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Participatory Assessment and Adaptation for Resilience to Climate Change

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Abstract

Traditional monitoring and evaluation tools are often costly and are not well placed to assess complex, multi-dimensional dynamic livelihood attributes, such as resilience. While these approaches may be accurate in measurement, they often fail to empower respondents to take action. Drawbacks of other participatory resilience approaches include a requirement for a large amount of information, significant time required to administer surveys, and data analysis burdens (Schipper and Langston 2015, 19; COP 2016). They also need a baseline and an end line to assess change. They typically fail to capture how farmers actively address specific shocks and stresses or what lessons can be learned. Given these limitations, an opportunity exists to review alternative approaches and develop different tools.

Our approach and tool, farmbetter, attempts to build on lessons learned from developing and implementing these tools. Rather than characterizing the user as lacking agency in a challenging environment, farmbetter helps users make conscious decisions to adapt and withstand specific shocks and stresses such as floods, drought, or conflict, which can require contradictory coping strategies. We aim to then further connect farmers whose properties have similar agro-ecological conditions and challenges to better facilitate knowledge-sharing between food producers, ultimately improving learning and resilience. This allows for the connection of big data with (traditional) knowledge and competences already being used by farmers to improve resilience. This is enabled by advances in technology (e.g. mobile phone availability), which offer new opportunities to more easily and cheaply collect data as well as giving access to marginalized groups' views and knowledge (e.g. Raghavan et al. 2016).

Keywords: Adaptation, Resilience, Climate Change, Agriculture, Participatory, Assessment

Introduction

Climate change and its effects on agriculture present a major global challenge to sustainable livelihoods. Agricultural adaptation and resilience to climate change are still poorly understood in the context of economic development, in part due to their complexity and paucity of data. With the new goals of Agenda 2030 (United Nations 2015), resilience and adaptation to shocks and stresses have gained importance. However, measuring and providing meaningful, action-oriented, and empowering recommendations remains difficult (Choptiany et al. 2017). This difficulty is due in part to recommendations requiring significant amounts of context-specific data, that advice be practical and actionable for people to become more resilient, and the diverse and multidimensional aspects that make up resilience (Altieri et al. 2015; Darnhofer et al. 2016).

Many of the current approaches are frameworks rather than tools that can be used to measure resilience, lacking the qualitative (self-assessment) and quantitative (academic) parts needed to assess the complex attributes of sustainability (Choptiany et al. 2015). A few tools, such as SHARP (FAO 2018b), are participatory, including both insider (self-assessment) and outsider (academic) assessments. Others, like RIMA (FAO 2018a), have a strong econometric basis, whereas others like UNDP's Community Based Resilience Analysis (CoBRA) provide an approach which works with communities to discuss resilience (UNDP 2018). All of these tools, however, fail to provide farmers with a set of actionable recommendations, lacking a significant step towards improving resilience at the farm-level. The 'one-off' snapshot produced by existing tools gives a picture of resilience but requires outsiders (often a development project or organization) to support changes following from the assessment. Additionally, efforts to measure resilience are often based on the need to monitor or evaluate development projects, rather than on empowering local communities to adapt or mitigate climate change themselves. They are thus top down and focus on the needs of development projects and practitioners.

Given the challenges climate change will be increasingly posing, traditional development projects will not be adequate due to their limited funding and capacity. Approaches focusing on sustainably empowering local populations directly have a higher potential for success. To be successful, such approaches should harness the knowledge of local actors, be sensitive to political, economic, and environmental factors, and build upon advances in research.

Based on these considerations we are proposing a novel approach described in the remainder of this article. The structure of our article is as follows: we first outline the objective, followed by a description of the methods and an illustrative case study of a section of the tool. We subsequently review the challenges and our proposed way forward before concluding.

Objective

Our objective is to empower farmers and pastoralists in developing and emerging countries to measure and improve their resilience. We believe that technological and economic developments are increasingly aligning for such an approach to become viable outside of developed countries. Our technology-based approach features knowledge- or labor-intensive solutions that are expected to not only improve resilience in the long-run, but also do not require financial investments due to their nature as a public good (and not patentable) (e.g. Vanloqueren and Barret 2009).

With the rise of increased computing power (both localized and server-based), higher mobile (smartphone) penetration rates even in rural areas in sub-Saharan Africa (GSMA 2018; World Bank 2016; QELP 2018; Deloitte 2016), and improved literacy rates (UNESCO 2017), a market is emerging for mobile app-based technologies operating on Android and iOS systems in developing countries. The increased availability of spatial data globally (e.g. open-source remote sensing data for assessing Normalized Difference Vegetation Index [NDVI]) and locally (e.g. sensor data from farm equipment or small weather stations used in precision agriculture (Walter et al. 2017)) is supporting the long-term viability of data-intensive approaches for farm-level assessments in developing countries.

We argue that this increasing access to data, if paired with additional relevant information through surveys (similar to the approach of the SHARP tool) (Choptiany et al. 2017), could serve to better measure resilience at the farm level in sub-Saharan Africa on a large scale. This approach becomes feasible as, in parallel to better assessment approaches and data sources, a growing evidence base of effective solutions to improve farming practices is being documented and becoming available online (Aker 2011).

While existing tools use individual segments of these approaches, the time is ripe to integrate them for a comprehensive and holistic farm-level assessment which provides recommendations for improvement of resilience using locally and globally sourced solutions presented in a farmer-centric approach.

Methods and Material

Below we describe five key parts of our novel approach, outline how we plan to marry machine-learning approaches with rapid prototyping, and highlight the schematics of our farmer-centric approach. We conclude the section with an illustration of a hypothetical case of a smallholder farmer in Kenya.

Novel methods

Based on these observations, we have developed a prototype of an action-oriented tool which measures resilience in a participatory manner, providing five crucial improvements:

First, it is a user-friendly mobile tool, available offline and accessible to anyone with a smartphone.

Second, the tool breaks from past conventions of a dependency on development actors by using a farmer-centric approach where the farmer is the primary user and entry point for the tool and to implement solutions (see Section 3.3 below). While development actors may find value in farmbetter to better understand and support farmers, the tool has been explicitly designed to be implemented and used directly by farmers. This empowers them to work without external support to improve their resilience.

Third, the tool disaggregates a person's livelihood into distinct resilience attributes to assess what specific shocks and stresses have impacted them in the past. This provides a better understanding of how the person has adapted in the past through a self-assessment of their effectiveness.

Fourth, farmbetter harnesses external data sources as foundational layers to build a unique profile of each farmer (e.g. agroecosystem zone, precipitation, soil type, land-use maps, climate projections, demographic data) and combines this with public, scientifically-verified databases of proven approaches to improve resilience (e.g. at the level of sustainable land management (WOCAT 2018); at the level of sustainable crop production (CABI 2018)). We hope to combine farmers' knowledge with a database of existing adaptation and coping mechanisms that have been shown to be effective at improving resilience or adaptation. Connecting this external data with the participatory resilience survey subsequently provides us with a set of individualized recommendations.

Fifth, the tool will ultimately provide actionable advice and access to information on how to adopt these practices. This includes the ability for users to interact and learn from each other (e.g. by identifying and visiting (virtually or physically) nearby farmers using the tool to witness a specific technology adopted), closing the farmer-to-farmer feedback loop. This will be done in a user-friendly way (i.e. using paired down text and visual descriptions where possible), recognizing the differing capacity levels of farmers in developing countries. Farmers are also able to rate solutions to improve our filtering system for recommending solutions.

From machine-learning to rapid prototyping

We aim to deploy a machine-learning tool (e.g. the open-source TensorFlow), including a recommender system, to ensure that recommendations for farmers are tailored specifically to their context and preferences and consistently improving based on user feedback (e.g. via adoption rates, solutions shared and user ratings of solutions of past and current approaches) . By drawing on externally verified technologies documented based on farmers' implementations, our machine-learning approach will be strengthened through the continuous evidence-based feedback from the farmers themselves (including the option for them to report and share their own solutions from past interventions).

Based on experience from developing and implementing SHARP and reviewing existing resilience measurement, monitoring, and evaluation tools, we have identified the above gaps and opportunities. To fill these gaps, we used the Google Venture Design Sprint Method to build an initial prototype between July 23rd and July

27th, 2018. It included interviews with seven thought leaders across various domains (development practitioners, entrepreneurs, survey implementors etc.) acting as outside experts and advisors during the week. We also began (re)engaging with practitioners who work in resilience building, M&E, and program management to understand their successes and challenges, which helped tailor our approach.

This method offers a stark contrast from the traditional development model of project cycles, which require a lengthy period of project development and annual or bi-annual cycles for monitoring and evaluating. By drawing on inspirations from lean start-ups, (Ries 2011; HBR 2013) design-thinking (Brown 2009), and human-centered design approaches (Brown 2009), we aim to work fast and directly with potential customers – commercial smallholders in loose and tight value chains (USAID et al. 2016) – to rapidly prototype the tool through several iterations in a build-measure-learn loop (Ries 2011).

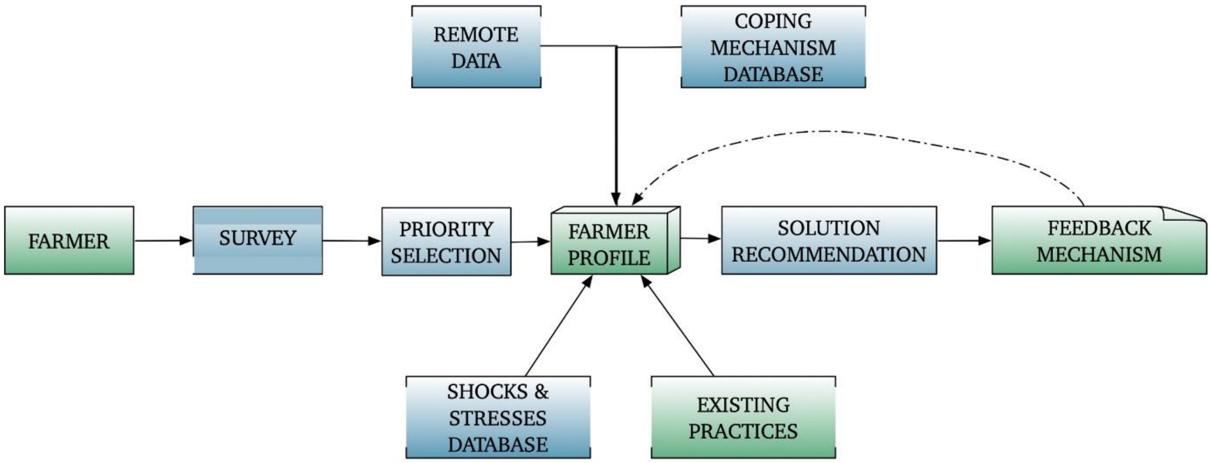
Farmer-centric approach

Inspired by Doing Development Differently (2014), we aim to work with local stakeholders to develop country-specific versions of a localized mobile app. This will train the learning mechanism in local contexts (on the high-tech side) and draw on local user-interface designers to illustrate and test the application (on the low-tech side). The trade-off of our chosen approach will be delayed indicators of the results from adoption of technologies in favor of ensuring the potential of the tool's usability, uptake, and scalability. By starting out with an approach that has farmers as clients, we aim to provide a turnkey solution that has a reduced dependency on donor funding or development partner support (see also later section).

The farmer-centric approach is furthermore emphasized by allowing the user to set their own priorities based on which resilience gaps they would like to address on their farm and what adaptations they would like to have strengthened.

The farmer profile represents the input side of the system. It is compiled based on the farmbetter survey alongside outside data sources. The solutions section is the output of the tool, with our custom recommender system matching the farmer profile alongside priorities to provide tailored resilience-building solutions. The steps and components of the tool are outlined in Figure 1 below.

Figure 1: Flowchart depicting farmer-centric tool



Source: Author's own

Illustration of Farmer-Centric Tool

Here we use the example of a fictional farmer, Anah, based in Muranga, Kenya to illustrate how segments of the farmer-centric tool might work. What follows are four key steps visualized.

The first visualization of the application (Figure 2) displays resilience building priorities. As farmbetter captures substantial amounts of data, only some of the key attributes are summarized here:

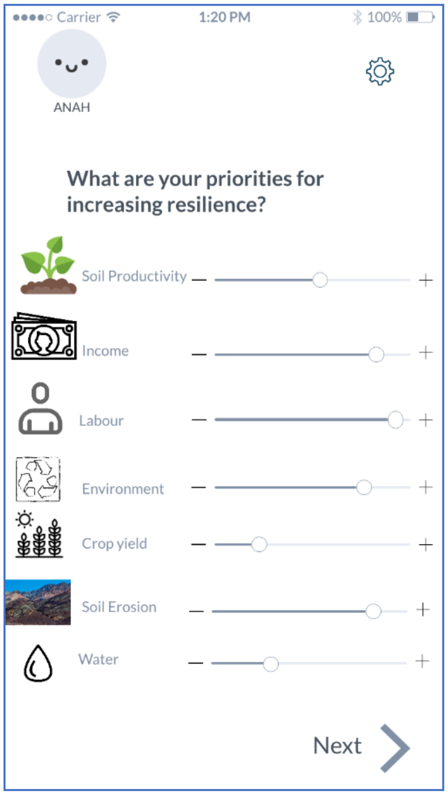
- Location: Muranga, in the highland area of Kenya
- Soil type: black cotton clay soils (suitable for maize)
- Crop production types: maize
- Slope: 8-16 degrees
- Temperature annual mean: 19.3oC
- Agroecological zone: tropics, cool
- Altitude: 1,550 m
- Annual precipitation: 1,027 mm

Shocks and stresses

- Flooding: fields flood once every two years
- Fire: never experienced a fire

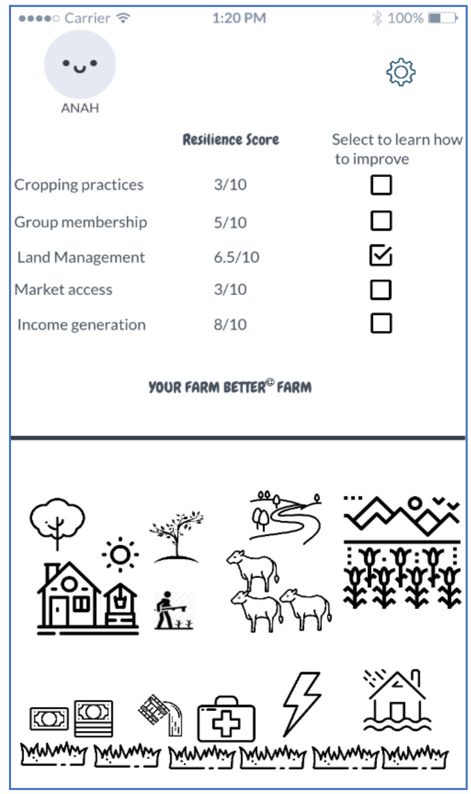
- Drought: has not severely impacted the area

Figure 2: Mockup of sample resilience improvement priorities selected by the farmer Anah



Source: Author's own

Figure 3: Mockup of resilience score from farmbetter above a graphical representation of her farm, illustrating some attributes as well as shocks and stresses experienced.



Source: Author's own

The results of the farmbetter resilience assessment tool are shown in Figure 3. This represents the farmer profile, which is then matched to potential resilience building solutions.

In this example, we have used the WOCAT Sustainable Land Management practices database to identify three potential solutions to present to Anah. Solutions (practices) have been labeled as decreasing, having no effect upon, or increasing (e.g. –, 0, +) the following seven attributes: labor requirements, crop yields, soil erosion, crop or animal water use, biodiversity, flood risk, and fire risk. Three of the sample technologies identified are:

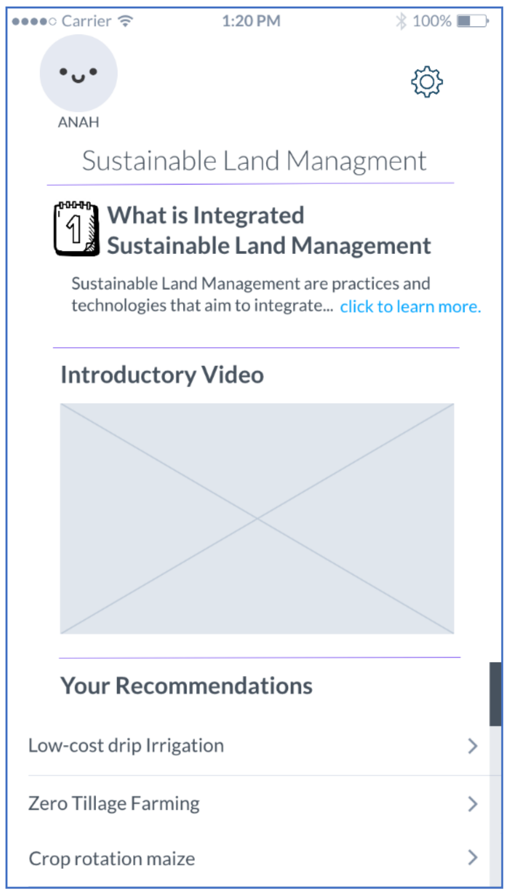
1. Low-cost drip Irrigation (an example from Nepal), which has the attributes of labor (-), yields (+), erosion (-), water use (-), biodiversity (0), flood risk (0), and fire risk (0);

2. Zero tillage farming, which has the attributes of labor (-), yields (+), erosion (-), water use (-), biodiversity (+), flood risk (0), fire risk (0); and

3. Crop rotation maize with legumes which has the following attributes of labor (0), yields (+), erosion (-), water use (0), biodiversity (+), flood risk (0) and fire risk (0).

Finally, Figure 4 outlines the solutions page of the tool. This provides a broad overview of Sustainable Land Management, followed by potential solutions. These solutions can be selected for more general information as well as step-by-step guides on implementation.

Figure 4: Mockup of sample recommendations for Anah based on her unique farmer profile, preferences and potential resilience improvement solutions.



Source: Author's own

Challenges

We have identified the following five key challenges. They range from difficulties of programming to implementation, adoption, and financial viability.

Regarding computer programming, the first significant obstacle is the development of a recommendation system which integrates machine learning. While there will be a human curation aspect of the system, filtering through many diverse and non-uniform datasets will be computationally intensive and calculations will need to be completed on a server in the cloud rather than directly on a device. The filtered data includes publicly available datasets serving as knowledge banks (e.g. sustainable land management datasets) and data gathered from farmers' input, such as their geolocation (e.g. matching with global agroecological zones), their agroecosystem, their soil use, and their land use. Tagging and sorting the recommendations database to allow matching filters to search for the solutions with these key agroecological variables represents the most significant challenge which will require extensive labor.

A second key challenge entails recording existing innovations at the farm-level that have taken place outside the purview of development practitioners. Beyond the participatory self-assessment of the current resilience state of a farm, it will be essential (yet challenging) to capture any successful adaptations that have already taken place, to build and complement existing databases. From a farmer's point of view, it is unfortunate that current resources – reflecting the existing reporting bias in development practice - only contain successful implementations, with failures, lessons learned, or adaptations (which would provide a pertinent field of learning) usually missing.

Regarding adoption, a third challenge is to ensure that the tool will build successfully upon the development field's improved understanding of successful adoption pathways. For example, while radio has been proven to serve as a successful pathway for advertising (ultimately creating interest or awareness for a tool or agricultural method), translating it into a decision and an action is much more challenging. Based on the literature, the approach needs to involve the ability for farmer-to-farmer learning, including visits to demonstration, trial, or implementation sites (see, for example, findings from the adoption of a knowledge-intensive technology in Kenya; Murage et al. 2011, 2012; Amudavi et al. 2009). Thus, we aim to avoid the technocentric pitfalls of a singular focus on the tool and its sole ability to positively transform livelihoods by embedding the deployment of the tool in group settings (e.g. among farmer cooperatives) and facilitating the ability to connect with other farmers (both virtually and physically). This enables them to share experiences, ask questions, and learn from each other. Providing feedback through the adaptation (or possible dis-adoption) of a technology option is key to reflecting the changing agroecological environment under pressure from climate shocks and stresses.

We are also breaking the pattern of donor dependency by creating a system in which farmers themselves are empowered to select and adapt recommendations out of a large pool of options.

A fourth key challenge with this approach is to make the tool financially viable and ultimately scalable, as the reduced dependency of donor flows also reduces the risk of becoming captive to ebbs and flows in donor financing. The conscious decision not to use the tool to promote sales (unlike e.g. MFarm), but rather to focus on the diffusion of public knowledge, poses an additional challenge to create a viable business model. This obstacle will be explored during the piloting phase of the tool to see under which conditions there is sufficient demand and a willingness to pay from farmers, which would make the app financially viable.

There is increasing awareness by development practitioners that "development is a fundamentally political process" (Thinking and Working Politically Community of Practice, 2018). Drawing on insights from the community of practice around thinking and working politically (TWP) will be a fifth key challenge for any application aiming to break through numerous political and economic layers to reach farmers effectively. The Agricultural Technology sector especially has historically operated with the premise that the landscape is an apolitical space. In this context, we draw upon our own additional expertise in advocacy work (both at the level of the UN and the scaling out of ecological agricultural practices) to ensure that our farmer-centric intervention is embedded not only within the immediate value chain of farmers, but also their political economy. This involves building upon rather than ignoring existing farmer networks (at local levels) or institutional support by governments (e.g. through extension officers), as well as engaging both local and national stakeholders in an eventual nation-wide launch of the tool with similar feedback mechanisms.

Areas of Future Work

Based on the methods and challenges outlined above, we have identified the following three areas of future work.

First, the task of creating an all-in-one tool to assess and improve the resilience of farms is substantial and challenging. For our future work, we have decided to postpone designing and programming the final application. Rather, we plan on building a "Minimum Viable Product" (MVP) as a first step, to validate whether a business potential exists. This will mean not developing all potential features at the beginning, but only building a basic version of the tool. In an early test with farmers – possibly in different countries – we are hoping to gain information on the market demand and the usefulness of such a tool to clients. Based on this we plan to either further develop the MVP into a full-fledged application, pivot to a new approach, or halt work altogether. These learnings from building a community-based prototype are expected to also be of relevance to actors beyond the farming resilience sector.

Second, we aim to document for the larger development community the data and information that this process and eventually the tool could provide for the mitigation of and adaptation to climate change. This will necessitate, in the mid-term, a research project to ensure that the data gathered can be used to this end. This includes partnering with national governmental actors to review research findings and position the tool in country-led strategies for resilience.

Third, we hope to establish a farmer-practitioner-academic network for collaboration to produce this scalable tool that is not dependent on volatilities in donor funding. Shocks and stresses, exacerbated by climate change, are also not static and therefore the responses recommended to build resilience to them will need to improve and adapt. This network, alongside machine learning from farmer feedback, will be used to continually improve a growing database of solutions and recommendations. Feedback from this network can continuously be used to engage policymakers and influential actors, such as the Global Resilience Partnership, on impacts and challenges in building resilience.

Conclusions

Climate change is one of the major challenges of our time, especially for farmers in developing and emerging countries who lack sufficient support systems. The trends towards increasing populations will only further exacerbate the pressure of climate change on agriculture.

While resilience is still an emerging concept and as such not clearly defined, development and research work on resilience has been growing. Approaches to measure resilience in agriculture have been developed and are in use. The main disadvantages of existing approaches are that they are often focused on the needs of development actors and stop at measuring resilience. What is needed, given the scale of the challenge, however, is to empower farmers themselves to improve their resilience to climate change.

With our tool, farmbetter, we ultimately hope to better equip farmers for an uncertain future by bringing together the best of (traditional) knowledge and technology, thus offering a unique approach that leverages local knowledge with academic research in a simple IT package to assess and improve their resilience to specific shocks and stresses.

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