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User Manual

Motivating the Bayes Model and Web Tool

A majority of rural smallholder farmers in the Volta and Limpopo Basins still live in poverty. Low and highly variable rainfall combined with inadequate policy and investment context and inappropriate technology transfers limit sustainable transitions out of poverty. Researchers, practitioners and farmers have identified approaches to manage rainfall for agriculture in efficient and productive ways from field to basin scales. Yet successful targeting and scaling out of appropriate interventions remains a challenge.

The targeting problem

- We want to out-scale agricultural water management (AWM) technologies
- We want to pick sites where the chances of success are relatively good
- A good way to decide is through rapid assessment in the field at prospective sites
- But where to do the rapid assessments?

The Bayes Model and online tool were designed to produce a framework and web-based "decision support" for targeting and scaling out of Agricultural Water Management (AWM) technological interventions. This decision-support tool maps the likelihood that the introduction of AWM interventions for smallholder farming systems are likely to be successful at the basin, country and sub-national scales. Additionally, the developers wanted this tool to build on accumulated experience and knowledge and improve on prior models of targeting and scaling-out.

This tool improves on existing models in two ways: first, by using a Bayes network modelling approach, the tool helps users account for uncertainties in joining data and information layers. It also enables inclusion of various sources of expertise in a spatial manner. Secondly, the tool includes dimensions of social and human capital known to be important for adoption and uptake of improved agricultural water management strategies among smallholder farmers, thus providing more realistic decision support. These innovative features and on-going consultation with end-users will help ensure that this project contributes to the CPWF BDC challenges and delivers frontline research and capacity building.

What can the tool do?

The decision about 'where' to undertake a rapid assessment is ideally informed by a certain amount of prior knowledge about the on-the-ground context in which a future intervention is proposed. Similarly, there exists prior knowledge about certain factors that contribute to the success or failure of AWM technologies e.g. biophysical, social and institutional, technological and implementation-specific factors. The factors usually cannot be observed directly, but there is indirect evidence that that they are present or absent. By incorporating existing and available data with Basin-scale coverage, the tool extrapolates where specific AWM technologies could be adopted with success based on Bayesian Belief Network modelling. The tool is designed to convey where conditions are promising enough that it is worth investing in a rapid field assessment; 'promising enough conditions' means that key 'factors of success' for a given technology are present.

The project seeks to answer the question of what works where and why, leading to greater impact from localised AWM success stories within the Limpopo and Volta basins. The question 'whether an intervention successfully applied in one location has a reasonable chance of success at any other location?' remains extremely difficult to answer. Numerous pilot studies and case studies have shown that detailed characteristics of the study location – economic, biophysical, institutional, and cultural – can all play an essential role in the eventual success or failure of achieving a successful outcome. However, for out-scaling of initiatives it is impractical to collect detailed information at every potential site where an agricultural land and water management (AWM) intervention might be introduced. This tool is based on the premise that, while certainty is unobtainable, degrees of certainty are both obtainable, using available information in a systematic way, and useful.

Who is the tool for?

The tool is intended for non-expert users who want to know which parts of a region have background conditions that will facilitate success of a planned AWM intervention.

What is informing the web-tool?

Each country's map tool is displaying the results of a Bayesian Model. The model, in turn, is driven by a group of **Factors** of Success, and numerous **Indicators** that convey the presence of those Factors.
A **Factor** is "a circumstance, fact, or influence that contributes to a result" in this case the result is the successful implementation of an AWM technology. Thus, we refer to them as Factors of Success.

An **Indicator** indicates the state or level of a factor, and in this case they act as proxy variables to convey the presence of given factor of success. Indicators have a number, or quantity that increases or decreases over time the data supporting each Indicator has been documented to provide a sense of the representativeness of the maps displayed.

Factors affecting success are both those related to the "**Context**" (outside of the implementer's control) and those related to "**Best Practice**" (inside the implementor's control).

A **Context Factor** is a characteristic of a project site that was present before the project started and is outside the control of the project (e.g. biophysical characteristics - rainfall, institutional characteristics - government policies, socio-economic characteristics - income, skills, health). The model further groups **Context Factors** into five categories of 'assets' of 'capitals' using the Sustainable Livelihoods Framework (DFID, 1999; Scoones, 1998). **Social capital** is the set of networks and relationships that support coordinated strategies for achieving livelihood goals. **Human capital** is individual skills and knowledge, as well as health and physical ability, that can be mobilized in livelihood strategies. **Physical capital** is the infrastructure, equipment, and other long-lived physical goods that people, households, and communities can bring into use. **Financial capital** is the pool of economic assets, including savings, cash or other liquid assets, and credit. Finally, **natural capital** is the natural resource stocks and services that can be used to support livelihood outcomes, including soil, water, genetic variability, and pollution sinks." (Kemp-Benedict et al. 2010).

Best Practice Factors also affect the likelihood that a technology will be successful, but are related to decisions made by the implementer through the design of the project and process of implementation (e.g. level of engagement with the community, prior relationship with the community leaders). These decisions can also affect the Context Factors e.g. capacity building can improve socio-economic and institutional factors; the strategy of implementation, targeting and participation of beneficiaries can affect *who* benefits, and therefore have mixed effects on the context. Best Practice characteristics can affect the context during and after the running time of the project; indeed, often the aim of the project is to positively affect the background context. How well the project is designed, planned and implemented dictates how much the background context is affected, and whether the effect is positive or negative.

Which AWM technologies does the tool cover?

The wide variety of AWM technologies discussed throughout the project. An initial listing of successfully and relevant technologies was developed in 2011 with Basin partners and experts. The second round of Learning Events enabled small working groups to offer input on what factors matter for certain technologies to be successful in Fall of 2012. The resulting model and tool integrates this expert input with available data, and the technologies have been subsequently grouped under three main categories. These categories are meant to cover the spectrum from rainfed to irrigated; as well as from community-level technology (storage), to more individual farm-level technologies (soil-water conservation and certain irrigation technologies):

1. Soil and Water Conservation technologies (Rainfed)
2. Small-scale irrigation technologies (individual irrigation)
3. Storage technologies (community irrigation from stored water)

While the technology choices for the user in the web-tool are specific, many of the contextual factors that lead to success e.g. biophysical features of a given area, are important for certain types or groupings of technology. As such we define the technologies and how applicable the model result would be for similar technologies in the following table:

Basin Web-Tool Technology Choice	**Definition and Applicability to Similar Technologies**
VOLTA BASIN	
Soil and Water Conservation	Represents in-situ soil and water management practices, including mulching, bunding, planting pits, windbreak hedging etc.; applicable to Conservation Agriculture
Irrigation	Represents small-scale irrigation technologies, including the use of shallow and deep wells and small pumps
Small reservoirs	Represents water storage technologies from which farmers may choose to irrigate (including market gardening)
LIMPOPO BASIN	
Conservation Agriculture	Represents in-situ soil and water management practices, including mulching, bunding, planting pits, minimum-tillage etc.; applicable to Soil and Water Conservation technologies
Irrigation	Represents small-scale irrigation technologies, including drip irrigation
Small reservoirs	Represents water storage technologies from which farmers may choose to irrigate

Getting started with the Tool

How do you use the tool?

The tool is first organized by river basin and then by countries within the Basin. The main tool page display results at the Basin Scale. For those interested in results at the country and sub-national levels, navigate to the country-specific models. Links for which, are available through the Basin page. Independent of the results-scale of interest, the user should select the AWM technology that he or she is most interested in seeing its success displayed. There are two other decisions the user needs to make before clicking 'Run': the **resolution** of the map display, and whether you want the map to convey the **strength of evidence**:

- **Resolution**: Given the various bandwidth capacities of our end-users, we have made the tool available in low, medium, and high resolution. The higher resolution has the finest map detail and the low, the inverse. Note that the results themselves do not change, depending on the resolution, only the level of detail in the district outline.
- **Strength of Evidence**: This reflects an assessment of the quality of the data underlying the model's result. For example, if the data is recent, consistently representative across the country, and is available at district level, for all factors in the model, the evidence base for the result is *strong*. If data is old, or not available at the geographic coverage or scale of analysis the model is at (district-level), the evidence base for the result is *weak*.

Steps:

1. **Choose the basin, then**
    a. Choose the technology
    b. Choose the display resolution
    c. Choose whether you are interested in seeing the Strength of Evidence
2. **Choose the basin, then**
    a. Choose the country
    b. Choose the technology
    c. Choose the display resolution
    d. Choose whether you are interested in seeing the Strength of Evidence
    e. Click on a district to view more detailed information
3. **Explore the results** on the interactive map
4. *Add steps for more advanced features once they exist*

Results: Interpreting the Map Display

The map conveys the Likelihood of Success at the sub-national, district-level based on the Bayesian model's computations of the Context Factors which include district-specific characteristics, as well as characteristics of the technology. The end results (Low - Medium - High) indicates the likelihood that an AWM project implemented in that district will be successful. The result is formed by the interaction of varying levels of the important influencing factors (e.g. rainfall, land, labour, infrastructure or skills). For example, if all important factors are present at high levels, the likelihood of success will be High. If all important factors are low the likelihood of success will be low. If some are high and some are low, then the result depends on how relatively influential each factor is, and how they interact with each other; this is where the need for the model becomes apparent.

What does that *mean* ?

- If a districts is shaded GREEN, implementing a project there will be likely to succeed, and could potentially lead to outscaling.
- If a districts is shaded YELLOW, implementing a project there will be less likely to succeed than those that are GREEN but have a higher likelihood of success than those that are RED.
- If a districted is shaded RED, implementing a project there will be less likely to succeed; the various factors present a less conducive to a successful outcome.

How do I find out more?

- Click on individual districts to view a pop-up window with information about the context - choose which data you would like to view
- Try another technology to see if it is better-suited to a particular district
- There is more information about the project, the basins and the technologies on the About page [include link]
- For detailed explanation about the Bayes Model and web-tool development you can download the Technical Model Documentation

Model Considerations

There are some considerations and caveats for using the outputs of the tool:

- The needed data are incomplete and imperfect such that the tool's prediction will be associated with a level of uncertainty depending on input data quality
- No model can fully capture all the complexities of agricultural communities and their environments
- There will be continued learning and therefore a need to update the model

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