A methodology for measuring change in market systems

Uganda Market System Monitoring Activity

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1 INTRODUCTION

This document provides a brief overview of a methodology for measuring change in market systems. It describes a cycle of steps that enable the development, validation, use, and adaptation of a set of indicators for measuring system change. The following are included:

- methodology description;
- application of the methodology to the financial subsystem, including development of specific indicators; and
- application of the methodology to explore the regulatory subsystem's impact on other areas, including development of specific indicators.

Challenges Measuring change in complex systems is challenging for many reasons. Complexity of relationships among components and the scope and dimensions of changes to be measured is one reason. The measurement strategy must be both *comprehensive* enough to capture the scope and dimensions of changes and *simple* enough to be interpreted, analyzed, and used to learn from and adapt or design interventions. At the same time, the complexity of the system makes it difficult to measure the effects of specific interventions, and to define what needs to be measured, as this requires understanding of expected effects, along with ways to identify unexpected or underlying/systemic effects.

Goals To meet these challenges, this methodology aims to do the following:

- provide an overview of the system "status" at various scopes and levels of aggregation;
- be easily mapped to results chains and other existing representations;
- identify indicators that measure key and different parts of the system, yet can be aggregated at various levels; and

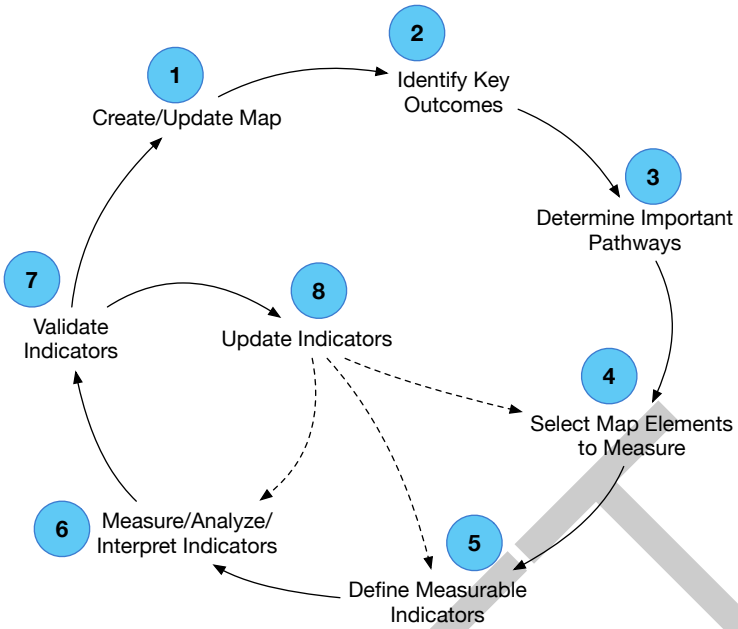


Figure 1: Summary of the measurement methodology.

- compile multiple sources of data to provide a comprehensive understanding of system status and identify data gaps.

A key distinguishing feature of this methodology is its basis in a detailed system map. We map the interacting ways in which a system may change to select indicators to measure changes in key behaviors,relationships, and conditions, to ensure indicators are comprehensive in spanning the relevant parts of the system while providing insight into key pathways of change within it.

Summary of methodology The methodology is summarized in Figure 1. It begins with the creation of a detailed system map, which shows how changes in behaviors, relationships, and conditions enable one another. Second, the desired outcomes are identified from among the elements on the map. Third, the important "pathways" which enable (or prevent) the desired outcomes are identified. Fourth, elements from the map – and particularly, from the important pathways – are selected to be measured as indicators of change in the system. Fifth, for each of these selected map elements, measurable indicators are defined. Sixth, the indicators are measured, analyzed, and interpreted, to enable understanding of how the system is changing. Seventh, the indicators are validated and may (eighth) be updated if necessary. The newly gathered data informs changes to the system map, and the process repeats.

This document summarizes each of the steps, then provides two examples of application of the methodology, both from the Feed the Future - Value Chain (FTF-VC) project in Uganda. One deals with outcomes in the financial "subsystem", and the other deals with the impact of change in the regulatory environment on inputs distribution.

Applicability The methodology described here is most valuable in the context of systems approaches to development. Specifically, it is valuable when interventions are in multiple and different parts of a system, and when desired changes must among and even require complex interactions in a system.

The methodology may be applied to a single activity or set of activities, such as a *project* (which consists of one or more interventions and one or more desired outcomes). The goal in this case is to understand progress toward desired outcomes, and the scope of interest is clearly defined. The methodology may also be applied to a *system*. In the latter case, the goal is to understand how the system as a whole changes. Many projects aiming to create systemic change will be interested in applying it both at the *project level* to measure desired changes and at the *system level* (perhaps less frequently) to understand how the system as a whole is changing, and perhaps to identify any unexpected benefits, barriers, or unintended consequences. Figure 2 illustrates the differences in these scopes.

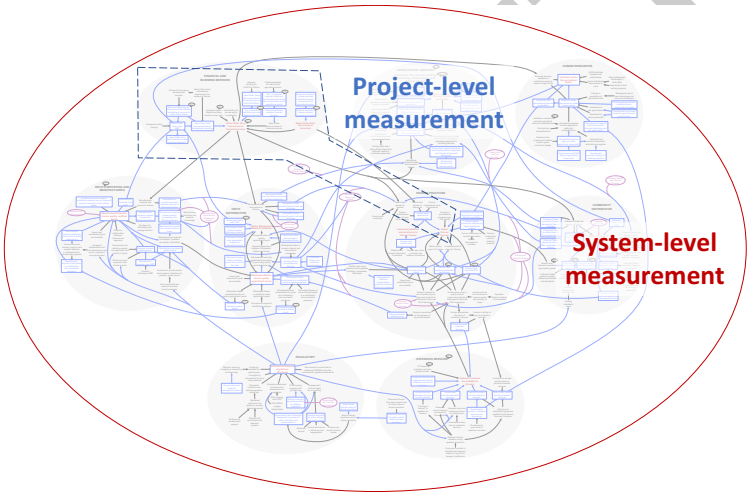


Figure 2: Project-level measurement examines progress toward the outcomes of a desired project, while system-level measurement aims to measure changes in the system as a whole. Many projects may utilize both levels at different frequencies.

2 METHODOLOGY

This section describes each of the steps in the methodology. (See Figure 1 for a summary of the steps.)

2.1 STEP 1: CREATE AND UPDATE MAP

What The first step in the methodology is to describe the system in a manner that captures the many possible "pathways" or sets of changes that are likely to enable (or prevent) change in the system.

The "Behaviors, Relationships, and Conditions" (BRC) mapping framework is a method for visualizing how a system is expected to change, including sets of changes that enable (or prevent) change. There are five main components in the framework: behaviors, relationships, conditions, interventions, and the enabling connections between them. Key outcomes may also be labeled on the maps, and are particularly relevant for this measurement methodology.

Figure 3 provides a generic example of a BRC map. The intervention at the bottom enables two conditions, which in turn enable two different behavior changes. One of these behavior changes, in combination with a relationship among the two actors, further enables the second behavior change, which enables the key outcome. This type of map is important because it captures complexity of the system, such as multiple possible paths to a key outcome, as depicted in this example.

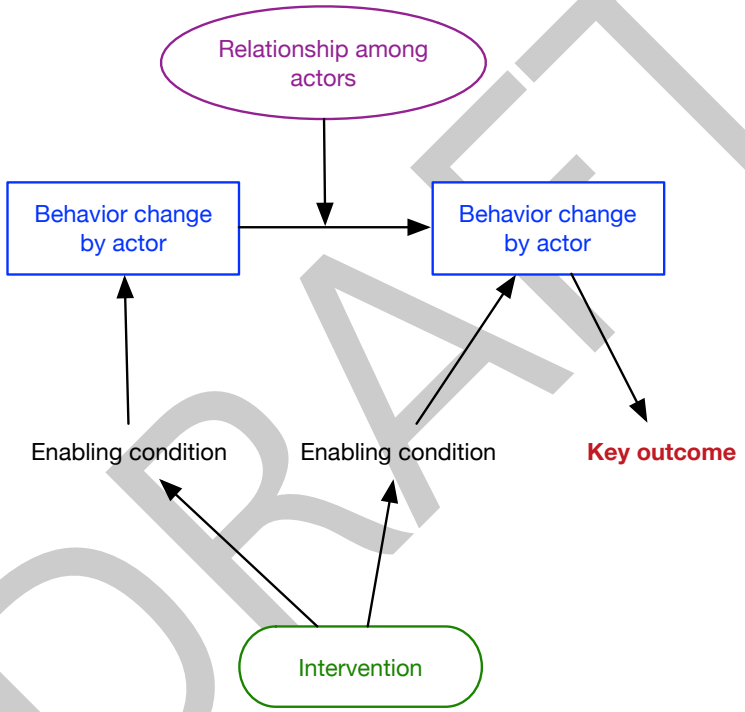


Figure 3: Generic example of a BRC map.

How Building a BRC map is a complex process. A complete description is out of scope for this document. For comprehensive background and instruction, please see previous MSM reports (MSM, 2016a, 2017).

We provide a brief summary here, for completeness. To build a BRC map, use knowledge of the target system and its interactions to brainstorm behaviors, relationships, and conditions that are important and easily identifiable. Think backwards about what existing and potential components enable the ones already identified; draw these new components and the enabling arrows. Continue this process of brainstorming, adding components, and connecting them with enabling arrows. Keep in mind the BRC map does not just represent the system in its current state, but also how it may change. What components might not currently exist, but could exist

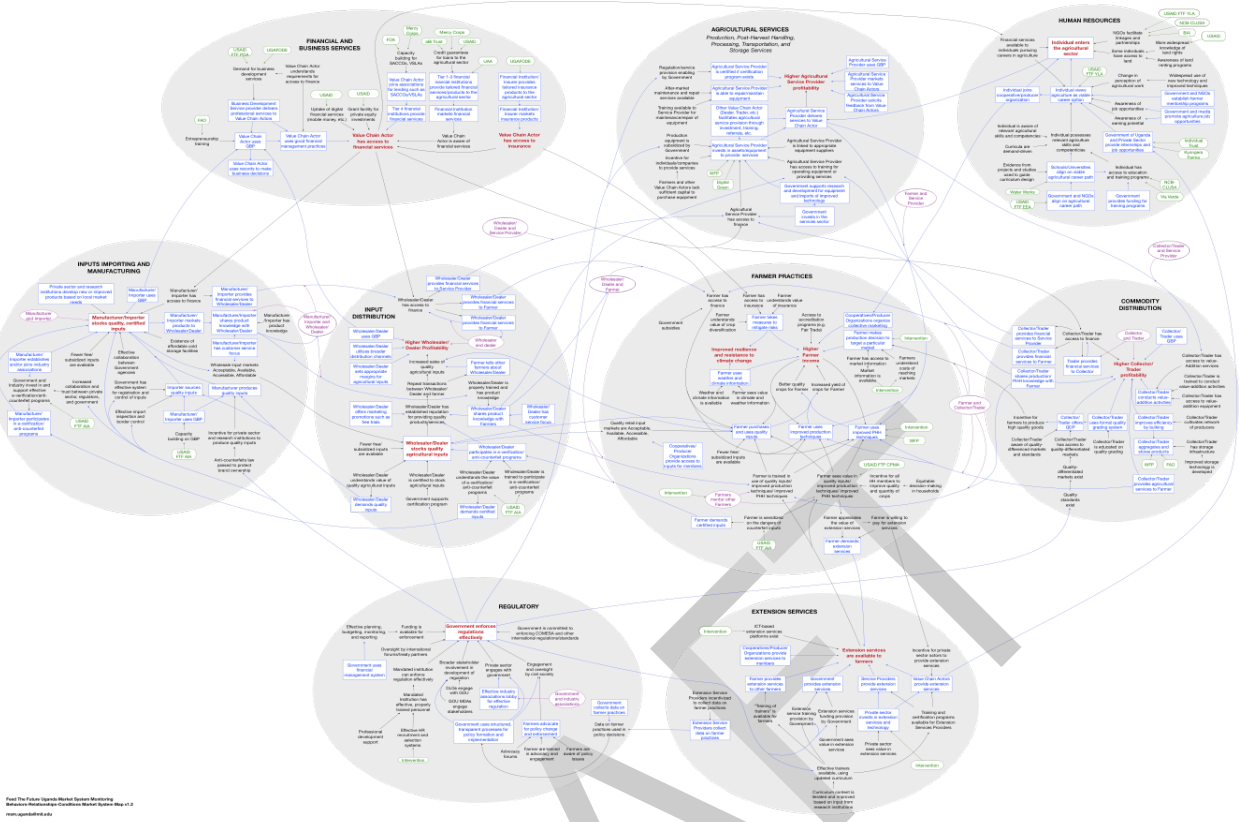


Figure 4: System Map.

in the future? It is important to look at each component added to the map and ask, "What enables this? What does this enable?" One should use his/her best judgment to determine when the map has reached an appropriate level of completeness to accurately characterize the system. One may choose to use gray ovals to group subsystems so the map is easier to interpret by stakeholders.

Inputs The initial map is only a first step, and it should be refined as much as possible to consider all appropriate existing knowledge of the system. The **key inputs** are the following:

- input from key stakeholders within the system or who understand the system well;
- existing data about different parts of the system; and
- literature and reports about other related projects.

The first version of the map should be a best-possible representation of current knowledge about the system. It can be refined later based on data and understanding developed in the process of measuring change in the system. The final step is to update and refine the map.

Figure 4 shows the entire system map for the Uganda project.

2.2 STEP 2: IDENTIFY KEY OUTCOMES

What The second step in the methodology is to identify key outcomes. A *key outcome* is a desired change toward which a project or collection of projects is working. If the methodology is applied to a development activity which has already been clearly defined and has clear goals, key outcomes may already be identified; we call these *project-level* outcomes. If, instead, the goal is to understand how an entire system changes as a result of a collection of activities, key outcomes may be widespread across the system. We call these *system-level* outcomes. It is possible to develop both project- and system-level outcomes for a single project, but we discuss them separately.

How and Inputs At the project level, we assume key outcomes have been identified during project design. These can be identified on the map (developed in Step 1) through consultation with stakeholders.

When the analysis is at the system level, identifying outcomes is more difficult. They should be identified based on the following:

- overall program goals (For example, a program may specify the key outcomes that are relevant.);
- stakeholder and expert input;
- resources invested by development actors, government, private sector, or others: consider potential outcomes of these resource investments (For example, if training is facilitated, consider outcomes of training.); and
- system components on "critical paths" in the map, in the sense they enable many other components or many other things enable them;
- comprehensiveness, or the set of system-level outcomes spans the parts of the system in which changes may be expected;
- considering "sentinel" outcomes that may act as quick checks to show whether changes are occurring in each interesting part of the system; and
- existing data, literature, and other secondary sources to identify key outcomes examined in the past, or those linked to the interventions or resource investment.

Outcomes are typically identified on the system map in bold red text. (An example is shown in Figure 3.)

For a more realistic and detailed example, please see Section 3.2 and Figure 12, below.

2.3 STEP 3: DETERMINE KEY PATHWAYS

What We use the map to identify key pathways to or from key outcomes or key enablers. A pathway is similar to a results chain in it encompasses a set of changes required to achieve

an outcome from intervention. We usually select a set of linear components based on the methodology outlined in greater detail below.

Figure 5 illustrates how pathways can be identified in a simple BRC map.

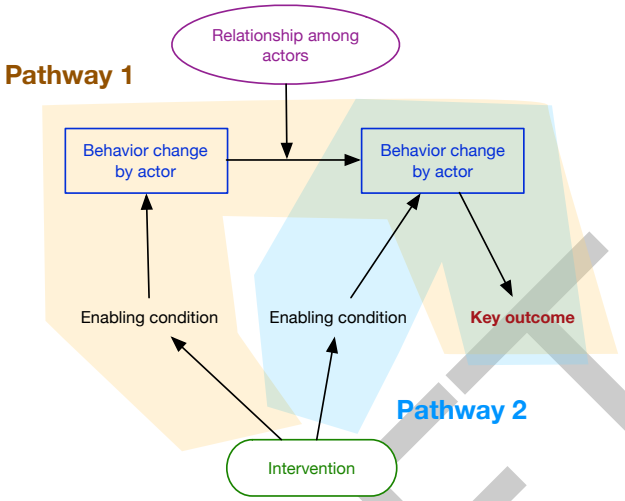


Figure 5: Two pathways identified in the generic BRC map: an orange pathway (1) and a blue pathway (2).

How Pathways should be identified starting from interventions and tracing to key outcomes. If clear interventions are not defined, pathways still follow from behavior, relationship, or conditions to key outcomes. In these cases, it may be helpful to identify the critical leverage points or key enablers that are likely to enable change in the key outcomes, and use these leverage points as the start of the pathways.

Pathways may take many forms. Figure 6 shows two common forms: a linear pathway and a cycle (discussed below).

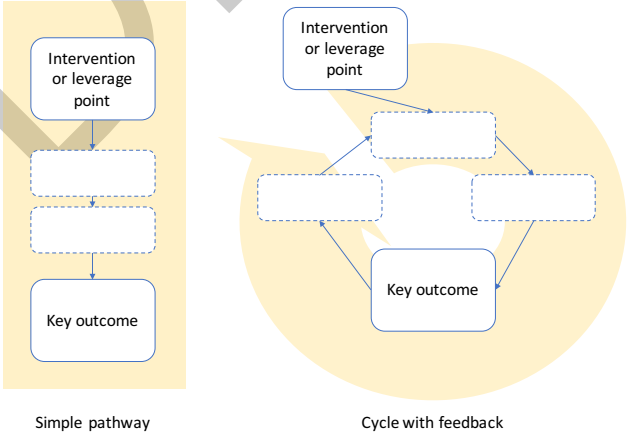


Figure 6: Simple examples of pathways and cycles

Depending on scope, many pathways may be identified and it is likely necessary to **prioritize** the pathways most important to measure.

Inputs Criteria can be used to select and prioritize key pathways.

- A project MELP (monitoring, evaluation, and learning plan) is a useful starting point because it can point to key outcomes and/or key enablers or leverage points; once these are identified, work backward or forward from those within the map.
- Experts and key stakeholders may identify critical pathways to achieving change.
- Behaviors, conditions, and relationships that have many arrows emanating to/from them are likely important to the system's behavior because they are so well-connected to other parts of the map. Therefore, beginning with some of these highly connected map elements and working backward and forward from these may identify high-priority pathways.
- Consider potential barrier pathways that may prevent the achievement of key outcomes, in addition to those than enable the outcomes.

Beyond pathways Not all key outcomes or sets of changes can be represented as a single linear pathway. Below are two particularly important structures that may not be captured by this approach:

- underlying or systemic drivers of change, which can affect many parts of the system (for example, the impact of improvement in trust or transparency among actors throughout the value chain, or changes in the regulatory environment), and
- circular pathways representing improved outcomes (or barriers) through continuous iteration in a reinforcing loop. (These cycles may be particularly important in achieving systemic change, since small changes can iteratively build into larger and more widespread changes over time.)

These concepts should also be considered. Underlying or systemic drivers of change may require a supplementary map and/or framework, or menu for considering pathways. This is a work in progress. Reinforcing loops represented as circular pathways may be considered using the same or similar methodology as above.

2.4 STEP 4: SELECT MAP ELEMENTS TO MEASURE

What The next step is to identify the elements on the map – behaviors, relationships, and conditions – which will be measured to provide indication of a system's state.

An indicator is a measurement of a particular characteristic of a system; the measurement reveals some aspect of the system state, usually related to outcomes about which stakeholders care. *This methodology suggests creating indicators from elements of the BRC mapping framework: changes in behaviors, relationships, and conditions*.

In order to gather information about the status of the system, data need to be collected and evaluated in many parts of the system. The key outcomes and key pathways to the outcomes, identified in the previous two steps, help identify important areas of the system to be measured.

In this step, we select particular behaviors, relationships, and conditions from the maps; the next step transforms these into measurable indicators.

Types of indicators Our methodology defines two types of indicators: ***outcome indicators*** and ***diagnostic indicators***. Outcome indicators are typically applied to the key outcome at the end of a pathway, but may also be applied to critical and intermediate outcomes anywhere on the map. For example, one key outcome might be, "Farmers access financial loans." Diagnostic indicators are applied to other map elements that might indicate *why* an outcome is or is not being achieved. Continuing the example, if farmers are not accessing financial loans, a diagnostic indicator might measure how many farmers have a financial institution within an accessible distance; a second might measure whether agriculture-suited loan products are offered by financial institutions.

Distinguishing these two types of indicators is useful because they serve different purposes and may be measured at different frequencies or at different times during the project. Outcome indicators show whether important project outcomes are being achieved. If they are, diagnostic indicators may not be worth measuring. On the other hand, the key outcomes in a systems-oriented project may take a long time to achieve. Diagnostic indicators may change more quickly, enabling progress to be measured earlier. In addition, diagnostic indicators can help explain *why* an outcome is not being achieved; for example, financial institutions may offer agriculture-suited loan products but farmers may not be able to reach financial institutions, highlighting which of these two issues is a barrier to success.

Selecting map elements to measure Most outcome indicators can be identified by selecting the key outcomes that are already found in Step 2 of this methodology. On occasion, if the pathways identified are complex, or have an obvious important step in the middle of them, additional map elements can be selected as outcome indicators.

Diagnostic indicators must be selected along important pathways found in Step 3 of this methodology. In order to select elements to become diagnostic indicators along the pathways, many factors should be considered.

- Different levels of depth along a pathway may be of interest: it is important to select some indicators that will change quickly when the intervention begins, to ensure it is working as expected, and other indicators that may take more time to change but are closer to the outcome of interest.
- Data availability/ease of measurement should be considered: ease of measurement or availability of existing data can make limited measurement resources go farther.
- There will be perceived importance or strength of causality derived from the map: if a map element seems to be a result or enabler of several important changes, it may be a good place for an indicator to check whether it changes as expected.
- Expert opinion should be considered: stakeholders very familiar with the system may identify important and particularly difficult-to-achieve changes to be measured.

Figure 7 shows the two pathways identified in our earlier example, along with one outcome indicator (red diamond) and two diagnostic indicators (orange diamonds). The two diagnostic indicators were selected in order to show the status of each of the two pathways. (These diagnostic indicators could alternatively have been applied to the enabling conditions rather than the behavior change; in this example, the choice is arbitrary).

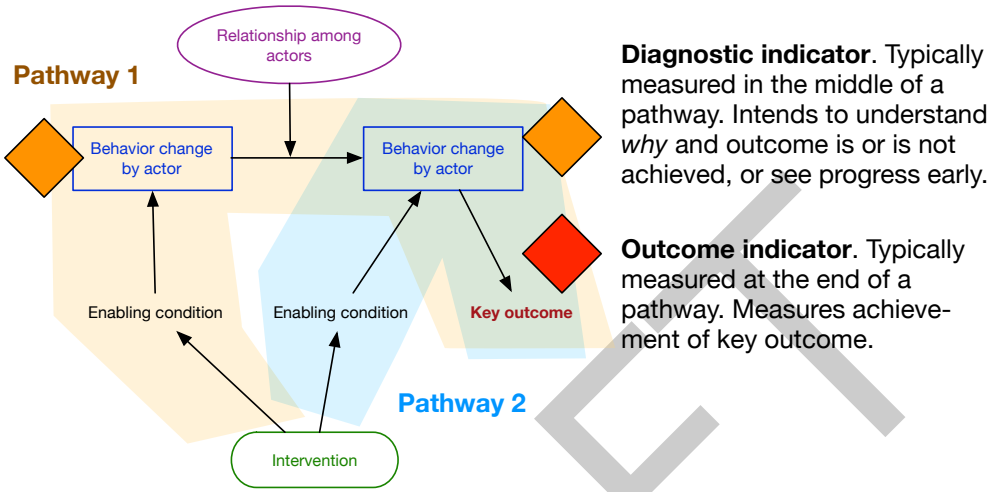


Figure 7: Generic example of selecting map elements to measure, including diagnostic and outcome indicators

When many key pathways are identified in the previous step, it may be necessary to prioritize a subset of pathways for measurement. There is a trade-off between measuring many points along a small number of pathways and measuring few points along a larger number of pathways. Both strategies may be used.

2.5 STEP 5: DEFINE MEASURABLE INDICATORS

What The next step is to frame the map elements selected for measurement so they are clearly measurable. Indicators will require further definition, such as which actor(s) are to be measured and what measure of the behavior change will be employed, as well as scope of measurement, such as the number of districts to be sampled, amount per sample, etc. For example, the map element might be the behavior change, "Dealers stock e-verified inputs,"; the resulting indicator might be "Percent of dealers self-reporting selling e-verified products," in six districts in which the development intervention is applied, each with a sample of 100 dealers.

If the map element is particularly complex, such as a relationship among actors, this step may require development of an index or other creative way to operationalize the concept depicted in the map. This step is a work in progress.

The indicators should be framed so they are not only quantifiable, but also intuitively understandable and comparable. These are challenging goals to achieve, but the difficulties are often apparent only when delving into the details of indicator development.

What There is a large amount of guidance to develop indicators in literature on monitoring and evaluation, much of which is relevant here. (See, for example, (USAID, 2008, 2010b).) Instead of repeating this guidance, we highlight a few key points especially relevant to developing indicators to understand a *system*, in particular.

Comparability To compare multiple indicators across the system and interpret them easily, we suggest each indicator map to a 0-1 scale. Whenever the indicator refers to a behavior, the scale could be, "Percent of actors who have adopted this behavior change". However, these numbers are not always readily interpreted. For some behaviors, a 50% adoption would be good, while for others, 50% is mediocre and 90% would be good. Therefore, reference points for "good", "bad", and "medium" levels could be added. These levels could be chosen after a baseline has been established.

(In some cases, it may be difficult to determine the appropriate endpoints for the 0-1 scale. We have had success in utilizing this scale as a "percent of x" who have done something, who have access to something, or who have been reached, where x could be people, organizations, or even geographic areas. In systems-oriented development, the *spread* of a change is one of the key measures, and spread may easily be framed in this way.)

Frequency of measurement Measuring indicators should follow a regular schedule or time frame, so any progression of change through the system can be viewed and understood. Determining how often to measure each indicator is important. The measurement frequency should depend on (1) the expected speed of change and (2) the urgency of knowing the value of the indicator in order to adapt the intervention. We suggest developing two sets of indicators: some that are measured frequently (such as every six months) and others that are measured infrequently (such as every one or two years). Any indicators expected to change rapidly and/or are critical to knowing whether an intervention is working should be measured frequently and/or early, respectively. Slower-changing and less-critical indicators can be measured less frequently and later, respectively.

This guidance means diagnostic indicators on the most critical pathways in the map should be measured frequently and early in the project, and may be dropped later in the project after the resulting outcomes are seen. Outcome indicators may be measured less frequently, but should be measured consistently throughout the entire project and perhaps past its end-date, to demonstrate the pace and extent of change. Other diagnostic indicators on less critical pathways may not initially be measured, but may be measured later in the project to determine why an outcome is not being achieved.

Trade-offs in scope and speed of data collection There are many trade-offs in determining the data to be collected. A survey with a very large sample size may yield the most powerful and reliable dataset, but may take so much time and resources that no other data can be collected. On the other hand, a small and poorly designed survey may not yield useful information. In measuring systems change, this trade-off is particularly difficult, because there may be several

important outcomes to measure in many parts of the system, and many other indicators to show degrees of progress along key pathways to these outcomes.

As with measurement frequency, we suggest using different strategies for different indicators. The key outcomes should be measured with more reliable methods (though less frequently), in order to demonstrate the achievement of the project's goals. Diagnostic indicators, on the other hand, may be measured using faster, less resource-intensive approaches to get a quick check on whether expected changes are taking place. For example, changes could be measured in one district, rather than country-wide, or with a smaller sample size. If the results are ambiguous, of course, further data collection could be conducted. This "tiered" measurement strategy should enable appropriate balancing of resource usage and data reliability.

Metadata In addition to each indicator having a 0-1 measurement, it is possible to add extra parameters for information more complicated to interpret. For example, if data were collected with a smaller than usual sample, a parameter around confidence could be appropriate to demonstrate measurement limitations. Additionally, the importance of an indicator can be given a value as well. If one indicator is perceived as being the most influential along a pathway, it could be given a high importance value. As more data collection occurs, the indicator value itself, as well as any parameters associated with it, should be updated. In ongoing work, we develop further guidance around these parameters.

2.6 STEP 6: MEASURE, ANALYZE AND INTERPRET INDICATORS

What First, this step involves the measurement of the indicators defined in Step 5. Once data have been acquired, analysis and interpretation are required. In systems-oriented development projects, in particular, interpretation may be challenging because data provide insight into different parts of the system, and aggregating data across actors, subsystems, geographic areas, and other divisions is not straightforward. The goal is to appropriately scale or aggregate indicators to provide measures of the "health" of different parts of the system. This will allow development of insight about how the health of particular parts of the system enables or prohibits system health at the different levels.

How This methodology continues to use the system map as the basis for understanding and interpreting systemic change measurements. The data are collected as indicators of change in particular map elements, such as behaviors, relationships, or enabling conditions. These data can be readily interpreted to show the status of these elements, and identify where the intervention is working and where it is not.

We suggest first evaluating each indicator's result (which should be on a 0-1 scale) against expectations to determine whether the results are 'good', 'mediocre', or 'poor'. Recall the indicators typically measure spread of change in a behavior, relationship, or condition. Depending on the previous state of the system and expectations for the specific element being measured, a 70% score may be a very good result or a disappointing result. This interpretation should be

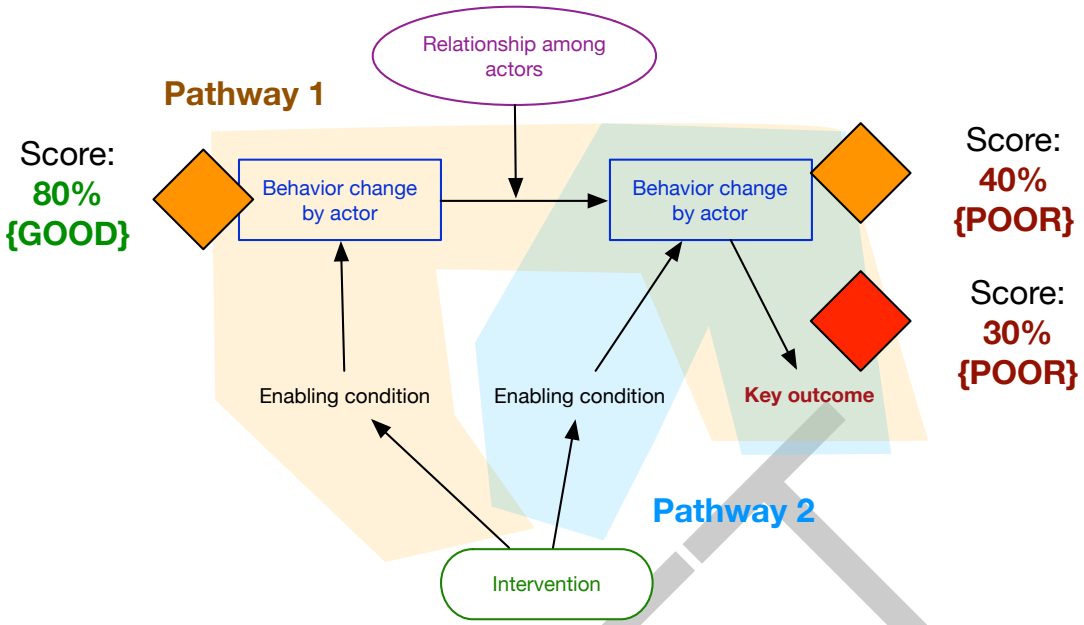


Figure 8: Putting the measured indicator scores and evaluations directly onto the map aids in interpretation by showing how well- or poorly-performing changes are likely to affect the rest of the system.

made first, and scores may thereafter be labeled with a color (for example, green for good, and red for poor).

Moreover, when multiple measurements of the same indicator have been made over time, the *changes* in the scores may be evaluated to determine whether they show significant change in the desired direction, limited change in the desired direction, no change, or change in an undesired direction. As before, the scores may thereafter be labeled with a color to indicate the level of satisfaction with the indicator's value.

Finally, we suggest returning to the system map and labeling each measured map element with the value of the indicator: the 0-1 value, its evaluation (good/poor) and/or its direction and extent of change. Figure 8 provides a notional illustration. Displaying indicators on the map aids in interpretation by clearly identifying which poorly performing map elements may act as barriers, and *how they are likely to affect the rest of the system*.

Aggregating for insights at various levels of the system Because the indicators are designed to be comparable, it is possible to aggregate them to understand not only which map elements are changing, but also which pathways to change are succeeding and which are blocked, and which subsystems are changing and which are not.

Figure 9 provides an illustrative example (using notional data). Each indicator measures a single map element, such as the behavior change, "Dealers sell e-verified inputs." This indicator is part of a pathway: retailers are accessible to farmers, they sell e-verified inputs, and farmers buy it and use it (the key outcome). By examining all the diagnostic and outcome indicators along the pathway, it becomes clear where barriers to change exist. While retailers are accessible to most farmers, few of them sell e-verified inputs, which likely prevents many farmers from buying and

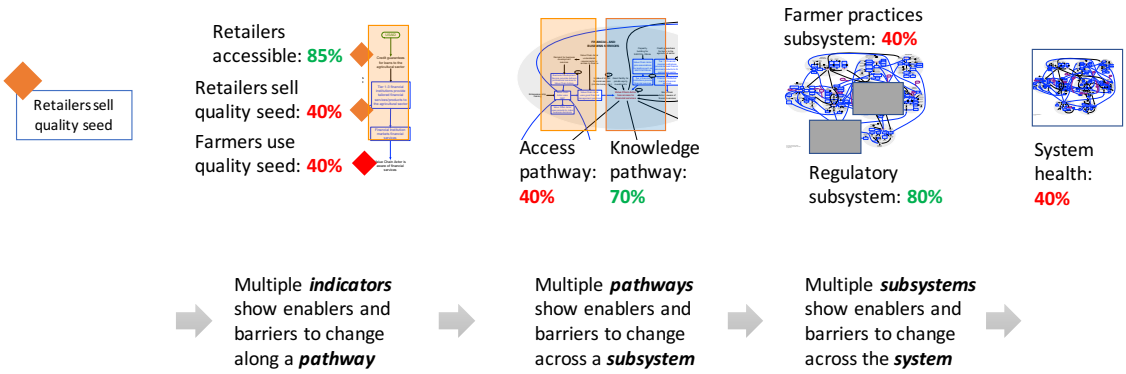


Figure 9: Illustration (with notional data) of aggregating indicators to understand system health at various levels.

using them. Thus, aggregating indicators along a pathway provides insight into the status of the pathway and which specific map elements – behaviors, relationships, or conditions – act as barriers to or enablers of change.

Continuing with the example depicted in Figure 9, the next step is to examine multiple pathways in a subsystem. While the "access pathway" discussed above is somewhat stalled, perhaps the "knowledge pathway", in which farmers learn the value of quality seeds, is more successful. Comparing the status of all the pathways in a subsystem highlights which are acting as barriers to or enablers of change. Some pathways may be substitutes for one another, in that only *one* of several pathways needs to be successful in order for a change in the subsystem to be achieved. In other cases, multiple pathways must be successful in order to see lasting change.

Next, the status of several subsystems can be described based on the status of the pathways within them, showing which parts of the system are "healthy" and which are less so. Finally, a status can be attached to the overall system health.

Of course, much information is lost when aggregating in this manner. One solution is to consider "zooming" in and out: for example, to understand why system health is poor, one can zoom in to see that one key outcome has an indicator that is poor; one can zoom in again to see that one of the pathways leading to this outcome has a poor indicator, and zoom in again in order to determine which set of behavior changes is impacting indicator performance. In this manner, the reasons for the system's overall health are relatively easy to identify.

2.7 STEP 7: VALIDATE SET OF INDICATORS

What To validate a set of indicators means to assess whether they are able to achieve their purpose. The indicators themselves can be validated using standard techniques such as evaluation of them against indicator standards and use of data quality assessments (USAID, 2010a, 2014, 2008). We provide a "cheat-sheet" version of this type of assessment to support at-a-glance interpretation of the data validity.

Second, we focus on identifying criteria against which to validate the *set* of indicators, i.e. it enables a sufficient view of the system status to draw the desired conclusions.

Indicator: 1.0.1: percent of value chain actors accessing loans

Data source: AgInputs Agrodealer Survey, 2016

Date of collection: end of the October 2015 - March 2016 growing season

Location: all 25 districts where AgInputs works

Methods: AgInputs workers know of all agrodealers from working with them; at the time of survey, send interviewer to all business; collect information from those that are open.

Number of samples: 194

Question asked: From which of the following sources do you access working capital (can choose multiple)?

Possible answers: Bank, money lender, Sacco or VSLA, personal/family/friends, micro-finance (5 binary variables)

Figure 10: Example of a validation card.

Validation cards We suggest use of validation cards to provide an at-a-glance interpretation of data validity. A card can be maintained for each indicator. Key information about the data source is made available in order for users to gain intuition of the scope and validity of the measurement. A data validation card is a quick way of providing a user with a summary of some of this metadata. A validation card should include specific information, such as where and when data were collected, as well as sample size. The card should also include the specific measurement taken, e.g. the actual question asked to survey participants. Additionally, answer options or possibilities should be included on the validation card. Were there choices from which a survey participant could select only one answer? Was it an open-ended question or yes/no? If applicable, units of the response should be included. The verbiage of the question and possible answers can orient a user to nuance of what the measurement represents. Finally, it is important to include a sentence or two about the data collection methods. How was the sample population chosen? Who was surveyed?

To interpret a validation card, the user should check that the question asked and range of answers closely align with the intention of the indicator, such that data can be said to measure the indicator. Were data collected recently enough to be acceptable? If not, did they measure something static such that old data are still relevant to today? The threshold of "recent" will vary from case to case and users should use their best intuition for the specific indicator. Were important regulatory changes made between when the data were collected and now that would affect the measurement? Was a new technology introduced and widely adopted between when the data were collected and now that affect the measurement? The sample size and location of the data collected should be assessed to understand how the measurement can be generalized. Was it taken in just a very specific region, or were responses collected from many different places? Were many people sampled, and can the results be considered an accurate representation of a population? Again, the threshold of "many" will vary case by case, and users should use their best judgment. Users should consider the methods employed in data collection to understand biases and potential confounding factors could be present. Overall, users must integrate all of the information on the validation card to gain a better picture of how accurately a measurement represents an indicator.

Validating the *set* of indicators To support an assessment of whether the *set* of indicators usefully describes the system health, we first suggest assessing whether the results of measurement are aligned with expectations. If they are not, there could be several reasons for the deviation from expectations. We suggest using the following list of questions to attempt to diagnose the problems.

1. *Were there problems with data collection or other exogenous events that call the data into question?* Such problems could account for the misaligned results, and the set of indicators remains valid. USAID's tools for data quality assessment could be used to identify data quality issues (USAID, 2014). Other exogenous events should be considered, such as a poor harvest season, an election, etc.
2. *Are the selected indicators sensitive enough to detect change?* Change may be occurring in parts of the system that were not selected for measurement (such as early in the pathways), and/or the selected indicators are too broad or ask the wrong questions to detect the kinds of change that are occurring.
3. *Is change slower than expected?* An unacknowledged time delay might exist somewhere in the system, which prevented the expected results from occurring quickly enough to be seen at the present stage.
4. *Are there missing pathways or elements in the system map?* The system map could be incorrect in it does not reflect some barriers to change.
5. *Are there incorrect pathways or elements in the system map?* The system map could be incorrect in it shows enabling pathways not present in the system, connections that do not seem to occur, etc.
6. *Is the intervention ineffective?* The intervention may simply be ineffective. To detect this, indicators could be placed very early in the pathway from intervention to outcome, perhaps on the changes that immediately follow the intervention, to determine whether it is working.

It may be difficult to diagnose which of these explain misalignment between results and expectations. We suggest proceeding through diagnostic questions in the order they are listed above, which first examines the simplest and most likely explanations. Once an explanation has been identified, the map, set of indicators, measurement approach, and/or intervention can be updated, depending on the identified problem.

2.8 STEP 8: UPDATE INDICATORS & STEP 9: UPDATE MAP

As indicators are measured and updated, more information can be displayed to provide sense of systemic change over intervals of time.

It is *expected* that interventions seeking systemic change may be adapted as the system and its responses to intervention are better understood; therefore, updating not only the indicators, but also the system map are critical steps. As more data are available and clearer understanding of the change pathways in the system is gained, the map and indicators should both be updated

to focus on the key areas of change and concern. However, some subset of indicators should be maintained throughout the life of the project, to ensure some consistent measurements can show the total change in the system over the lifetime of the intervention. In particular, we suggest *outcome indicators* be measured consistently throughout the life of the project and perhaps beyond to determine its sustainability. On the other hand, *diagnostic indicators* may be dropped once changes are known to have occurred in the relevant outcome indicators; other diagnostic indicators may then be added to detect change in other parts of the system.

3 APPLICATION 1: THE FINANCIAL SUBSYSTEM

The methodology described above was applied to the financial "subsystem" – the portion of the map that deals with financial institutions and loans. The following subsections describe each step of the methodology. **The application of the methodology results in indicators for measuring progress in the financial subsystem, and attempts to measure them using existing data, in order to demonstrate the current state of the system and highlight data gaps.**

3.1 FINANCIAL SUBSYSTEM STEP 1: CREATE/UPDATE MAP

A BRC map for the Ugandan agricultural market system had already been created and gone through several rounds of iterations before the start of the indicator selection process for the financial subsystem. This involved meetings with multiple stakeholders, considerations of current data and analyses, and capturing the known dynamics at play in the system. Figure 11 shows the entire subsystem map with the financial subsystem boxed in red, and Figure 12 shows a closeup view of the BRC map for the financial subsystem.

3.2 FINANCIAL SUBSYSTEM STEP 2: IDENTIFY KEY OUTCOMES/ENABLERS

The key outcome for the financial subsystem is that value chain actors use financial services and loans. It is circled in red in Figure 12. This was selected through stakeholder engagement and expert opinion: USAID and other development and private sector stakeholders highlighted it as the key goal for many of their interventions. The financial services sector has been historically very unequal in its accessibility to different groups, and the ability to use financial services can help many other actors in the system. Its importance on the entire system map also cannot be underestimated, since it is shown to enable factors in many other subsystems, meaning it is a crucial point for success system-wide. (These connections are not shown in Figure 12 but can be seen in Figure 11 as the many arrows emanating from the financial subsystem to other subsystems.)

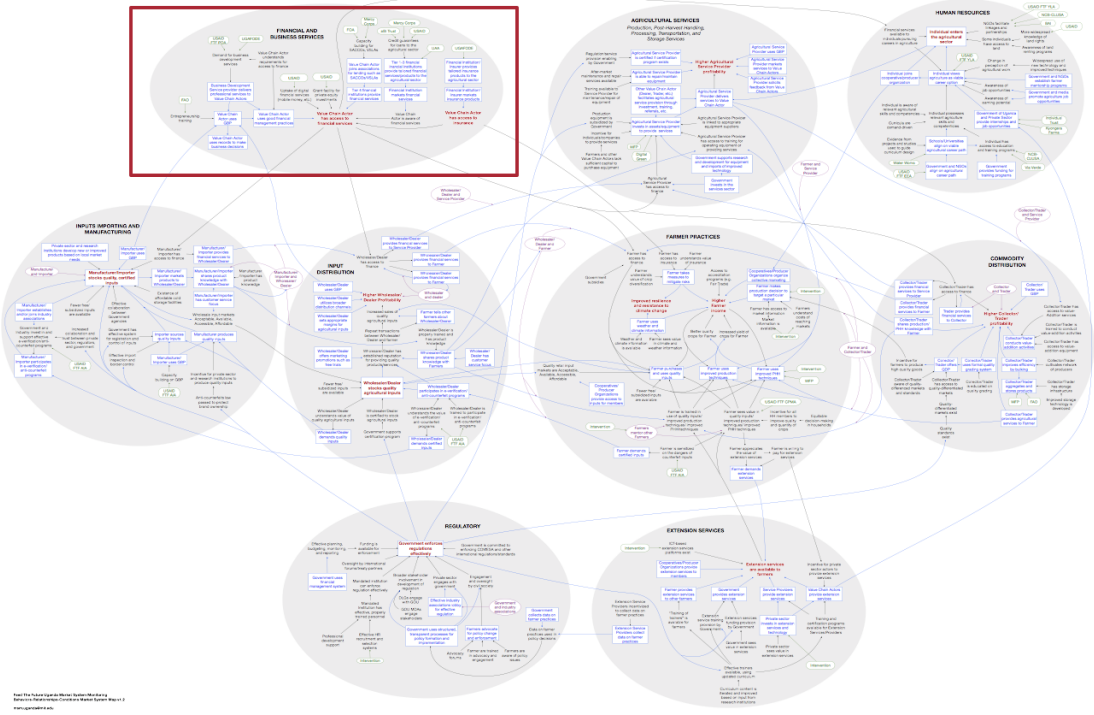


Figure 11: System Map with Financial Subsystem Identified.

3.3 FINANCIAL SUBSYSTEM STEP 3: DETERMINE PATHWAYS

When selecting the pathways for the financial subsystem, interventions had already been in place, so they were used as the starting points for the pathways. Then the paths were traced from those interventions to the key outcome, touching upon all of the elements between the intervention and outcome. In the case that there are many paths to choose from, prioritization may be necessary, but for the scale of this key outcome, three seemed to be comprehensive. Figure 13 shows the identified pathways on the system map for the financial subsystem, and Figure 14 shows the same pathways in a more familiar, results-chain-style format without the rest of the map.

The first pathway, highlighted in blue, focuses on actors using good financial management practices such as bookkeeping or giving receipts. This can be referred to as the "practices pathway". The second one, highlighted in orange, focuses on the accessibility of different methods for financial services and loans, including physical locations as well as mobile money. This will be referred to as the "access pathway". Finally, the last pathway in yellow focuses on the financial institutions tailoring and marketing their products to the agricultural sector. This will be the "specialization pathway".

These pathways can also be viewed in a more traditional results chain format, seen in figure 14.

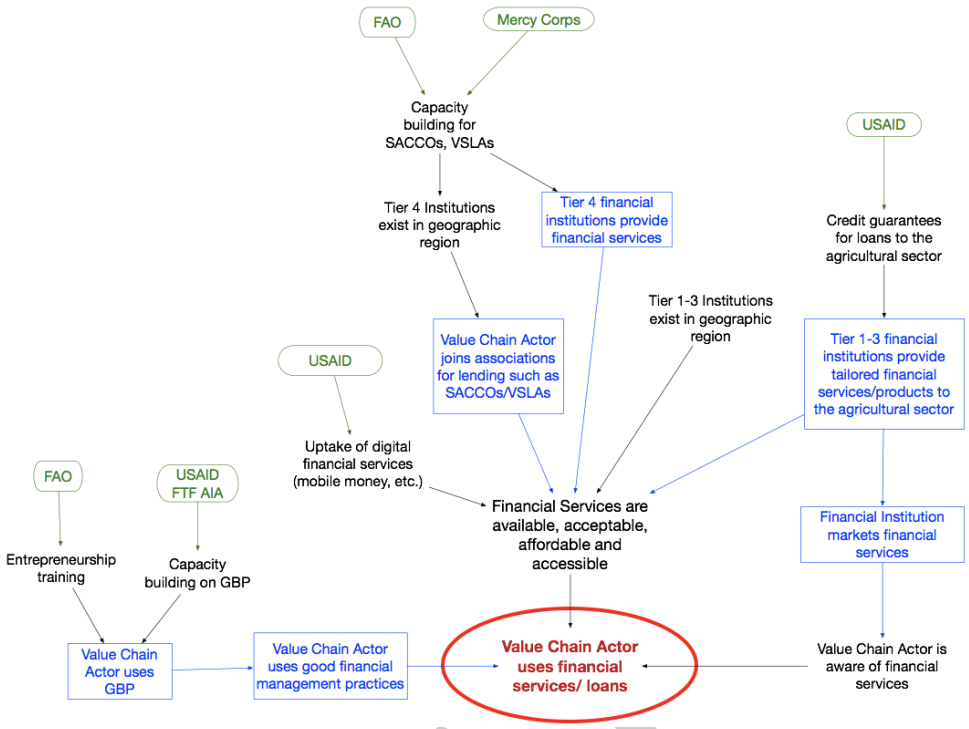


Figure 12: Key outcome shown in financial subsystem.

3.4 FINANCIAL SUBSYSTEM STEP 4: SELECT INDICATORS

Step four is to select the map elements to become measurable indicators. (The actual transformation of the selected elements into measurable indicators will be discussed below in step 5.)

First, the main indicators to be defined and measured are based on the key outcomes identified in step 2. Therefore, the main **outcome indicator** for the financial subsystem is the map element "Value Chain Actor uses financial services/loans". This is marked with a red diamond in Figure 15. Therefore, the indicator will examine how many individuals are able to get access to financing and loans.

The other map elements that are selected to become indicators will mostly serve the purpose of being **diagnostic indicators**, meaning they help understand why the outcome indicator is behaving as it is. These additional indicators are selected by looking at each individual selected pathway. The final selections are indicated as orange diamonds in Figure 15.

The indicators along these paths were selected for various reasons. For example, along the practices pathway (in blue), it was important to have two elements that were at different distances from the key outcome and from the intervention. These were identified as having good business practices, which is closer to the intervention, and having good financial management practices, which is closer to the key outcome. Ideally, having good business practices would influence or enable the outcome of having good financial management practices. Because the two diagnostic indicators span the depth of the pathway, the propagation of change result-

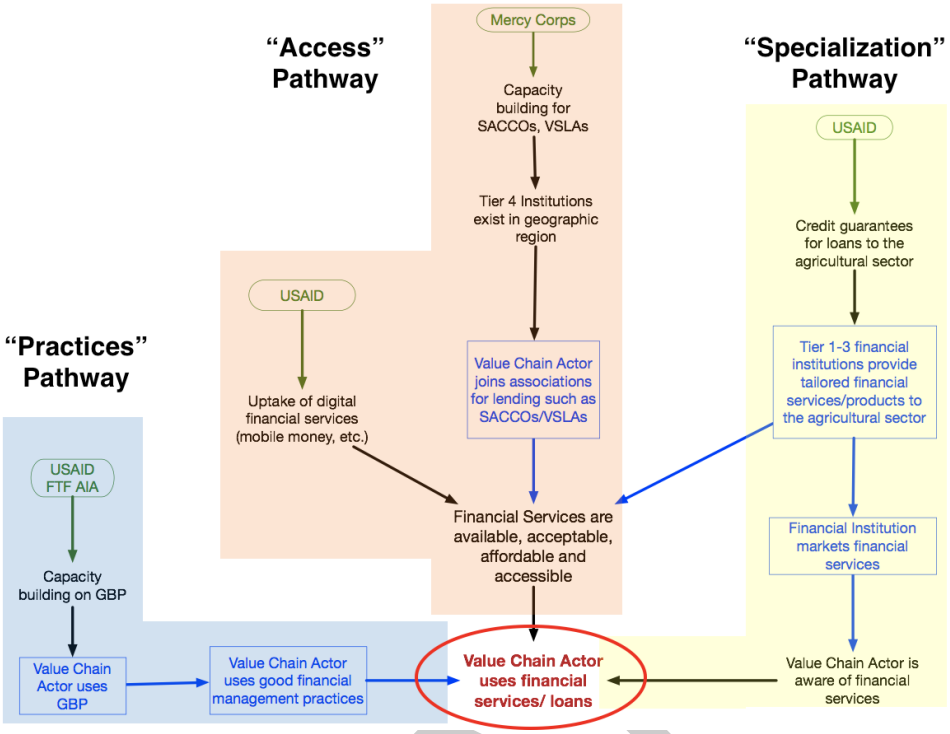


Figure 13: Pathways from financial subsystem identified.

ing from intervention can more easily be identified, and any problem areas or barriers can be pinpointed to their location along the pathway.

The same technique was used on the specialization pathway (in yellow) to identify the two indicators at various depths along the pathway.

The access pathway, however, has two interventions leading to the key outcome that go through similar BRCs. This means it was important to select map elements on each branch of the pathway to decipher what was working from each intervention. The first one takes into consideration the usage of mobile money techniques, while the other looks at the physical location of financial institutions relative to the agricultural population. These elements might not flow directly into one another but they both impact the ways that value chain actors can interact with financial institutions so they both are important things to measure in this pathway.

Additionally, many of these indicators were selected because they had some data available on them already, so they could be analyzed and interpreted immediately after selection, to provide a baseline measurement.

As mentioned earlier, Figure 15 shows all the outcome and diagnostic indicators identified along each of the financial subsystem's pathways. This is only one way of representing the indicators. They can also be represented on a results chain view (by adding information to Figure 14, for example) and in a list format, as shown in Figure **??** below. (This view also has additional information from applying step 5, below.)

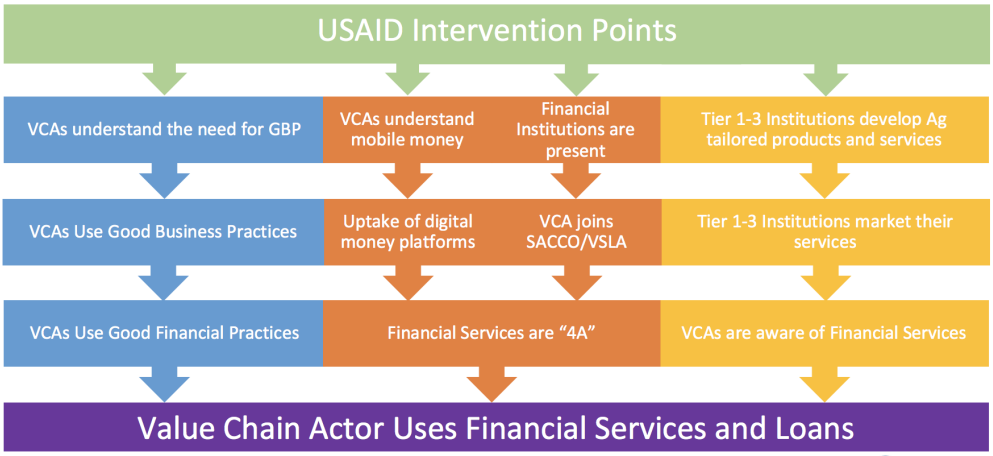


Figure 14: Indicators represented as a results chain

3.5 FINANCIAL SUBSYSTEM STEP 5: DEFINE MEASURABLE INDICATORS

For step 5, we take the map elements selected for measurement in step 4 above (and highlighted in Figure 15 with orange or red diamonds), and define them all as measurable indicators with specific sampling approaches recommended. (Some of these map elements were originally selected because of their availability of data; however, all of the map elements were still transformed into indicators according to our methodology, whether or not the available data fit the indicator's definition.)

For all of these indicators to become measurable, two main data collection strategies were identified. The first was a survey of agribusinesses and farmers, and the other was an interview with financial institutions. These can both be used together for some of the indicators as well. The sample for the survey would be 100 farmers and 50 agribusinesses in four districts, while the interview would be 20 financial institutions in four districts.

For each map element that was selected in step 4 above (and highlighted in Figure 15 with orange or red diamonds), a measurable indicator is developed. Each one is broken down below and we discuss how it is defined as a measurement. These can all also be viewed in Figure **??**.

- "Value Chain Actors access loans" is defined in two ways for measurement. First it is defined as "percent of respondents who have identified that they accessed a loan in the past year" which would come from the farmer and agribusiness survey. It is also additionally defined as "percent of accepted loan applications from farmers and agribusinesses" which would be data collected from the financial institution interview. These two measurements should give a clear idea of who is able to access loans.
- The map element "VCA access other financial services" is defined as an indicator as "percent of respondents who have identified that they accessed financial services in the past year." This would come from the farmer and agribusinesses survey which would give input on who has accessed financial services recently.
- On the first pathway, the practices pathway, the element "VCAs use good financial prac-

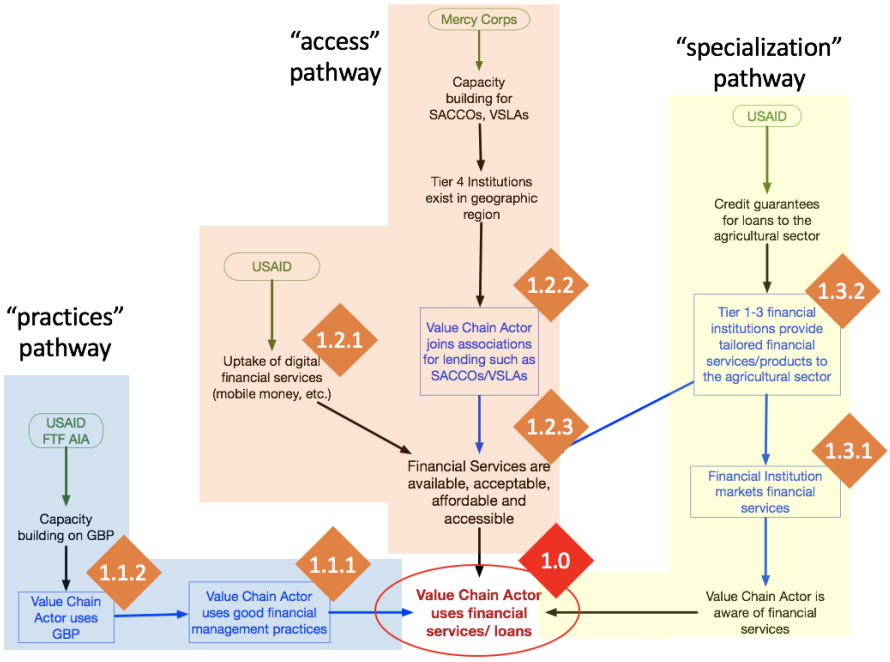


Figure 15: Map with Indicators

tices" was defined as the indicator "percent of respondents who have identified that they use good financial practices (record keeping, inventory management)." This comes from the farmer and agribusiness survey.

- The element "VCAs use good business practices" was defined as the indicator "percent of respondents who have identified that they use good business practices (financial, customer and supplier relations, outreach etc..)" This comes from the farmer and agribusiness survey.
- The second path, or the access pathway, identified "VCAs use mobile money" as an element of importance. This was defined as "percent of respondents who have identified that they have and regularly use (once a month) at least one mobile money account" This comes from the farmer and agribusiness survey.
- Also on the access path, the element "Financial Institutions are accessible to actors" was defined in two ways. First, as "percent of respondents part of a SACCO or VSLA" and then also as "percent of population within 10km of a Tier 1-3 Financial Inst." The first is taken from the farmer and agribusiness survey. The latter would need to be taken from geographic financial inclusion data, which some organizations have already mapped.
- On the last path, the specialization path, the element "VCAs are aware of financial services" was selected. This was defined as an indicator as "percent of respondents who have can identify a financial service provider available to them." This comes from the farmer and agribusiness survey.
- Lastly, the element "Tier 1-3 financial actors create ag-specific loans/services" is defined

using the financial institution interview as "percent of institutions that state with supported evidence that they create/offer ag-specific products."

Key	Map Element Selected	Data Source	Measurement	Sample
1.0.1	Value Chain Actors access loans	Farmer and Agribusiness Survey/ Financial Institution Interview	a. percent of respondents who have identified that they accessed a loan in the past year b. percent of accepted loan applications from farmers and agribusinesses	100 farmers and 50 agribusinesses /20 Financial Institutions in 4 districts
1.0.2	VCA access other financial services	Farmer and Agribusiness Survey	percent of respondents who have identified that they accessed financial services in the past year	100 farmers and 50 agribusinesses in 4 districts
1.1.1	VCAs use good financial practices	Farmer and Agribusiness Survey	percent of respondents who have identified that they use good financial practices (record keeping, inventory management)	100 farmers and 50 agribusinesses in 4 districts
1.1.2	VCAs use good business practices	Farmer and Agribusiness Survey	percent of respondents who have identified that they use good business practices (financial, customer and supplier relations, outreach etc..)	100 farmers and 50 agribusinesses in 4 districts
1.2.1	VCAs use mobile money	Farmer and Agribusiness Survey	percent of respondents who have identified that they have and regularly use (once a month) at least one mobile money account	100 farmers and 50 agribusinesses in 4 districts
1.2.2	Financial Institutions are accessible to actors	Farmer and Agribusiness Survey/ FSP Financial Inclusion Map Data	a. percent of respondents part of a SACCO or VSLA b. percent of population within 10km of a Tier 1-3 Financial Inst	100 farmers and 50 agribusinesses in 4 districts
1.3.1	VCAs are aware of financial services	Farmer and Agribusiness Survey	percent of respondents who have can identify a financial service provider available to them	100 farmers and 50 agribusinesses in 4 districts
1.3.2	Tier 1-3 financial actors create ag-specific loans/services	Financial Institution Interview	percent of institutions that state with supported evidence that they create/offer ag-specific products	20 Financial Institutions in 4 districts

Figure 16: List view of selected indicators

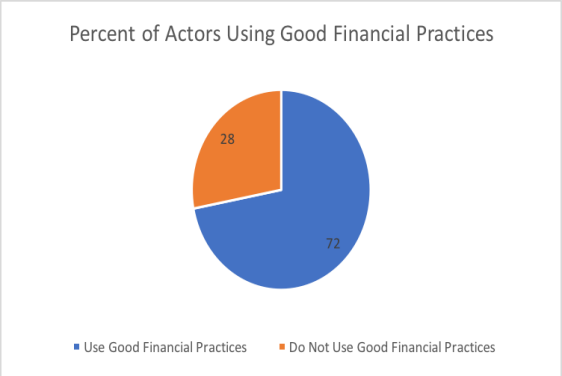
These definitions will be what are used to actually conduct the data collection and measure the change in the system using the methods in Step 6 below.

3.6 FINANCIAL SUBSYSTEM STEP 6: MEASURE, ANALYZE, AND INTERPRET INDICATORS

At this stage in the methodology, the next step would be to conduct data collection using the farmer/agribusiness survey instrument and the financial institution interview approaches described in step 5 above. However, we attempt to measure some of these indicators using existing data that do not precisely fit the indicators defined, in order to provide a baseline status for the financial subsystem.

Because these measurements were taken from other sources and were not aligned with the indicator methodology, the measurements were not all taken in ways that could easily be normalized to a 0-1 scale. To combat this, for most of the indicators, the frame for measurement was made to be percentages (usually of adopting behaviors), which could then be translated into the same 0-1 scale. However, not every indicator had representative samples, which limits the accuracy, and the populations used are not consistent between indicators of the same actor type. Nonetheless, the indicator measurements were taken from previously collected data from multiple sources.

Note most of the indicators for the financial subsystem (see Figure **??**) focus on "value chain actors", of which there are many types. It is therefore necessary to break these indicators down into different types of actors. We focused on three types of actors among all those actors who might be involved in the financial subsystem: farmers, traders, and input dealers. For the



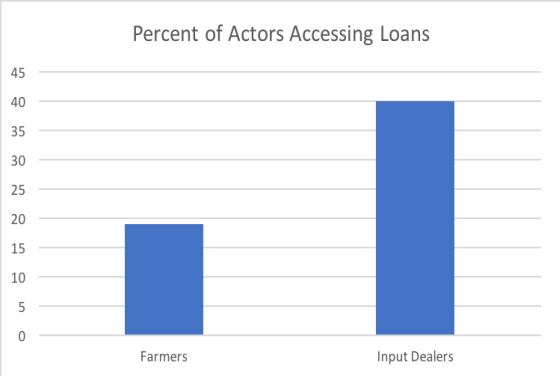


Figure 17: Representation of Financial Subsystem Indicator Data for Indicators 1.0.1 and 1.1.1.

first indicator 1.0.1, "value chain actor accesses loans", we were able to get measurements from sources for both farmers and input dealers. We were able to transform that data into a rough percentage of the measurement population, and then combined the two numbers for an aggregate value for the whole indicator. About 19% of farmers and 40% of input dealers access loans. For indicator 1.1.1, "value chain actor practices good financial practices", there was only data on this from input dealers. But about 72% of input dealers said they used good financial practices at some point. This percentage turned into the indicator value. These measurements can be seen in Figure 17.

The other indicators below have measured values that have been incorporated to their respective scores in similar manners as described above. As the values get filled in, a bigger picture emerges about the overall status of each of the pathways and the key outcome as a whole. For example, the first pathway, which focuses on use and knowledge of good financial practices seems to be in a decent state, especially compared to the second pathway which is more focused on access to financial services methods and locations. This could mean that while many people in the agricultural industry know about options for loans and financial services, they are not accessing them due to some constraint. This then could be considered a barrier and a potential area of investigation for the future.

3.7 FINANCIAL SUBSYSTEM STEP 7: VALIDATE INDICATORS

Since the indicators from the financial subsystem were taken from a variety of sources from many interventions, much of the data, even along the same pathway, do not represent the same population. In future collections, it would be ideal to collect data from the same population, through the same methods. That would help minimize discrepancies caused by using different samples.

The pathway that would most likely have a fault is the access pathway, since there has been relatively little impact after the intervention. There could be a time delay since that is the one that is struggling the most, despite its intervention. If this is believed to be the case, an even earlier indicator, closer to the intervention should be created and monitored. Alternatively, there could be a barrier left out of the map that could be stopping the intervention from being

effective, which has not been previously recognized. Further investigation into the system structure with stakeholders and actors would be necessary to figure this out.

3.8 FINANCIAL SUBSYSTEM STEP 8: UPDATE INDICATORS

If the financial subsystem is found to have indicators that do not properly measure elements from the map or that the system map itself is not accurately representing the dynamics, they should be updated. This process should continue throughout the duration of the project, while trying to maintain longitudinal data where possible. For example, the BRC map and the financial subsystem in particular has evolved significantly through two workshops and many other meetings to review the map with key stakeholders. Changes to the map are already being made based on the analysis reported here; in particular, to capture some of the feedback cycles that are not captured in the current version of the map.

4 APPLICATION 2: IMPACT OF REGULATORY CHANGES ON THE SYSTEM

Next, we provide a second complete application that focuses on a different portion of the map: the impact of regulatory changes on the rest of the system, and in this case, the Inputs and Commodities Distribution subsystems. As in the financial application, **the application of the methodology results in indicators for measuring progress in regulatory impact on the value chain and attempts to measure them using existing data, in order to demonstrate the current state of the system and highlight data gaps.** Below are steps in alignment with the methodology outlined above.

4.1 REGULATORY APPLICATION STEP 1: CREATE/UPDATE MAP

The Regulatory subsystem map and its interactions with the broader map have been developed through multiple iterations with stakeholders, in the same manner as for the financial subsystem. We also reference the 2016 Government of Uganda Agriculture and Forestry national strategy outlining national and local government's role in enforcing standards to support the agricultural industry to inform how the national government enables behaviors and conditions in the other parts of the system (MAAIF, 2016).

The portion of the system map relevant to this indicator development effort is shown in Figure 18. The regulatory subsystem is shown at the bottom of the map, and most of the enabling arrows and pathways point upward (the orientation is opposite that of the financial map in the previous section, due to the relative placement of the subsystems on the overall system map).

4.2 REGULATORY APPLICATION STEP 2: IDENTIFY KEY OUTCOMES/ENABLERS

This regulatory example is different from the financial example in two ways. The first is that the key *outcome* in the Regulatory subsystem, "Government enforces regulation according to

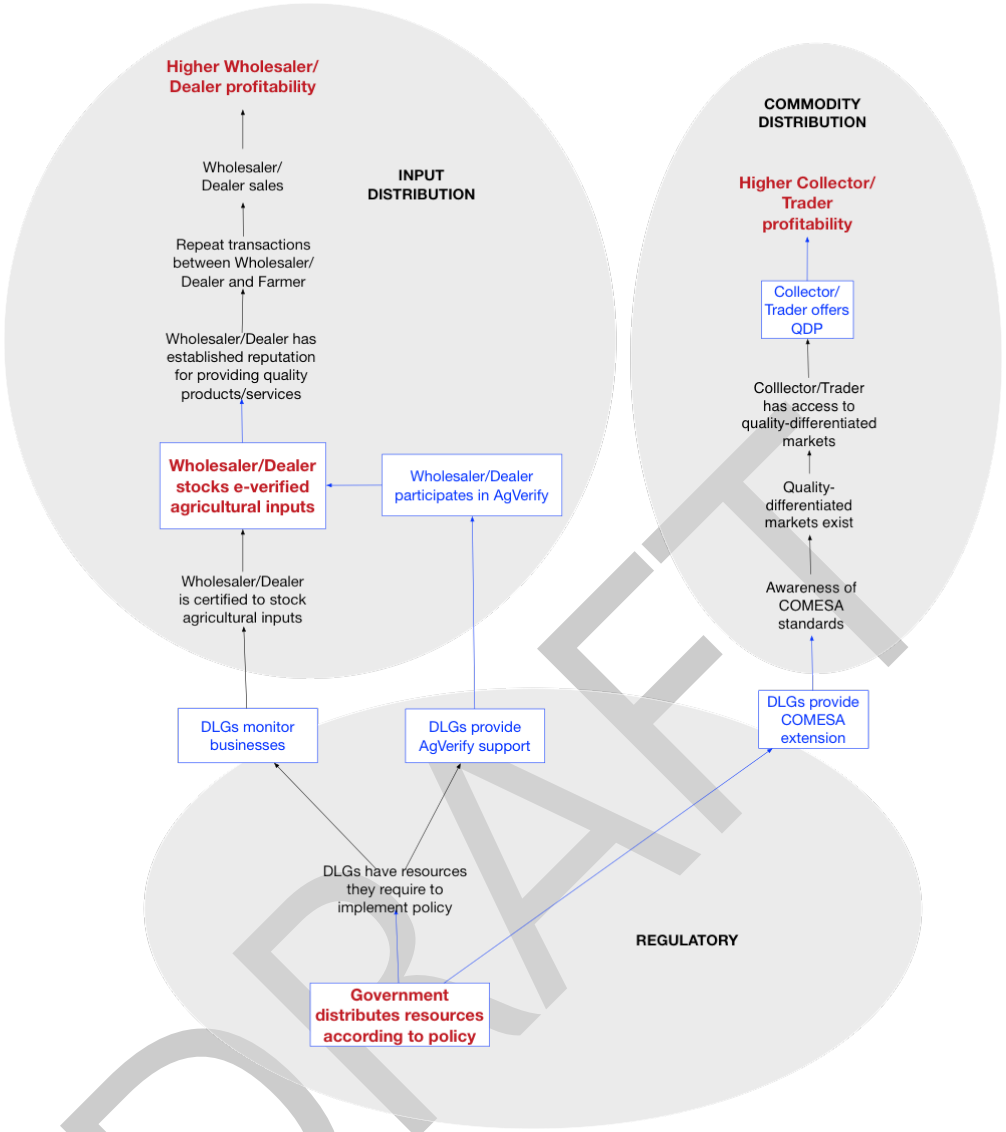


Figure 18: Map of regulatory subsystem.

policy," was identified by stakeholders as also being a key *enabler* of important change in the inputs and commodities distribution subsystems. A key enabler is an underlying driver of other important change throughout the system. Therefore, this key outcome is actually the *starting point* of pathways to other parts of the system.

Change in the key outcome of the Regulatory subsystem leads to key outcomes in the Inputs and Commodities Distribution subsystems: "Higher Wholesaler/Dealer profitability," "Wholesaler/Dealer stocks e-verified agricultural inputs," and "Higher Collector/Trader profitability." Each of these outcomes are seen in the context of the pathways leading from the Regulatory subsystem depicted in Figures 18 and 19, in bold red text.

These key outcomes in the Regulatory, Inputs, and Commodities Distribution subsystems were selected based on stakeholder input and activity objectives. Stakeholders and documents from

the major Feed the Future activities were consulted to determine the key goals of their work, and these were selected as key outcomes.

Higher incomes for value chain actors directly enables a common PMP goal across FTF-VC activities e.g. (CPMA, 2014): "Economic growth from agriculture and the natural resource base increased in 34 districts of Uganda." We know from stakeholder input that stocking quality inputs is a targeted behavior change that enables increased income for wholesalers and dealers. Stakeholders also provided input on selection of the key outcome in the Regulatory subsystem, which is distribution of resources according to policy.

4.3 REGULATORY APPLICATION STEP 3: DETERMINE PATHWAYS

The second way in which the regulatory example is different from the financial subsystem is that pathways cross among subsystems. As stated above, these pathways are chosen based on a key enabler (in the Regulatory subsystem) leading to key outcomes in other subsystems. The pathways were identified from stakeholder input on the most important areas in which the impact of regulatory changes were expected to appear.

These form pathways along which we will select indicators about the regulatory subsystem's impact on the rest of the system. It is a case for exploring how we develop indicators for change that is not isolated to one part of the system. This example considers three subsystems and three pathways. The pathways are highlighted in Figure 19.

The orange pathway shows how regulatory activities, such as monitoring businesses and supporting the existence of an e-verification entity, enables wholesalers and dealers to stock e-verified inputs and then become more profitable. The blue pathway shows how regulatory support from quality standards enables quality-differentiated markets and then higher profitability for traders. The yellow pathway shows how appropriate resourcing by regulatory officials enables the implementation of policies.

4.4 REGULATORY APPLICATION STEP 4: SELECT MAP ELEMENTS TO MEASURE

Along these pathways from our key enabler to key outcomes, we select map elements as indicators. There are many potential indicators here, since we are concerned with three subsystems; however, each map element tells us different things about the state of change along the two pathways. Early change along a pathway can tell us more about how the regulatory environment changes (or does not change), whereas change toward the end of a pathway tell us about how the private sector changes (or not) as a result of the Regulatory subsystem behavior.

We consider our two types of indicators: outcome and diagnostic. As discussed in the methodology, outcome indicators tell us the system is changing with regard to the things about which we care most: we are reaching, or are on the path to reaching, key outcomes (or we are not). We use diagnostic indicators to understand why we are or are not reaching key outcomes, along the pathways we have selected. Diagnostic indicators tell us more about intermediate progress toward these outcomes.

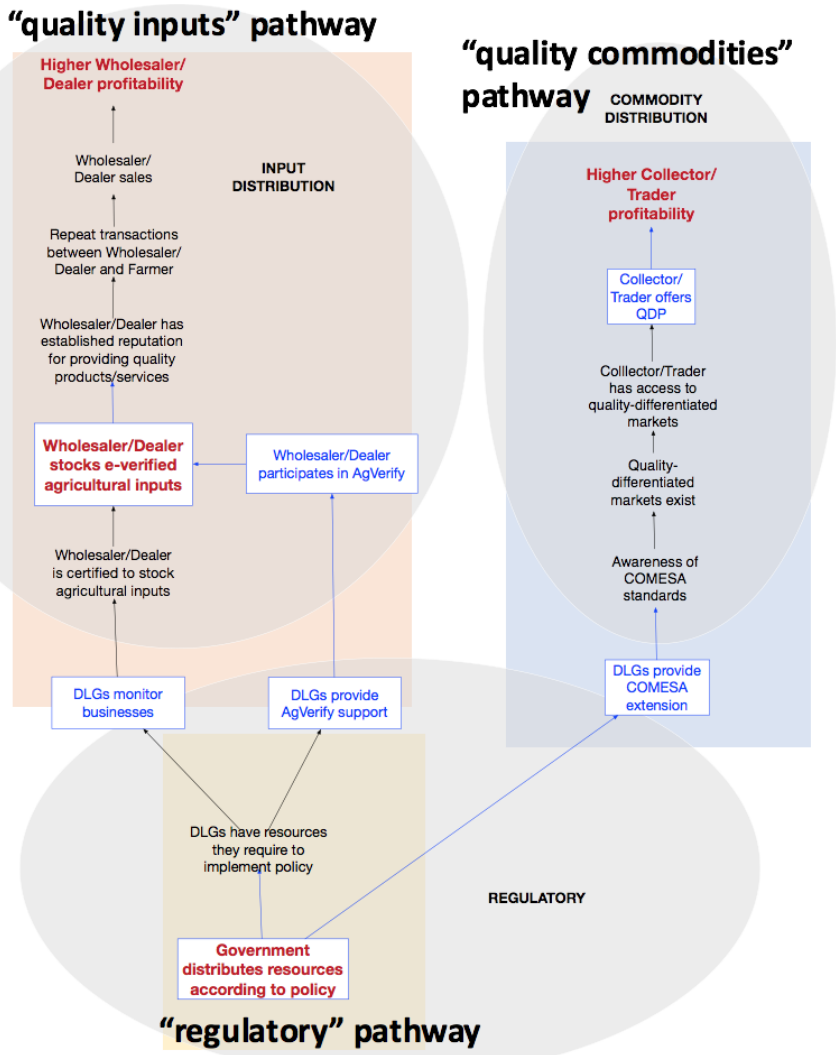


Figure 19: Regulatory pathways.

In this case, diagnostic indicators are closer to the Regulatory subsystem, and key outcome indicators are in the other subsystems, because we are considering pathway context. This is because we want to understand how change (or lack of change) in the private sector changes as a result of "Government enforces policy according to regulation." Indicators selected are depicted by orange diamonds in 20.

In this application, we do not select key outcomes themselves as indicators. This is because we want to capture change along the two pathways at three levels: national government, local government, and private sector. More specifically, we want to capture propagation of change at each level to the next. Therefore, we do not select key outcomes themselves as indicators, but those that should directly enable propagation of change from the Regulatory subsystem to other areas of interest in the map. Since we are interested in inter-subsystem change, we are more focused on intermediate change than perhaps in other areas of the map where we focus more on key outcomes.

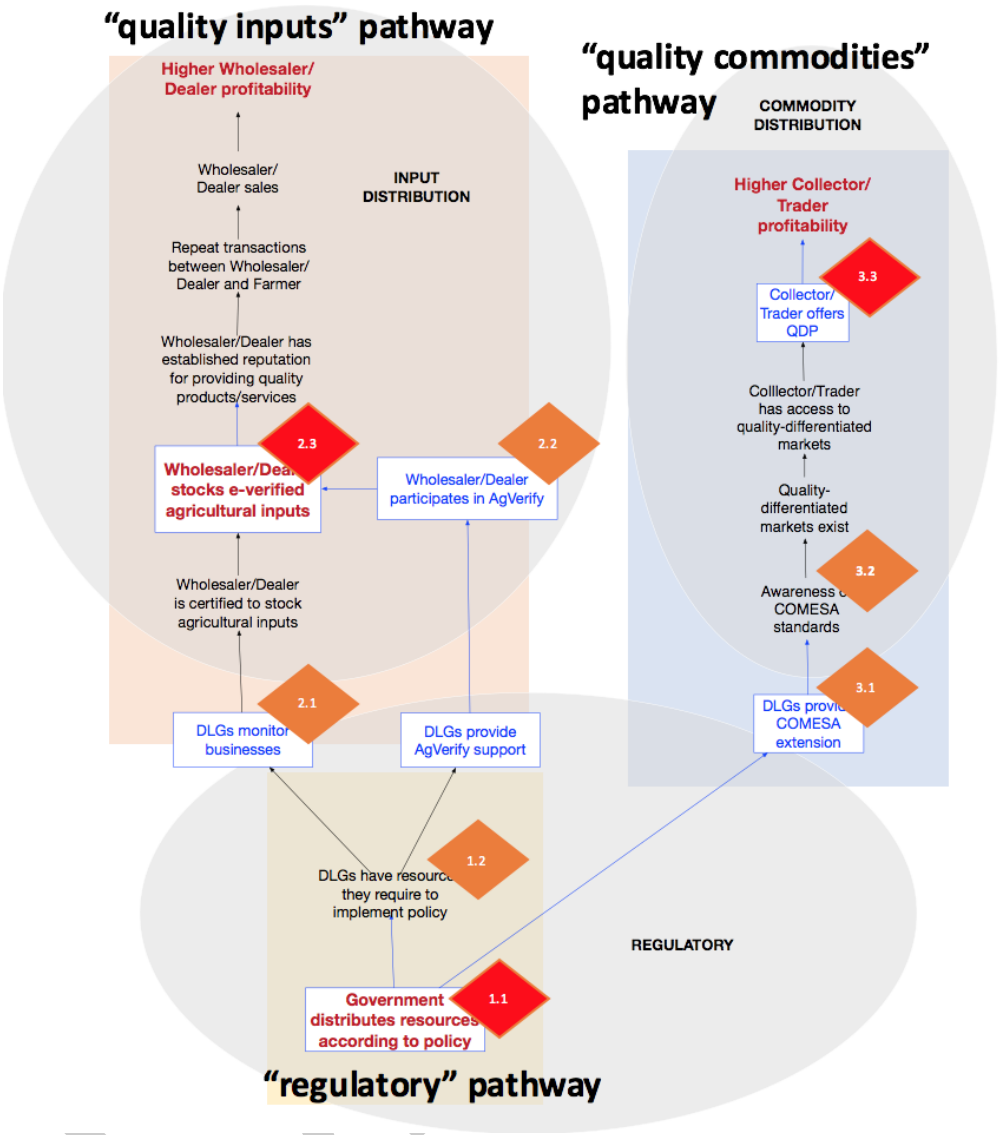


Figure 20: Regulatory indicators.

4.5 REGULATORY APPLICATION STEP 5: DEFINE MEASURABLE INDICATORS

Below is a table of indicators selected. The indicators in the Regulatory subsystem will need to be altered based on specific policies depending on pathway context. The nature of the data sources and measurement (surveys and percent budgetary support, for example) can generally be applicable to all types of policies. The sample will change based on the appropriate Ministry or organization within the government responsible.

- 1.1 Government distributes resources according to policy. This behavior is especially difficult to measure due to lack of transparency. The data sources we recommend are the Government of Uganda policy portal to identify specific policies to be studied, and surveys of Ministry employees for measurement. Surveys should be administered by an activity responsible for engaging with government. Surveys should ask about the proportion of

funds allocated to a particular policy that were distributed for implementation of that policy. The measurement used is UGX distributed divided by UGX allocated. This is a straight-forward way to measure how resource distribution, which is likely both the most important indicator of change in the regulatory environment, as well as the most influential in change along enabling pathways to other parts of the system. We choose a sample size of ten, but this should be adjusted according to policy, Ministry, and responsibility or chain of command. The measurement should be averaged across the sample.

- 1.2 DLGs have resources they require to implement policy. This element is chosen to measure regulatory change at the implementation level: DLGs, who are responsible for interacting with private sector actors. The data source for measuring DLG behaviors and conditions is interviews with DLG representatives. This could be measured as a percent of funds the DLG should have received or of those the DLG representatives perceive they require to do their jobs. We choose the latter because we feel it is a better indicator to capture enabled change along these pathways. This measurement should be along a spectrum (i.e. not binary) and should be averaged across the sample. c (size) and policies (responsibilities).
- 2.1 DLG monitors businesses. This element is chosen to understand change a the private sector level, as a result of interaction with DLGs that is enabled by resource allocation at the national government level. The data source for private sector behaviors and conditions in the "quality inputs" pathway is interviews with wholesalers and dealers, and observations of stores. The measurement comes from answer to the question, "Does your DLG check your registration?" This is binary and should be measured as a percent of the population claiming DLG visits. We choose 80 wholesalers/dealers as the sample size, but again, this should be adjusted based on the number of wholesalers/dealers in the district of study. This indicator may also have a time element, according to how it has been defined: for example, "Has your DLG visited you within the last six months to check your registration?".
- 2.2 Participation in AgVerify. This is another element that captures change at the private sector level; so, the data source will be the same as above. This is another binary measurement and is obtained from response to the question, "Do you participate in AgVerify?" This should be measured as a percent of actors responding, "yes". The sample size is the same as above and should be considered for adjustment in the same way.
- 2.3 Wholesaler/dealer stocks e-verified inputs. This element should be measured primarily through observation of inventory. The measurement is more vague, but one could confirm there is e-verified inventory, and measure the indicator as a percent of dealers/wholesalers having e-verified stock. The sample size is the same as above and should be considered for adjustment in the same way.
- 3.1 DLG provides COMESA extension. This is another behavior change at the private sector level. It is measured by asking if traders, exporters, and/or traders if their DLG provides COMESA extension services, and is measured as a percent of the total population claiming "yes". The sample is from 20 traders, processors, and/or exporters in a particular district and should be adjusted based on the number of these entities in the district. As with the

inputs dealers, this is meant to be a census sample within a district.

- 3.2 Awareness of COMESA standards. This element is used to measure the effect of extension about COMESA standards at the private sector level. The data source for measuring private sector behaviors and conditions in the "quality commodities" pathway is interviews with traders, wholesalers, and/or exporters. This is an enabling condition for quality production and selling. It is measured in terms of response to the question, "Do you know about COMESA standards, from your DLG?", and measured as a percent of the sample. We realize they might have the information, but not have obtained it from their DLG, and this should be captured, but for this particular element along the pathway from regulatory change to private sector change, this is a straight-forward means of measurement. The sample is from 20 traders, processors, and/or exporters in a particular district and should be adjusted based on the number of these entities in the district.
- 3.3 Trader/collector offers QDP. This is another private sector behavior change in the "quality commodities" pathway; so, the data source is interviews with those actors, as described above. This is measured with the question, "Do you offer quality differentiated prices to your suppliers?", and should be measured as a percent of the sample, as above. The sample is from 20 traders, processors, and/or exporters in a particular district, as above, and can be adjusted accordingly.

As means of budgetary support and implementation, or channels through which these occur, vary, these different pathways to impact should be considered, as well. These indicators should be informed by stakeholders in the map development process, but also in this step to ensure mechanisms for implementation are accurate. This structure allows us to consider impact from national policy to district local government activity, and as a result, private sector behaviors and conditions.

4.6 REGULATORY APPLICATION STEP 6: MEASURE/ANALYZE/INTERPRET INDICATORS

We specify data available for two key outcomes, and data gaps that exist about regualtory impact along pathways to these outcomes.

- 2.3 Wholesaler/Dealer stocks e-verified inputs. The AgInputs activity collected data about use of e-verification in their last round of agrodealer census data collection (AIA, 2017). In their survey, they asked whether or not a dealer participated in e-verification, and when he or she started, given six-month periods. Since this is a census survey, we can learn the percent of the agrodealer population by district and in FTF target districts as a whole participating in e-verification, and about when the practice began. We do not have these data currently, but they can be analyzed going forward.
- 3.3 Collector/Trader offers QDP. MSM performed a study about quality differentiated prices in 2016 in which we interviewed traders about access to and existence of quality differentiated markets and prices (MSM, 2016b). The study found the following: "QDP exists in the supply chain, but is not always formal. There were two approaches for implementing quality-differentiated pricing: Price based on quality grade – actors use

Table 1: Regulatory indicators.

	Map element	Data source	Measurement	Sample
1.1	Government distributes resources according to policy	MAAIF policy portal and stakeholders (for policy details); Surveys of respective Ministry employees (for measurement)	Percent funds distributed according to policy	10 Ministry employees
1.2	DLGs have resources they require to implement policy	DLG interviews	Percent DLG representatives stating they have what they require to implement policy or regulation	30 DLG representatives in particular district
2.1	DLG monitors businesses	Wholesaler / dealer interviews	Percent wholesalers / dealers stating having been visited by DLG to enforce agribusiness certification	80 wholesalers / dealers in particular district
2.2	Participation in AgVerify	Wholesaler / dealer interviews	Percent wholesalers / dealers stating use of e-verification	80 wholesalers / dealers in particular district
2.3	Wholesaler/dealer stocks e-verified inputs	Wholesaler / dealer interviews, observations	Percent wholesalers / dealers with observed e-verified product stocked	80 wholesalers / dealers in particular district
3.1	DLG provides COMESA extension	Trader / processor / exporter interviews	Percent traders / processors / exporters reporting DLG offers COMESA extension service	20 traders / processors / exporters in particular district
3.2	Awareness of COMESA standards	Trader / processor / exporter interviews	Percent traders / processors / exporters reporting they are familiar with COMESA standards as a result of DLG extension	20 traders / processors / exporters in particular district
3.3	Trader/collector offers QDP	Trader / processor / exporter interviews	Percent traders claiming to offer quality-differentiated price (for example, as defined by MSM QDP study)	20 traders / processors / exporters in particular district

distinct pricing brackets for different grades determined by common perceptions of specific quality characteristics. Price based on adjusted weight – certain quality attributes (e.g. moisture content, presence of foreign matter) affect the weight of a given quantity purchased; many buyers perform secondary processing that results in weight reduction. Therefore, they may "reduce the kilograms" purchased in a transaction to account for reduced revenue potential."

- We currently do not have data about the national government's allocation of resources to district local governments in support of either business certification and e-verification, or COMESA extension. One can design a study based on the indicators in the above table to do this analysis. We would expect if resources are allocated according to policy at the national level, the DLGs would have appropriate means to enforce these policies, and the private sector would be enabled to participate in AgVerify and COMESA standard. Alternatively, if resources are not allocated at the national level, for example, we would expect hindered progress further along the pathways.

4.7 REGULATORY APPLICATION STEP 7: VALIDATE INDICATORS

Because the indicators have not been measured directly in accordance with our methodology, validating them at this stage is premature. However, we consider some of the key places along the pathways where we might expect to find barriers to success.

If there is support for certification and e-verification in the district selected (indicator 2.1), but wholesalers and dealers are not stocking e-verified product (indicator 2.3), there must be a barrier along this pathway, or another enabling condition, such as unavailability of e-verified product, that is hindering change at this point in the value chain. We would look at the larger system map to see which other enablig conditions point to the outcome "Wholesaler/Dealer stocks e-verified agricultural inputs" to see whether any such barriers are included, or consider updating the map to include barriers previous not envisioned.

Similarly, if the DLG is receiving the funding they require and offering COMESA extension (indicator 3.1), but traders are not offering quality differentiated pricing (indicator 3.3), there may be another enabling condition that is hindering this private sector behavior change, such as inexistence of a market that demands quality commodities.

In this study, we would also need to consider mitigating potential bias in the sample. For example, Ministry employees may be incentivized to overstate support for policy, while DLGs may be incentivized to understate support. In this step, we would need to consider whether potential bias influences the results in a way that prevents us from gaining understanding about real change along the pathway. If it does, we then need to consider alternative ways to measure indicators.

In general, pathways that cross subsystems will likely have data gaps regardless of context. Data should be representative of the same population and phenomenon, and should tell us about change transferring (or not) from one part of the system to another. We choose a particular district for this reason: focusing on change within that district enables measurement of a single,

smaller population as an indication of what is going on in other parts of the country.

4.8 REGULATORY APPLICATION STEP 8: UPDATE INDICATORS

We should also update indicators based on the validation process. The measurement technique should be under critique in addition to the actual indicator selected, as specified in the validation step. The process for learning and adapting for an inter-subsystem pathway may be different than that in a subsystem because of potential disparate and different data sources. Stakeholders should be more involved then. In this case, we involve stakeholders involved in AgVerify and Feed the Future employees who interact with government to ensure we have used the right elements to describe pathways to change from the Regulatory to Inputs and Commodities Distribution subsystems.

5 DISCUSSION AND CONCLUSIONS

There are many advantages to this methodology. First, the process helps identify effects of an intervention in the context of a system, which may not be regarded with intention with traditional M&E techniques. The reason is indicators are tied to elements of a system map, so their values can be interpreted in the system context, including implications for change in the rest of the system. Second, as a result of the above, the methodology does a good job at identifying opportunities: system locations where work could be focused or improved, as well as locations where barriers to change or general limitations exist.

Third, the approach can be mapped to different views beyond the BRC map, such as results chains and lists of indicators, for easy understanding and communication of a project or systems goals. Each indicator can be examined individually, or aggregated for comprehensive understanding at various level of detail, as described earlier. Fourth, the ability to easily "zoom" in and out from a high-level system status to details of potentially problematic behavior changes for the system, and to see how those behavior changes relate to important outcomes through the system, should enable clearer understanding of systemic change.

5.1 ONGOING AND FUTURE WORK

This approach may be expanded upon, edited, and focused in the future. We expect the methodology to evolve as it is tested in more sectoral and geographic areas.

The financial and regulatory applications in this document represent a first iteration through steps 1-5 of the methodology, with partial completion of step 6 where existing data allowed. As expected in an iterative methodology, several problems with the form of the map were identified, and these will be incorporated into an updated version of the system map (returning to step 1 of the methodology). In particular, there are many cycles or loops (see Figure 6) present in the system, but excluded from the map for simplicity. These will be added to the map in the next iteration.

In addition, we are currently developing new ways to measure changes in relationships. Relationships are particularly tricky to measure because there are multiple relevant dimensions to them. Our approach focuses on measuring various dimensions that improve economic outcomes for the relationship participants, such as information exchange and market access.

Feedback on this methodology would be very welcome. Please contact MSM at msm.uganda@mit.edu.

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