The idea: **Virtual learning for real farmers**

The MimeaMaster app will allow farmers to explore the impacts of inputs and management on crop yield using a virtual field that is carefully calibrated to their actual field, combining up-to-date soil prediction surfaces, crop modeling and context-appropriate, user-centered game design principles. Rather than simply giving farmers fertilizer and other management recommendations, the app allows farmers to experiment with the inputs and learn as they would on their own farm – without bearing the risk of purchasing inputs first! Using the app, farmers can learn about the complex returns to – and interactions between – different input combinations and soil characteristics on a virtual field that is calibrated to their own production conditions and context by way of the satellite data.

More specifically, we will leverage CGIAR-generated soil parameter predictions based on extensive and systematic field surveys combined with big data analytics and remote sensing data (e.g. Moderate Resolution Imaging Spectroradiometer (MODIS) platform for Africa, Landsat ETM+, or Sentinel 2), careful crop modeling using the DSSAT (Decision Support System for Agrotechnology Transfer) model and user-focused game design.

Our approach differs from other input recommendation services/apps by acknowledging that experimentation is a crucial feature of how farmers learn. In the same way that not all students learn best from lectures, not all farmers will accept soil health and fertilizer recommendations at face value. Our app demonstrates, using visual, engaging and interactive animations, the trade-offs and relationships between different inputs, soil parameters, and farm profits. Further, by leveraging the cutting-edge key soil characterization estimates based on ICRAF's Land Degradation Surveillance Framework (LDSF), we will be able to account for fine-scale variation in soil variability in a way that regional soil maps cannot—and do so at scale and at low cost taking advantage of the plethora of open access satellite data now readily available. Currently applied to maize, the app is easily scalable to other crops and agricultural management practices.

Our prototype app has been tested (and endorsed!) by smallholders in Kenya. Most pilot participants played substantially more "seasons" than was required, 95% of them reported enjoying the experience, and even more stated that they learned something from the game. But we worried that they might just have said this to be nice, so we also tested it empirically: farmers were allowed to allocate small sums of money to three different inputs (DAP, CAN, and lime – the latter of which none of them had ever used). After playing the game, farmers updated their allocations and were much more likely to demand unfamiliar inputs – especially lime. This effect was strongest among those who had high predicted returns to lime (farms with low pH)!

Given the importance of tailoring management practices to specific soil conditions, incorporating accurate soil maps into the app will improve the accuracy of the game outputs and provide farmers with realistic outputs – i.e., outputs that mimic what they can realistically expect to achieve on their farm! In the prototype app, all simulations were based on actual plot testing, which has serious limitations for scaling. By using ICRAF's LDSF framework, we will be able to maintain accuracy while facilitating scale.

We have identified our current weaknesses and have outlined a pathway to scale – we are confident that we can create a scalable, relevant product that can revolutionize agricultural extension and place soil health information in the hands of countless smallholder farmers.

Next steps

While our prototype has the basics down, we aim to substantially improve the product by joining forces with the CGIAR and incorporate big data analytics to improve the prediction accuracy of the outputs! The key development issues that we want to address in the first phase of the Inspire Challenge:

* Join forces with teams at ICRAF (including Karl Hughes, Leigh Ann Winowiecki, Tor-G. Vagen, and Patricia Masikati) to bolster the crucial behind-the-scenes foundations of MimeaMaster. Specifically:
  - Improve the modelling of maize yield returns based on soil properties from ICRAF's GeoScience Lab spatially explicit maps of soil parameters. These data will be incorporated in crop models for individual farmers' fields across landscapes. Incorporating the new data will require simulating yields for a large number of input combinations, rainfall scenarios, and spatial locations.
  - Expand the available inputs to include more of a Systems Approach, including farmyard manure and compost, and possibly agroforesty systems commonly practiced in the region.
  - Program the app to pull yield simulations based on GPS location, with a key-in location option for non-GPS enabled devices.
  - Begin laying the groundwork for incorporating other crops: identifying crop models and running initial simulations with relevant inputs. *Estimated cost: $57,500*

* Conduct additional farmer focus groups with the app, iterating the design to ensure that it remains accessible for farmers of a variety of backgrounds. Our team has engaged a reliable programmer who would be ready to jump in as soon as funding becomes available. *Estimated cost: $15,000 for 3 sets of focus groups @ $5,000 each + $15,000 for programmer time = $30,000*

* Conduct focus groups with agricultural extension workers, as another source of likely users and disseminators of the app. *Estimated cost: $5,000*

* Travel for US-based team to Nairobi (2 trips each for two team members, Emilia Tjernstrom and Travis Lybbert). *Estimated cost: $7,500*

This phase of refinement and further development will yield a deliverable consisting of a ready-to-deploy app, with a user manual and well-documented code to be made available on GitHub. The team will additionally produce a concept note and a short video detailing the app's uses and functionality, as well as grant proposal applications to fund a randomized control trial of the products effectiveness.

After this initial 12-month period, the team plans a randomized trial of different information delivery modalities: traditional extension with government-issued input recommendations, soil-adaptive input recommendations based on plot soil health, and app-based experimentation using MimeaMaster. In parallel with efforts to produce rigorous evidence of impact, we will begin investing heavily in alternative crops and form partnerships with potential partners. **Within another two years,** MimeaMaster **will be ready to deliver big data to smallholder farmers – helping them improve their farm management, yields and incomes!**