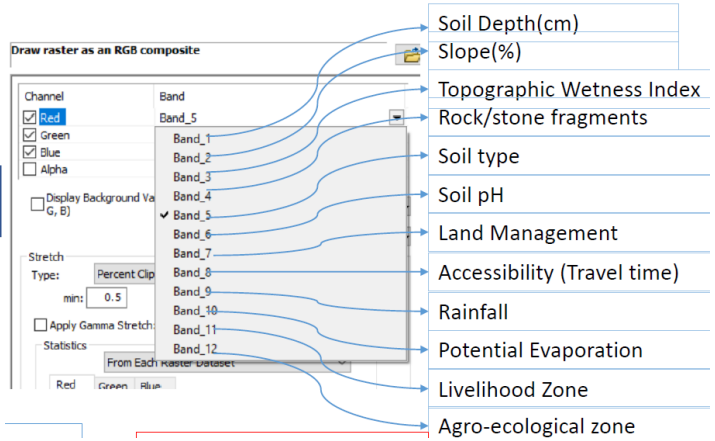
Covariate data

Hillslope

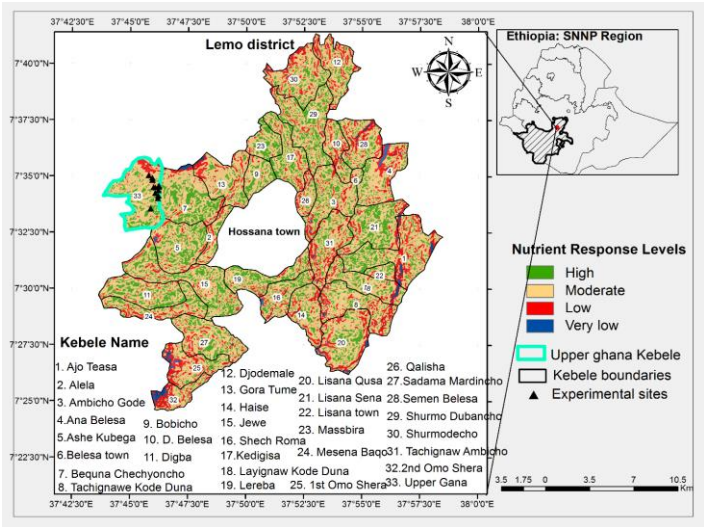
Mid slope

Foot slope

Homogeneous Fertilizer Response Units – Multivariate classification of factors



Woreda Level Fertilizer Response Map and dashboard – MVP2



Calibrated and Validated Fertilizer Advisory for Extension Agents and Woreda Decision Makers

Africa Rising, GIZ-IFSM, IFDC, etc

Process for Soil Data

ISRIC World Soil Information

Soil Properties

Geolocation of sites

Soil attributes
1. Soil Type
2. Bulk Density
3. Soil pH
4. Soil OC
5. CEC
6. Clay
7. Sand
8. TPI
9. TWI

Trial Data
1. Yield
2. Landscape strata
3. Crop System
4. Variety
5. Macro nutrients (amt)
6. Micro nutrients (amt)

Weather Attributes
1. Seasonal Rainfall

Process for Rainfall data

GEE Cloud database

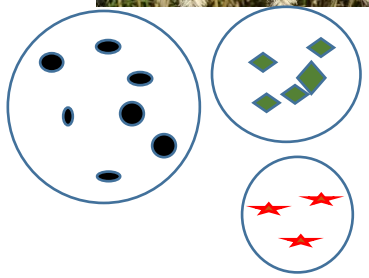
API

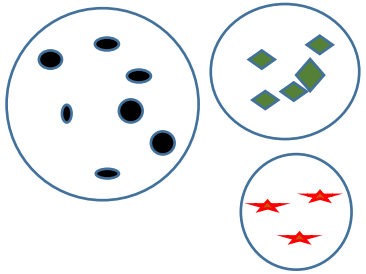
Geolocation of Weather stations

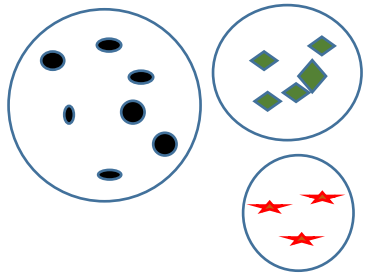
CHIRPS Data

SWR, ML (ANN, RF) based feature selection

Decision Clusters for each crop, soil and weather attributes



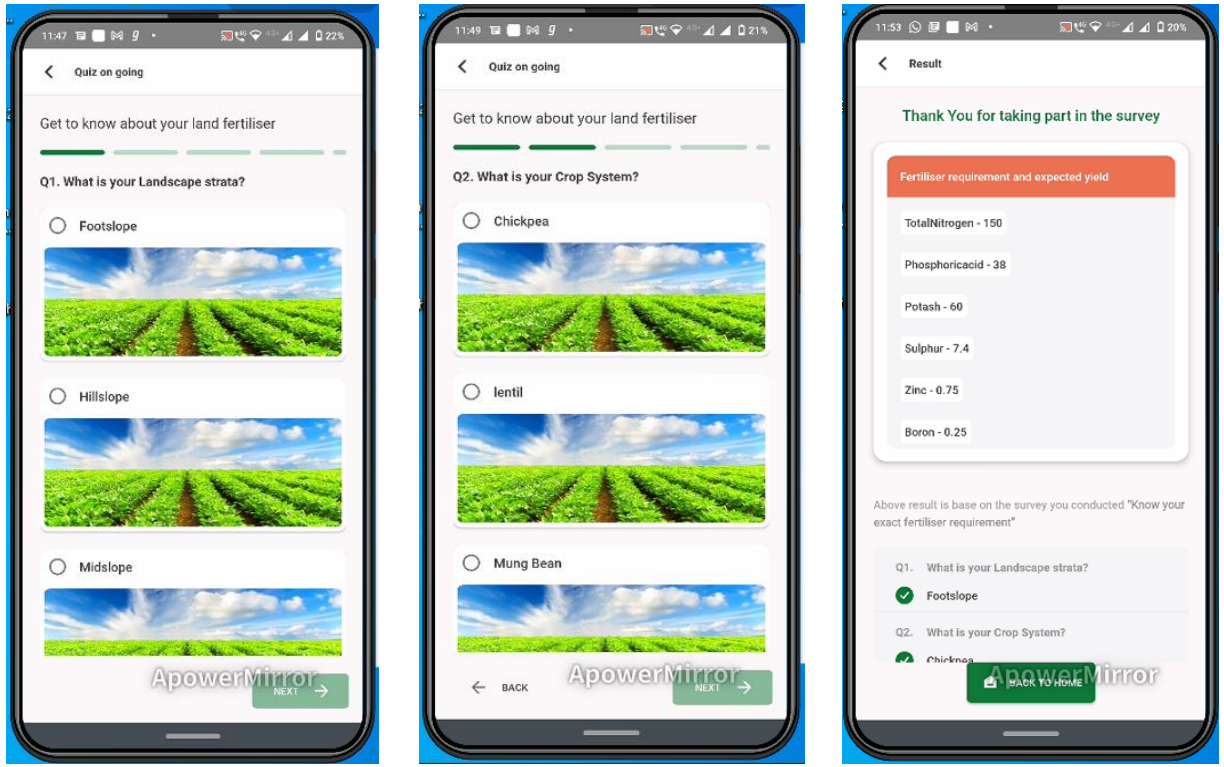




Landscape	N	P2O5	K2O	S	Zn
Footslope	98	74	80	30	5
Footslope	98	74	80	30	5
Footslope	138	69	80	40	12
Hillslope	98	74	80	30	5
Hillslope	98	74	80	30	5
Midslope	98	74	80	30	5
Midslope	138	69	80	40	12
Midslope	98	74	80	30	5

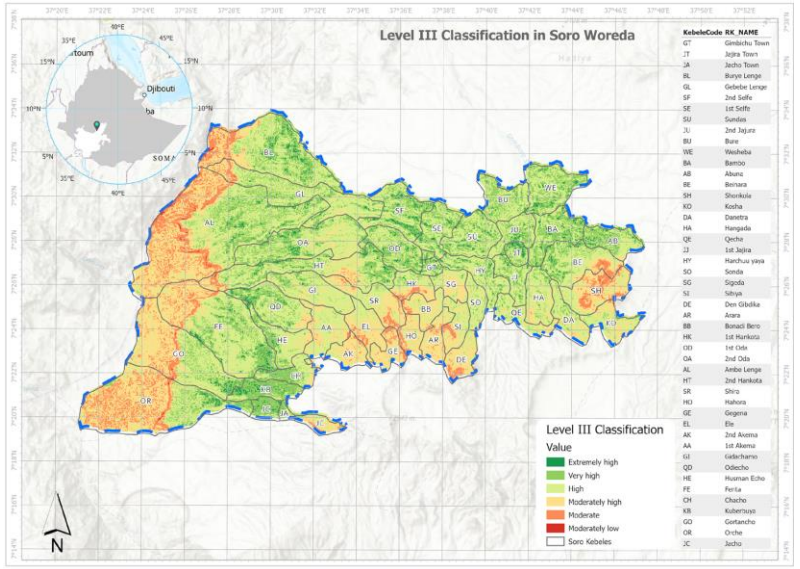
4. Decision tools - prototype

Mobile app (MVP1)



Fertilizer recommendation domain map and dashboard (MVP2)

Hierarchical multi-stage multi-variate classification



5. Validation process

Product 1: Mobile-based landscape specific fertilizer recommendation rate (mobile app)

Recording every agronomic practices, feedback to validate the LSFR

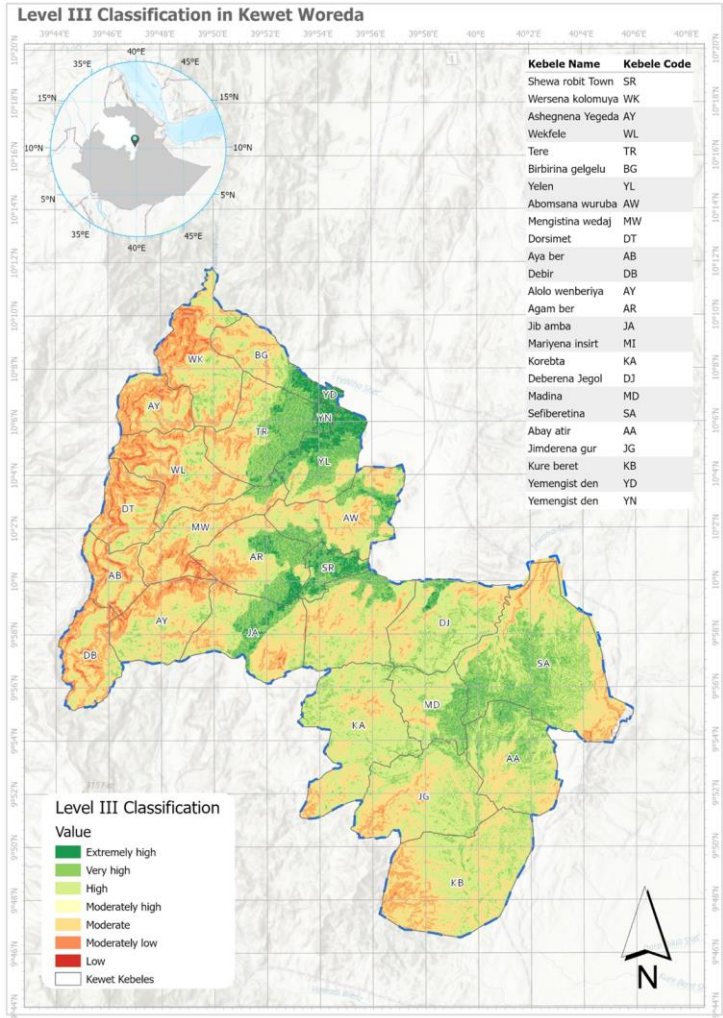
Farmer

Extension ⟷ **Research**

Coordinate activities, providing trainings, facilitate co-learning, data collection; feedback on LSFR, MAPS

Co-design, facilitation, data monitoring, data collection

- Product 2: District fertilizer recommendation domain map and dashboard



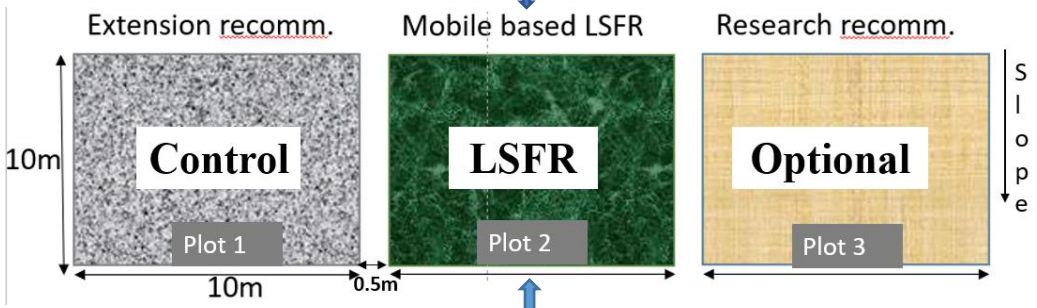
Validation process

Technical evaluation of landscape specific fertilizer rates

- Product 1: Mobile-based landscape specific fertilizer recommendation tool

- **Hillslope**
- **Mid slope**
- **Foot slope**

Landscape	N	P2O5	K2O	S	Zn	B	Se
Footslope	138	69	80	40	12	0	0
Footslope	138	69	80	40	0	0	0
Footslope	180	114	90	22	2	1	0
Footslope	98	74	80	30	5	0	0
Hillslope	46	23	80	40	12	0	0
Hillslope	138	69	80	40	12	0	0
Hillslope	138	74	80	40	5	0	0
Hillslope	180	114	90	22	2	1	0
Midslope	138	69	80	40	12	0	0
Midslope	138	74	80	40	5	0	0
Midslope	180	114	90	22	2	1	0
Midslope	180	114	90	22	2	1	0
Midslope	98	74	80	30	5	0	0



Algorithm V1

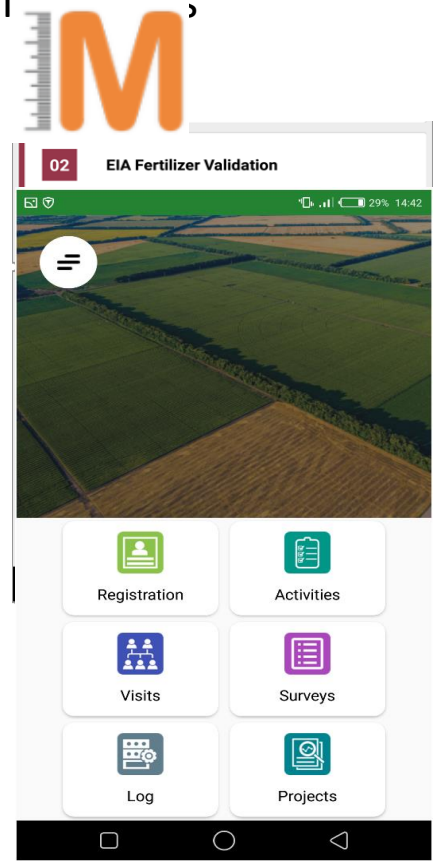
Validation question

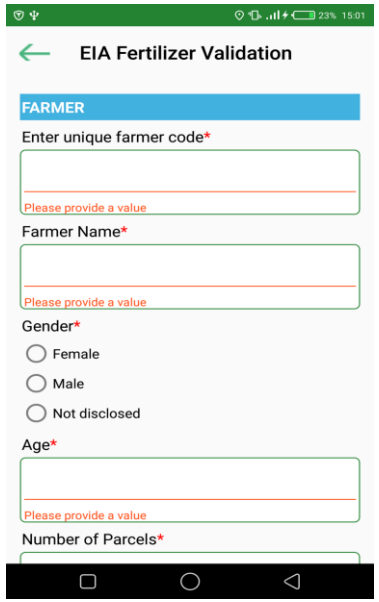
1. How significantly vary the yield response, use efficiency and income from the model compared to the extension or blanket recommendation?
2. How significantly match the yield response of the model compared to the yield range obtained in the calibration (algorithm V1)?

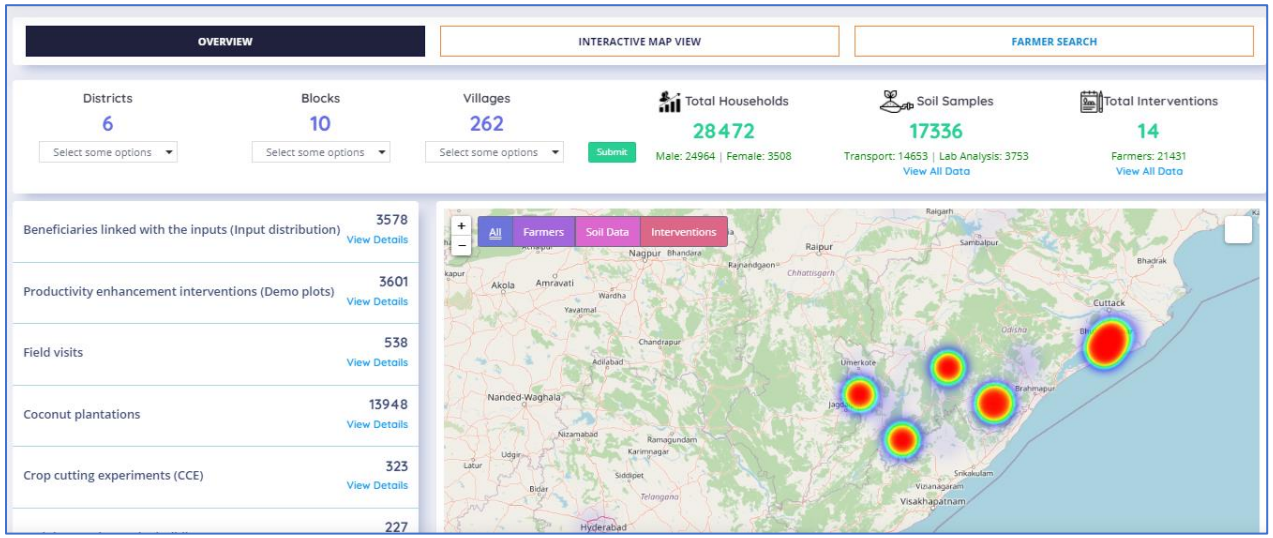
Validation process

Data collection and feedback on experiences of farmers, extension agents and researchers – mobile tool (MPRO)

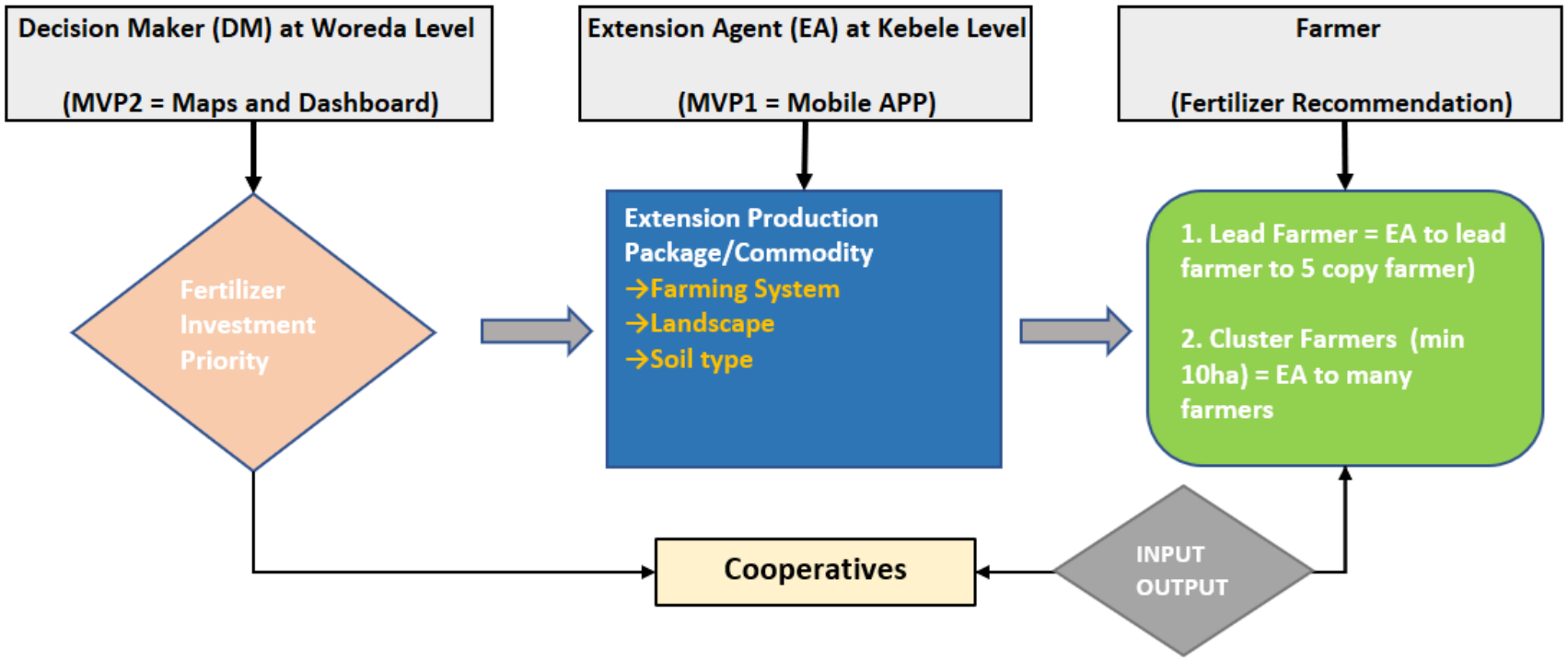
MPRO is a data collection system that uses analytical, synthetic or mathematical methods for estimating performance indicators; survey feedbacks







6. Potential Scaling Pathway



7. Conclusion

- Finalize the mobile app and recommendation domain maps
- Testing the mobile app and recommendation domain and validating on field with demand partners
- Refining the decision tools

Thank you