Netflix for Agriculture?

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May 2017

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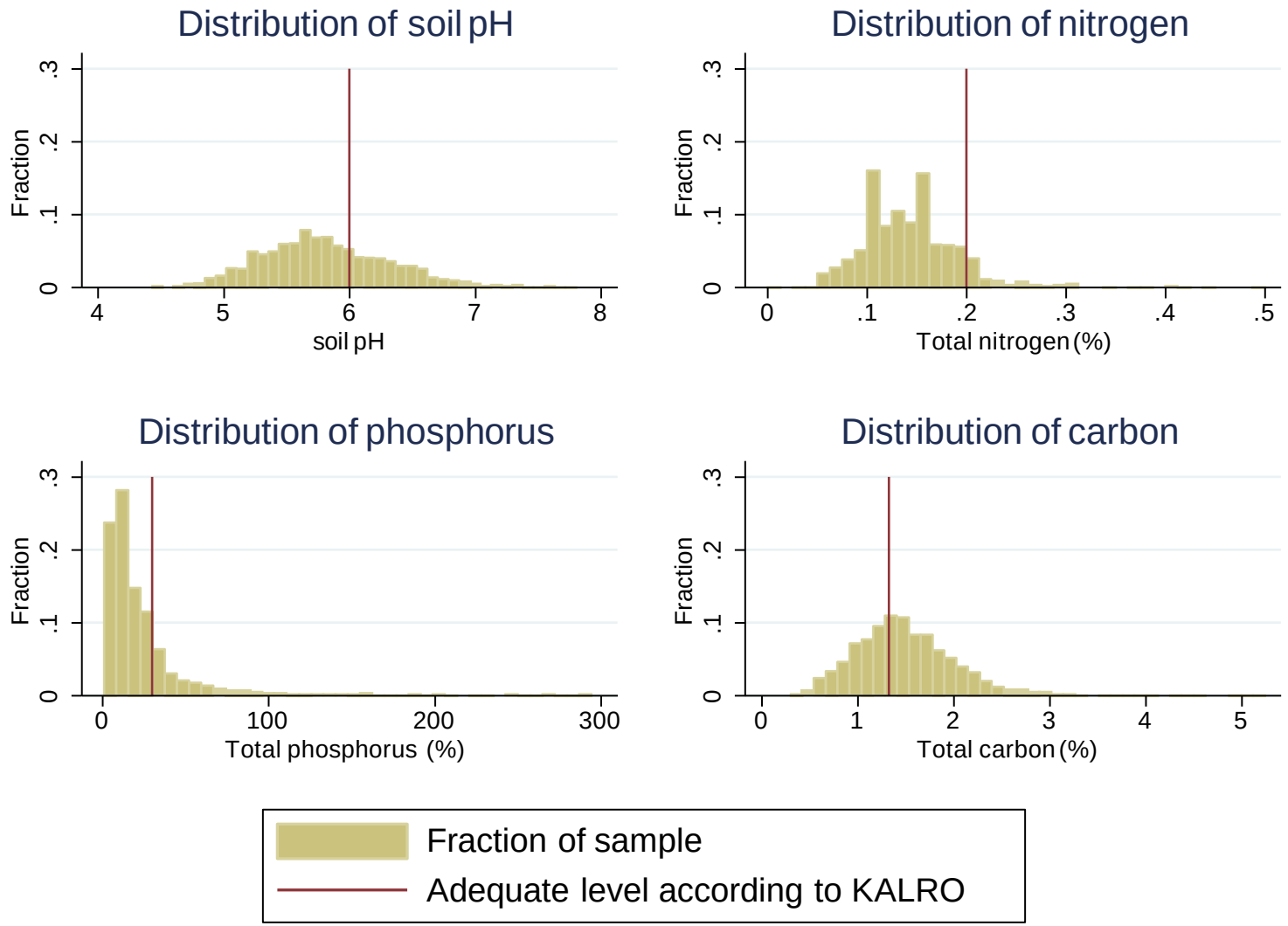
New Technological Opportunities

- Optimal agricultural practices may vary with soil type, weather, prices, input and output markets, etc.
- Technological advances facilitate learning about local characteristics.
  - Spectroscopy techniques (mid-infrared light)
  - Satellite or drone photographs (Burke & Lobell 2017)
  - Mobile soil analysis technologies
- Mobile phones enable cheaper delivery of local information, personalization of advice, real-time advice to match local agricultural season, two-way communication, message control.
- Smart phones with capabilities such as video; opportunities for taking pictures and sending them on.
- Behavioral economics and improved understanding of social learning may allow for improved messaging.
- Big Data techniques allow for personalized advice, A/B testing.

What Institutions are Appropriate for Generating and Disseminating Local Agricultural Information?

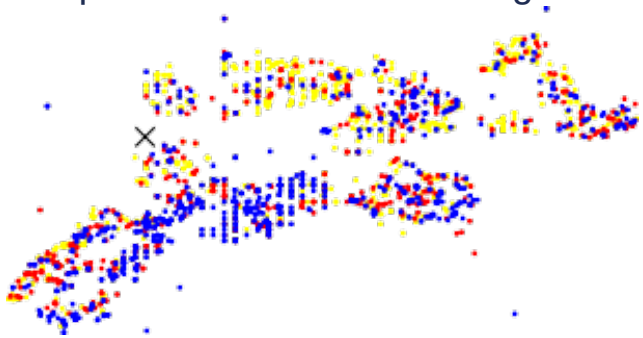
- Decentralized markets for information are subject to numerous distortions
  - Static efficiency requires pricing at marginal cost, which may be close to zero.
  - Investment incentives limited by marginal cost pricing and/or customers passing on information to other potential customers
  - Information asymmetries may create potential for abusive practices, reduce trust, willingness to pay.
- Government failures, need for competition
- Global public good issues

Optimal Practices Heterogeneous Across Farmers

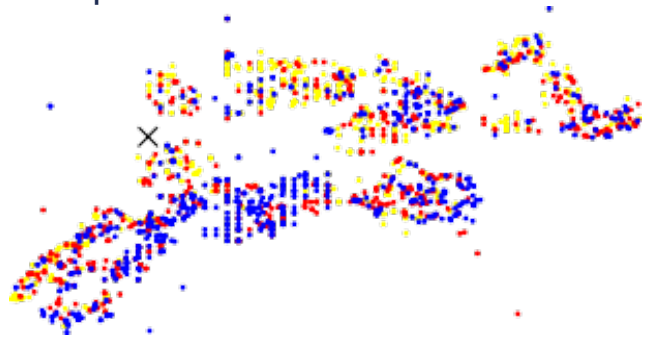


Soil Characteristics are Spatially Correlated

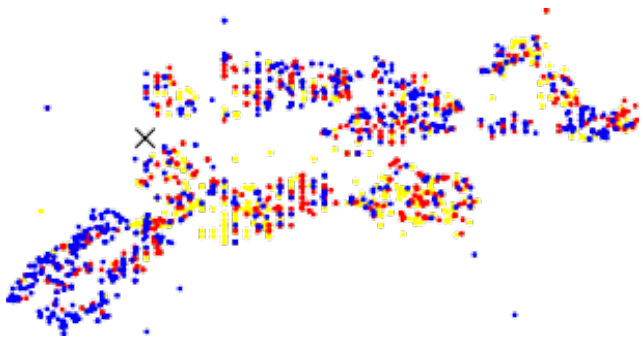
Spatial Distribution of Nitrogen



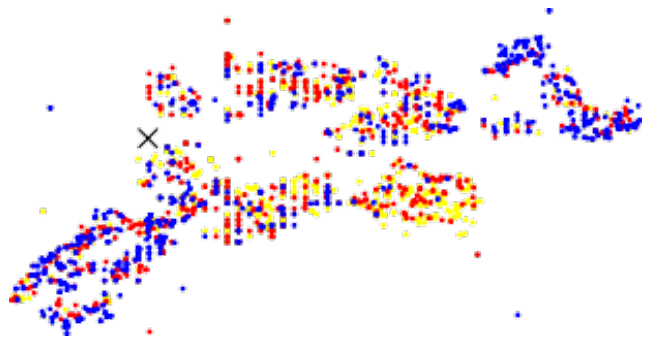
Spatial Distribution of Carbon



Spatial Distribution of Phosphorus



Spatial Distribution of pH



First tercile · Second tercile · Third tercile × Busia

Limits to Individual/Social Learning

- Individual Learning?
  - Soil test/re-test correlation approximately 0.7
  - Test plots are noisy. Very few farmers doing test plots.
  - Implies information from neighbors is potentially helpful
- Social Learning?
  - Some contexts with social learning (Conley and Udry 2010)
  - But others with limited relevant information exchange among farmers (Duflo, Kremer, Robinson, 2008, 2011)
    - Little knowledge about neighbors' farming practices
    - No information spillovers of demonstration plots without explicit invitation to observe

Costs for the Creation and Dissemination of Information

- Fixed costs of collecting and disseminating information, but these are falling due to new technologies, and in some cases have already been incurred
- Social marginal costs of disseminating info by mobile phone in local areas close to zero (unused cell-phone tower capacity)
  - Amazon's web services SMS: $0.002 in India and $0.006 in US

Netflix for Agriculture?

- Interactive database and personalization software combined with mobile phones
- Personalized (or at least localized) recommendations
  - Geographic and temporal info: soil types, weather, altitude, local market conditions
  - Farmer-specific info: demographics, education, cognitive scores, risk aversion, previous farming experience
- Two-way communication and information aggregation
  - Farmers have incentive to contribute accurate information in order to get better recommendation from the system.
  - Information contributed by farmers leads to better recommendations for other farmers.
    - Example: Fall Army Worm outbreak in Kenya

Netflix for Agriculture?

- Trusted system could be useful platform for providing other info relevant to rural development.
- System could potentially be useful in aggregation
  - Communicating with purchasers
  - Communicating with input suppliers
  - Quality checks and reviews
- Links to agro-dealers and to extension agents
- Particularly useful in cases in which info varies with physical location, time, and other variables collected by the database
  - Disease outbreaks

Netflix for Agriculture?

- Use of behavioral techniques, social learning ideas to encourage adoption
- Software for personalized recommendations based on sophisticated prediction methods and ongoing A/B trials
  - Test which ag techniques work best for which farmers and how to encourage adoption
  - Outcome data: self-reported, contract farming partner, input coupon system, satellite data?
- Returns to scale
  - Fixed costs of software development
  - Farmer data generation

Other Distortions

- Many potential distortions might prevent optimal investment even with perfect information
  - Credit constraints
  - Education or other types of human capital
  - Labor supply constraints
  - Time-inconsistent preferences
  - Input supply constraints
- Important to test whether system works, how to target messages, match messages to farmers

Implication of Economies of Scale

- Dynamic reason for zero, negative price, especially early on
- First movers have an advantage
- May be able to exploit information asymmetries, monopoly position

Who Could Cover Fixed Costs?

- Private firms with a subscription model, NGOs, governments, contract farming organizations, input sellers
  - Since institutions only captures partial value of info, insufficient investment incentives
  - No financial incentive to share information outside the organization
- Global public good

Empirical Evidence on Various Questions

- Are there some settings in which:
  - (1) There is useful agricultural information that some farmers lack;
  - (2) Farmers respond to information delivered over mobile phones;
  - (3) Farmers provide accurate information that can be used to improve the system;
  - (4) Social benefits exceed costs?

(1) Is there useful agricultural information?

- In Kenya, perceptions of soil have limited correspondence with actual soil chemistry (Marenya et al. 2008; Berazneva et al. 2016)
- Example:
  - Over 50% of a random sample of farmers in Western Kenya never heard about agricultural lime, despite high levels of acidity and high returns to lime in agricultural trials.

(2) Can mobile phones be effective as a delivery method?

- Ongoing rigorous experimentation to identify existence of effects and in what circumstances they appear.
  - What works and when?
  - Combine lessons from multiple experiences
- SMS-based lime messaging in Western Kenya:
  - Impact evaluations of several phone-based systems, types of farmers, and types of messages
- Evidence from other contexts:
  - Hotline and text-messages to sugar cane contract farmers in Kenya
  - Phone-based extension hotline in India

Public Extension

- Partnership with KALRO to evaluate extension approaches
- One treatment arm randomized maize farmers into SMS-based extension (e.g."If your soil pH is less 5.5, apply lime") or control
- No effect from SMS-extension on redemption of 50% discount vouchers for lime in subsequent season

Local and General Messages for Lime Use

- Sample of 1,900 smallholder maize farmers recruited through previous projects randomized into local, general messages or control:

  (i) Text messages with ward-level (local) acidity information
    - "Lime reduces soil acidity.Based on soil tests, apply [quantity] lime"

  (ii) Text messages with general info about acidity
    - "Lime reduces soil acidity"

- All farmers received a SMS-based coupon redeemable for 10 kg of lime or bar of soap at local shop
- General messages increased likelihood of choosing lime by 4pp (*)
- No significant effect for local messages

Local Information to Agrodealer Clients

- Sample of 6,000 farmers who are customers of agro-dealers randomized into three treatments (or control):
  - (i) Text messages
    - "Lime reduces soil acidity.Based on soil tests, apply [quantity] lime"
  - (ii) Text messages + phone call from call center
  - (iii) Text messages + offer access to call center
- Outcome measurement through SMS-based coupons providing 15% discount on lime purchases up to 70 kg at local shop
- Those who are recommended lime increase redemption by 2pp (*) for text, 4pp (**) for text + offer
- Subset who is not recommended lime decreases redemption by 4pp (*) for text and text and offer

SMS on Lime Use for OAF farmers (On et al. 2017)

- Farmers who participate in One Acre Fund (OAF) program
  - OAF offers affiliated farmers ag products for purchase, including lime
- 4,884 farmers randomized into two treatment arms (or control):
  - (i) Broad local message ("Your soil is acidic. Use lime")
  - (ii) Detailed local message ("Your soil is [degree] acidic. Use [Kg] lime at [Ksh]")
- Measure impacts through OAF lime sales
  - Messages increased lime purchases by 4pp - 6pp (***)

SMS to Sugarcane Farmers (Casaburi et al. 2015)

- Two trials of text messages to sugar cane farmers with info and reminders.
- One trial found increase yields: 8% ITT, 12% ToT, but no significant gains in the other one.
- Evidence suggests value of productivity gains exceeds cost
- Positive externalities to other farmers

(3) Do Farmers Provide Accurate Own Information?

- For system to work farmers need to provide accurate information that could be used to improve services for others.
- Hotline to sugar cane company and query calls reduce late fertilizer delivery by 23% and non-delivery by 54% (Casaburi et al. 2015)
  - Provides proof of concept on using mobile phones to improve supply chains.
- Ongoing experimentation and future work in this area:
  - Allow farmers to ask questions to diagnose problems
  - Nutrient deficiencies by color of leaves, pests, etc.

(4) Do the social benefits of the system exceed its costs?

- Samuelson (1954) rule for public good provision: does sum of individual valuations exceed cost?
- Approaches to estimating aggregate social value of info

  (I) Estimates based on estimated impact of providing impact on yields and other outcomes

  (II) Estimates of behavior change combined with agronomic estimates of the effects of that change

Phone-based Extension in India (Cole and Fernando 2017)

- Evaluation with 1,200 farmers, offering toll-free access to service farmer hotline: Avaaj Otalo (AO)
  - Ask questions and receive responses from agricultural scientists, local extension workers and other farmers.
  - High take-up: 88% call into AO line
- Impact on farmer behavior
  - Increase in purchases of high quality seed, fertilizer quantity and pesticide for cotton
- Impact on yields
  - Increases in reported yields in cumin (26%) and cotton (8% for a subsample that received reminders)
  - Calculate 2-year social return at $200

Evidence on Pricing

- Willingness to pay (WTP) for cellphone extension services in India less than costs
- Average WTP for neighboring soil test information in Kenya more than cost, but some chose placebo information over cash
- Can estimate DWL associated with monopoly pricing

Summary of Evidence

- Taking evidence together, seems like some farmers respond to info, value info in some settings.
- Any one setting could be a fluke.
- Proof of concept, but need to better understand who responds, how to target, behavioral techniques, social learning.

Precision Agriculture for Development (PAD)

- Non-profit organization to provide locally-specific agricultural information to farmers in developing countries via their mobile phones
- Focus on collaboration with other organizations with wide reach, collaboration on use of behavioral techniques to maximize appropriate adoption, social learning; A/B testing and refinement over time
- Help draw lessons for other organizations delivering agricultural information via mobile phones

Some Examples of Partnerships

- Ongoing communication with Busia County, KALRO
- Government of Odisha, India
  - Current research collaboration to evaluate pilot mobile-based service with 70,000 rice farmers that complements existing extension efforts
  - Potential for 2 million rice farmers within 2-3 years.
- Government of Punjab, Pakistan
  - Letter of commitment to pilot and evaluate a mobile phone-based service with 20,000 farmers
  - Potential to reach 5 million farmers through government services
- One Acre Fund, East Africa
  - Evaluate SMS system aimed at promoting lime adoption in Western Kenya and Rwanda
- Interested in feedback, collaboration

Thank you!