Using Theories of Change in the CGIAR Research Program on Agriculture for Nutrition and Health (Draft)

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Abstract

Theories of change are increasingly being discussed and referenced in development evaluation even while the elements of what a theory of change consist of differ widely among applications. Equally, examples of actual use of theories of change other than as overview illustrations of interventions are rare. In this article, we present generic models of theories of change for both straightforward and more complex interventions. A number of examples of evidence based theories of change in the area of agriculture research for nutrition and health and are discussed. The need for different versions of a theory of change for different purposes is discussed. We discuss the use and analysis of these models in the planning, managing and assessing of research related interventions, illustrating the practical usefulness of well-developed theories of change.

Keywords

Theory of change, impact pathway, complex interventions, nutrition-sensitive agriculture, international agricultural research for development

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Introduction

The CGIAR Research Program on Agriculture for Nutrition and Health (A4NH) is one of 15 international agricultural research programs dedicated to reducing rural poverty, improving human health and nutrition, and ensuring sustainable management of natural resources in developing countries (http://www.a4nh.cgiar.org/). In A4NH, CGIAR research centers work in close collaboration with many partners, including national and regional research institutes, civil society organizations, academia, governments, development organizations and the private sector to develop and deliver improved agricultural technologies, policy and institutional innovations, as well as evidence on how agriculture can contribute to better nutrition and health outcomes.

Theories of change (ToC) and related impact pathways (IP) have recently become visible tools in the CGIAR. There are several reasons for this:

1. With the significant focus in the CGIAR on making a difference in the development agenda, there is a need for CGIAR research programs to explain how their research efforts are expected to contribute to development impacts. Despite the often long lag time between research and impact, research programs need to understand their intended and eventual pathways to impact and the models or theories of change behind the pathways.

2. As CGIAR research programs focus on making an impact with their research they need to be able to monitor their progress. Articulating IPs and ToCs often identify gaps in logic and evidence that need to be addressed. As these gaps are filled, ToCs are updated and may evolve. Stronger and more plausible ToCs can be evidence of progress.

3. CGIAR research programs are setting ambitious intermediate development outcomes targets over the next 10-15 years. They will need to show through evaluation that they have indeed contributed to these development outcomes. In many cases, they will need to use theory-based approaches to evaluating their impact, approaches that are getting increasing attention (Mayne and Stern, 2013; UNEG, 2013), and for which robust ToCs are essential.

A4NH recognizes that in working toward making a development difference, the actions of many others are also needed. Hence A4NH interventions are multifaceted and involve a range of activities across research, capacity building and engagement activities with a variety of partners to build a supporting environment. Furthermore, the sum of these activities is expected to be sufficient to make a difference, and the partnerships are a key aspect of A4NH pathways to impact. This does, however,

complicate the causal relations between A4NH actions and any observed impact. Indeed, A4NH research efforts are a contributory cause rather than a sole cause. They are part of a sufficient causal package of factors that bring about the desired result (Mayne, 2012b).

In some cases, or for parts of the impact pathway, evaluations using experimental designs may be feasible to isolate the A4NH contribution. However, for many impact pathways, experimental designs are not feasible, and alternative approaches will be needed, such as theory-based evaluations or qualitative comparative analysis (Mayne et al., 2013).

In this article, we first provide a brief introduction to impact pathways and theories of change and their use in the context of A4NH research activities. We then set out the generic components of impact pathways and theories of change for the kinds of complex interventions the A4NH research program is involved with. We then discuss the various ways that ToCs can be used in planning, managing and assessing A4NH interventions. It concludes by discussing key characteristics of A4NH theories of change, most of which apply to other multifaceted interventions.

Theories of change and impact pathways

To understand how and why an intervention is working, there is a need to understand how the activities of the intervention are expected to lead to the desired results—both the pathway or results chain from activities to outputs to a sequence of outcomes to impacts, and why the various links in the pathway are expected to work. **Impact pathways** describe these result chains, showing the linkages between the sequence of steps in getting to impact (Douthwaite et al., 2007). A **theory of change** adds to an impact pathway by describing the causal assumptions behind the links in the pathways— what has to happen for the causal linkages to be realized (Leeuw, 2012; Rogers, 2008; Blamey and Mackenzie, 2007; Weiss, 1995).

There is widespread use of theories of change in development settings. The use of theories of change in development evaluations has been reviewed by James (2011); Vogel (2012b) and Stein and Valters (2012). However, as these reviews point out, while there is general agreement on the big picture about theories of change, there is a proliferation of different interpretations of just what in practice a theory of change is, how to develop one and how to best represent it.
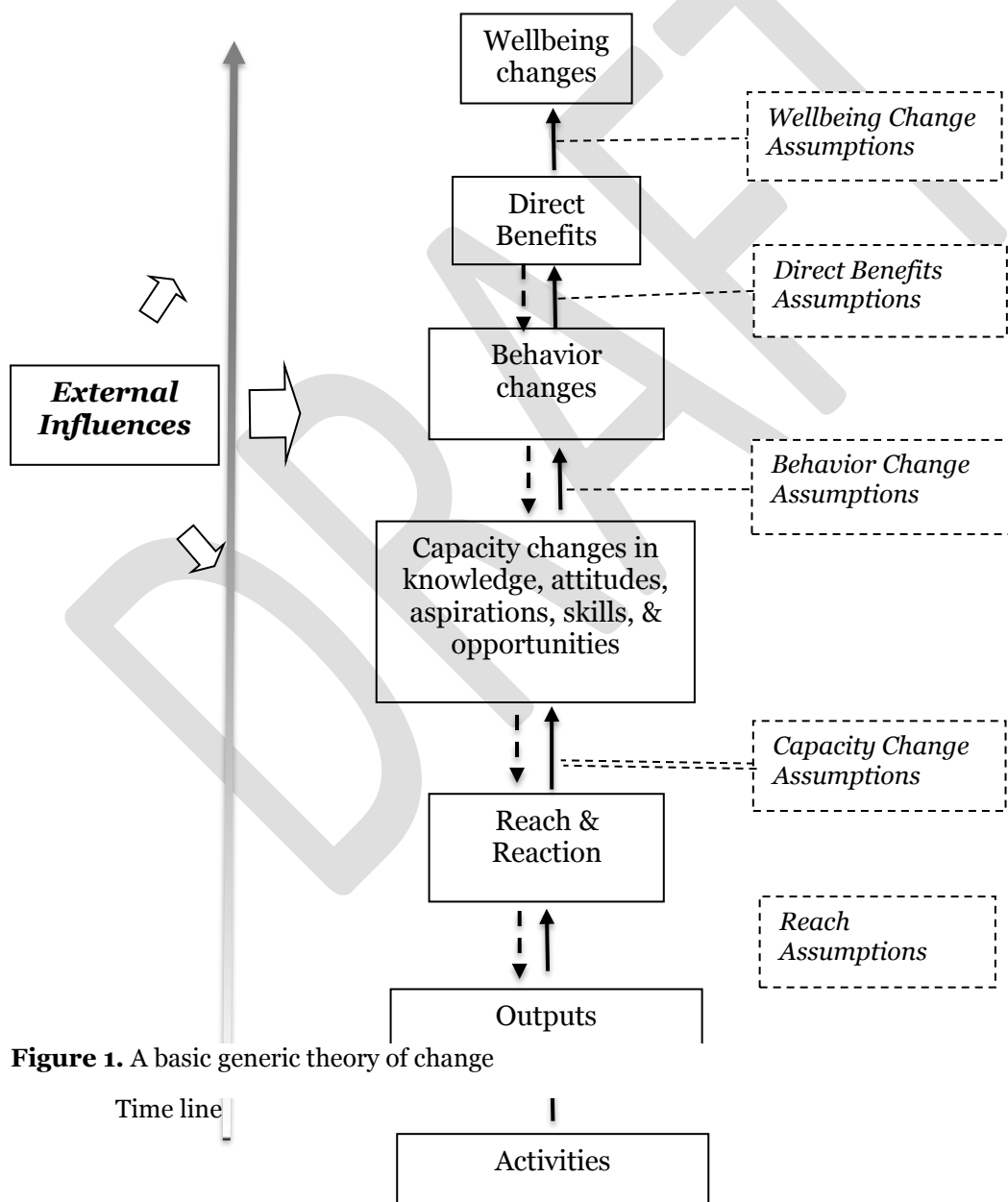
Figure 1 illustrates a basic generic theory of change that has proven useful in a number of settings. This sequence of boxes in the figure is the associated impact pathway—the results chain. This type of generic ToC is discussed in more detail in Mayne (forthcoming); Mayne (2014).

Rather than the more traditional model using outputs, immediate outcomes, intermediate outcomes, and final outcomes or impact, the model uses the more intuitive notions of reaching some target group, changing their motivation and behavior which results in direct benefit to them and subsequent improvements in their wellbeing. The model reflects the Bennett hierarchy (Bennett and Rockwell, 1995). It explicitly incorporates the idea of 'reach', increasingly recognized as important in building theories of change (Montague and Porteous, 2013; Uusikylä and Valovirta, 2007) as a way of explicitly having to consider ex ante which target group the intervention is specifically aimed at, and ex post which group was actually reached by the intervention.

As an example consider an intervention aimed at improving the diets of children. The outputs, say, are innovative education and training materials and approaches aimed at mothers on the benefits of a nutritious diet. The reach group should be the household decision-makers on food issues, who, of course, may not only be the mothers. Behavioral changes would be the changes in feeding practices that occur as a result of the improved knowledge from the training. Direct benefits would be children consuming a more nutritious diet and wellbeing change to which the improved diet contributes would be better nutritional and health status.

The *causal link assumptions* shown in the dotted boxes identify what events and conditions have to occur for each link in the causal pathway to work as expected. What is necessary for the link to work? Articulating causal link assumptions would entail a mix of stakeholder experience, social science theory and prior evidence, and may depend on the context in which the interventions will be implemented. For example, in the child nutrition example, an assumption could be that husbands and mothers-in-law are supportive suggested change to children's diets. Causal link assumptions cover all the risks associated with the link. Conversely, each of the assumptions is a risk to the realization of the ToC. In the example, risks concerning the availability and affordability of nutritious food would be captured by an assumption that nutritious food is available and affordable.

These assumptions are events and conditions that need to occur for the intervention to be successful. They are *support factors* (Cartwright and Hardie, 2012). The support factors plus the intervention activities are the *intervention causal package* represented by the ToC which is expected to be sufficient to realize the results depicted. That is, if the activities and the assumptions (support factors) occur, then the results will follow. If the support factors alone are not enough to deliver the results,

then the intervention is a necessary part of the causal package and can then said to be a *contributory cause* (Mayne, 2012a; Stern et al., 2012).

Figure 1. A basic generic theory of change

External influences are events and conditions unrelated to the intervention and its causal package that could contribute to the realization of the intended results. These could include another interventions with similar aims and/or general economic or social trends. External influences have positive effects on the intended results. For example, a reduction of the price of vegetables could also explain an increase in vegetable consumption that is unrelated to the training intervention. Industrial fortification of foods such as sugar or flour could also explain an improvement in micronutrient status. Negative effects, i.e., risks, are included in the causal link assumptions.

Not shown in Figure 1 are *unintended effects,* positive or—more usually—negative unanticipated effects that occur as a result of the intervention's activities and results. For example, if promotion of vegetable production among women leads to the development of markets for vegetables, men could take control of production and sales. This could have a negative effect on women's control of income, and could indirectly undermine the goal of improving child nutrition. Similarly, if an intervention demands a large amount of a mother's time, she may have less time to devote to feeding and caring for children, which could affect their nutrition outcomes. Care should be taken to identify and account for these potential indirect impacts when ToCs are developed. Ex post, unanticipated effects should be actively looked for. Note also that while Figure 1 looks linear, it explicitly allows for *non-linearity* via the feedback between the various stages. Many A4NH ToCs exhibit non-linear elements.

The contention is that in most interventions, including those in A4NH, each of these components of the generic theory of change—activities, outputs, capacity changes, behavioral changes, direct benefits and wellbeing change, along with the associated causal link assumptions—can be, and should be, identified and analyzed when developing impact pathways and theories of change.

Theories of change for multifaceted sufficient interventions

Figure 1 only shows one actor involved in the implementation of the intervention. But for A4NH and many other interventions, this is generally not the case. In order to make a difference, A4NH needs to engage and work with a variety of other intermediaries—researchers, governments, the private sector and NGOs and influence their behavior. A4NH conducts research with beneficiaries but generally

does not participate directly in the implementation of development interventions, especially at scale.

The ToC shown in Figure 1 identifies a chain of outcomes and a possibly wide range of causal link assumptions that need to occur if the direct benefits and wellbeing changes are to be realized. Therefore, as part of or in addition to conducting research, A4NH also engages with relevant *intermediaries*—implementers such as development organizations and enablers such as policy makers or donors—whose actions can ensure (or go a long way to ensuring) that the assumptions are brought about. Examples include working with NGOs to evaluate the nutrition-related impacts of development interventions, posting a researcher to a development bank to help integrate research findings into the design of agricultural programming to make it more nutrition sensitive, and identifying and targeting key decisions and decision makers in policy processes with evidence-based policy briefs and other materials.

These causal link assumptions can cover a range of events or conditions that create an *enabling environment* for the core A4NH activities—the delivery of quality research outputs—to contribute to impact. This results in a much more *multifaceted* overall intervention but with the aim of ensuring that it is *sufficient*: that the collection of A4NH research efforts, its engagement activities and the resulting actions by intermediaries are sufficient to realize the expected benefits and contribute to wellbeing changes. That is, the set of research and engagement activities are expected to ensure that the causal link assumptions are realized and risks minimized.

Figure 2 illustrates a generic impact pathway for an A4NH intervention, illustrating that typically A4NH does not deal directly with intended beneficiaries. The components of the impact pathway in Figure 2 were described earlier from Figure 1. Figure 2 shows both the research outputs and the research outcomes. Research outcomes are of two types:

1. *Capacity changes,* the changes in knowledge, attitudes and/or skills, of the beneficiaries and intermediaries.

2. *Behavioral changes* are the changes in actual practices that occur in the beneficiaries and intermediaries; beneficiaries and intermediaries do things differently or use the research outputs
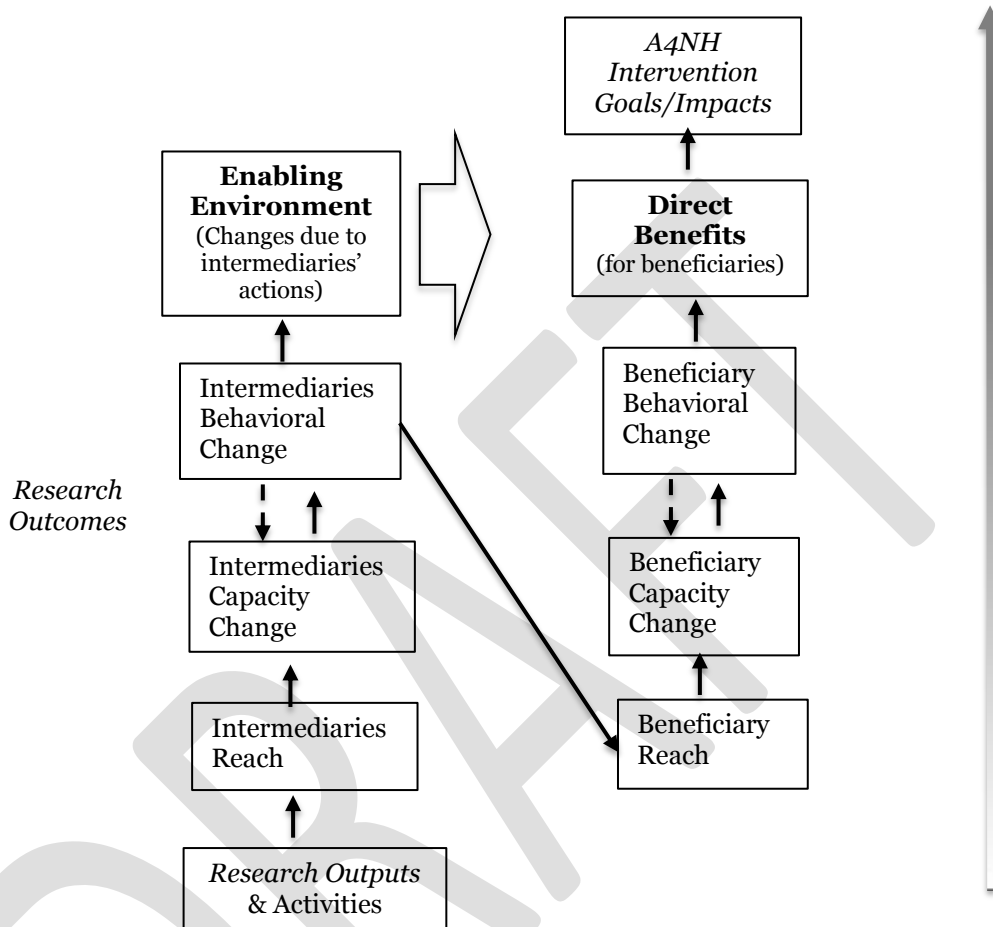
Figure 2. A generic A4NH intervention impact pathway

Within Figure 2 there are obvious *nested* impact pathways, such as the sub-pathways dealing with intermediaries and the one focused on beneficiaries. It is also clear that one could have still further nested pathways such as ones for each intermediary A4NH engages with. These would describe how A4NH engagement activities with the partner are expected to contribute to the realization of the intended benefits. If assumptions associated with the arrows in Figure 2 are identified, we would have a theory of change.
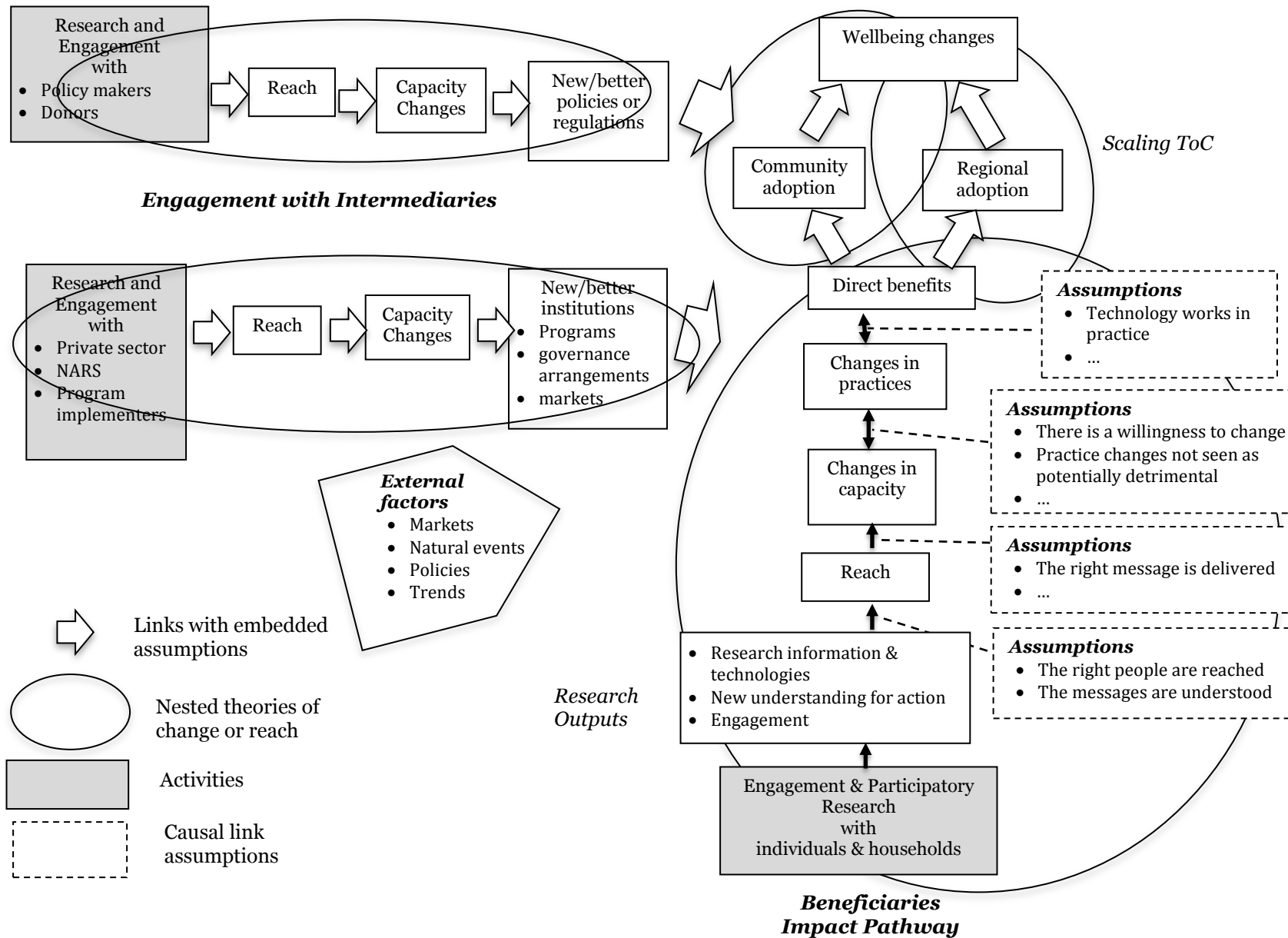
This is what Figure 3 depicts, adapted from (Mayne and Stern, 2013). Here only a few of the causal link assumptions are set out in the dotted boxes, with the remaining links in the ToC shown to

indicate there are embedded causal link assumptions involved. The dark shaded boxes in Figure 3 show all the (possible) actions (research, capacity building, and engagement) that A4NH and partners might be undertaking in the intervention: what A4NH believes is needed to make a difference.

The solid ovals in Figure 3 suggest where more specific (nested) ToC could be usefully developed. Others are also possible. These relate to various ways of 'cutting up' the intervention, focusing on different types of actors. In the top left of Figure 3, two possible theories of change are indicated focusing on the efforts undertaken to bring about changes in policies or institutions. The upper box focuses on "enablers" like policymakers or donors whose actions influence the behavior of other. In some cases, such as food safety work in Kenya, a change in dairy policy was needed for an research-based intervention to be implemented (Kaitibie et al., 2010). In other cases, such as biofortification—increasing the micronutrient of staple crops using conventional crop breeding techniques (Nestel et al., 2006)—the inclusion of standards for biofortified crop varieties in *Codex Alimentarius* was not needed for the initial intervention but is expected to support scaling up and sustainability (MacKenzie, 2014). Depending on the specifics of the intervention context, these could be further broken down into the efforts to influence specific research partners.

At the top right of Figure 3, possible theories of change are indicated to set out how scaling up to the community and to the regional level are intended to work. The large oval in the lower right of Figure 3 is the partially developed theory of change aimed at improving the wellbeing of beneficiaries. This is the ToC that would inform research areas, and the implementation of pilot interventions to test potential technological or institutional innovations. When considering the theory of change for a complex, multifaceted, long-term intervention, there is often a need for a series of such nested theories of change or theories of reach, i.e., separate theories of change to capture how the interventions are expected to work at different levels or stages of the process. Nested theories of change facilitate prioritization and sequencing of work on ToC development and validation. Ultimately, nested theories of change will show how the different parts of the A4NH program fit together and can provide a framework for an monitoring and evaluation plan that identifies what information is needed for which ToC and when.

Research and Engagement with
- Policy makers
- Donors

Reach → Capacity Changes → New/better policies or regulations

Engagement with Intermediaries

Research and Engagement with
- Private sector
- NARS
- Program implementers

Reach → Capacity Changes → New/better institutions
- Programs
- governance arrangements
- markets

External factors
- Markets
- Natural events
- Policies
- Trends

Wellbeing changes

Community adoption

Regional adoption

Scaling ToC

Direct benefits

Changes in practices

Changes in capacity

Reach

- Research information & technologies
- New understanding for action
- Engagement

Research Outputs

Engagement & Participatory Research with individuals & households

Beneficiaries Impact Pathway

Assumptions
- Technology works in practice
- ...

Assumptions
- There is a willingness to change
- Practice changes not seen as potentially detrimental
- ...

Assumptions
- The right message is delivered
- ...

Assumptions
- The right people are reached
- The messages are understood

Links with embedded assumptions

Nested theories of change or reach

Activities

Causal link assumptions

Figure 3. An indicative theory of change for A4NH interventions

Simplifying more complicated theories of change

Figure 3 illustrates how a quite complicated intervention with several partners can be depicted, and the nested theories offer a way to break down a more complex picture into something more understandable and practical.

Another way to handle complicated cases is to discuss the different major links in the ToC separately, such as getting from capacity changes to behavioral changes. In addition, discussion of, for example, the different assumptions can be done in an accompanying narrative which could also provide suitable references to prior research and evaluation that support the underlying assumptions. Examples of these approaches are shown and discussed below.

Simplification can also be achieved by using different versions of the same theory of change, showing different levels of detail. It is useful to have at least three versions of each theory of change.

The first is a text version, describing in a sentence or two how the specific intervention being planned or implemented is intended to work, a *theory of change narrative*. In the earlier child nutrition example, the theory of change narrative would be something like:

> By educating and informing mothers about the importance of a nutritious diet for their children, mothers will change their past behavior and seek to improve the diets of their children.

The underlying or *rationale* assumption here—the behavioral mechanism at work—is that better information will change behavior.

The second ToC version is a simplified *overview ToC* to show the big picture for a multifaceted intervention. Figure 4 illustrates an overview ToC for an intervention to improve food safety and

nutrition in informal dairy markets. In developed countries, food safety is managed through strict

regulatory standards; however in developing countries standards have proven to be ineffective

and often result in worse food safety outcomes (Roesel and Grace, 2014). Since the majority of

consumers get their meat and milk in informal (unregulated) markets, alternative approaches are

needed to provide value chain actors with incentives to improve safety and quality (Kaitibie et al.,

2010). In this intervention, A4NH works together with the CGIAR Research Program on

Livestock and Fish (http://livestockfish.cgiar.org/).
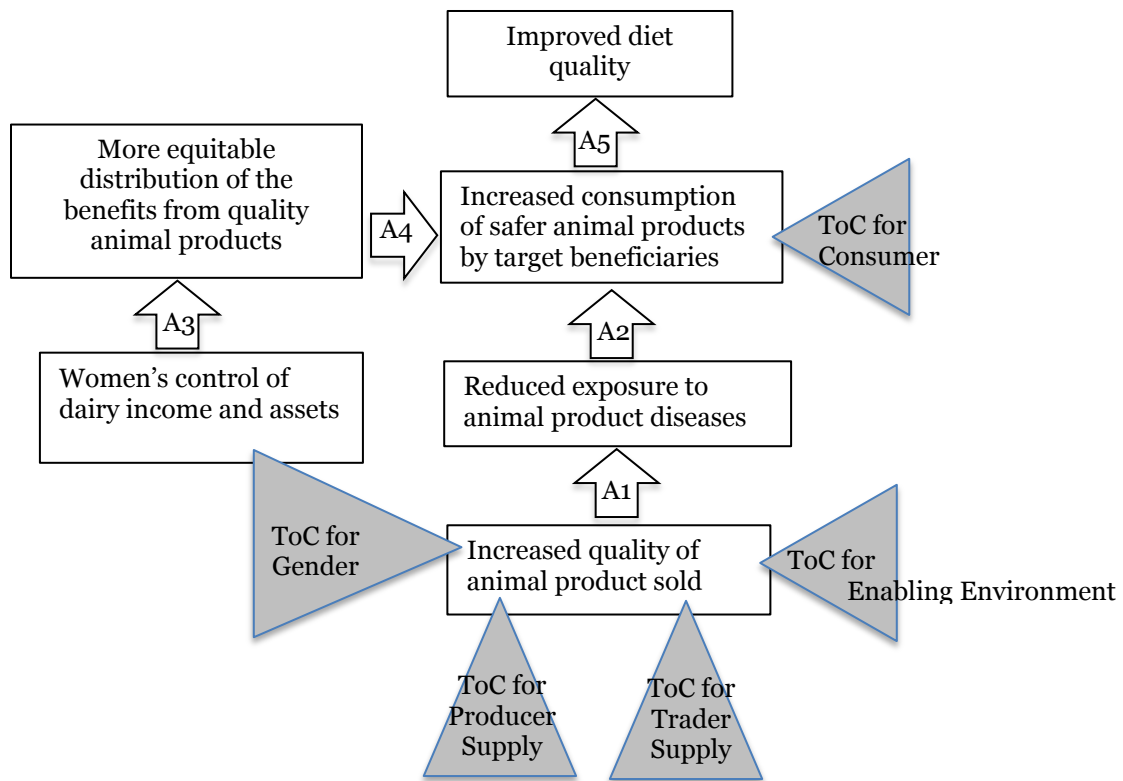
Figure 4. Overall theory of change for a dairy value chain intervention

Source: Johnson et al., forthcoming

The figure shows increased quality of milk sold being achieved through work with producers,

traders, consumers and women, and on the enabling environment, each of which has its own

nested ToC or theory of reach. This outcome reduces the exposure of consumers to

food borne diseases which in turn leads to increased consumption of safer milk. With more

equitable distribution of the benefits from improving the dairy value chain, improved diet quality

is achieved. The arrows indicate need for *causal link assumptions* (A1, A2, etc.) for various links

in the ToC.

The *ToC narrative* for this overview ToC is that IF safer milk can be made available and IF the

benefits from consuming milk can be more equitably distributed THEN improved diet will result
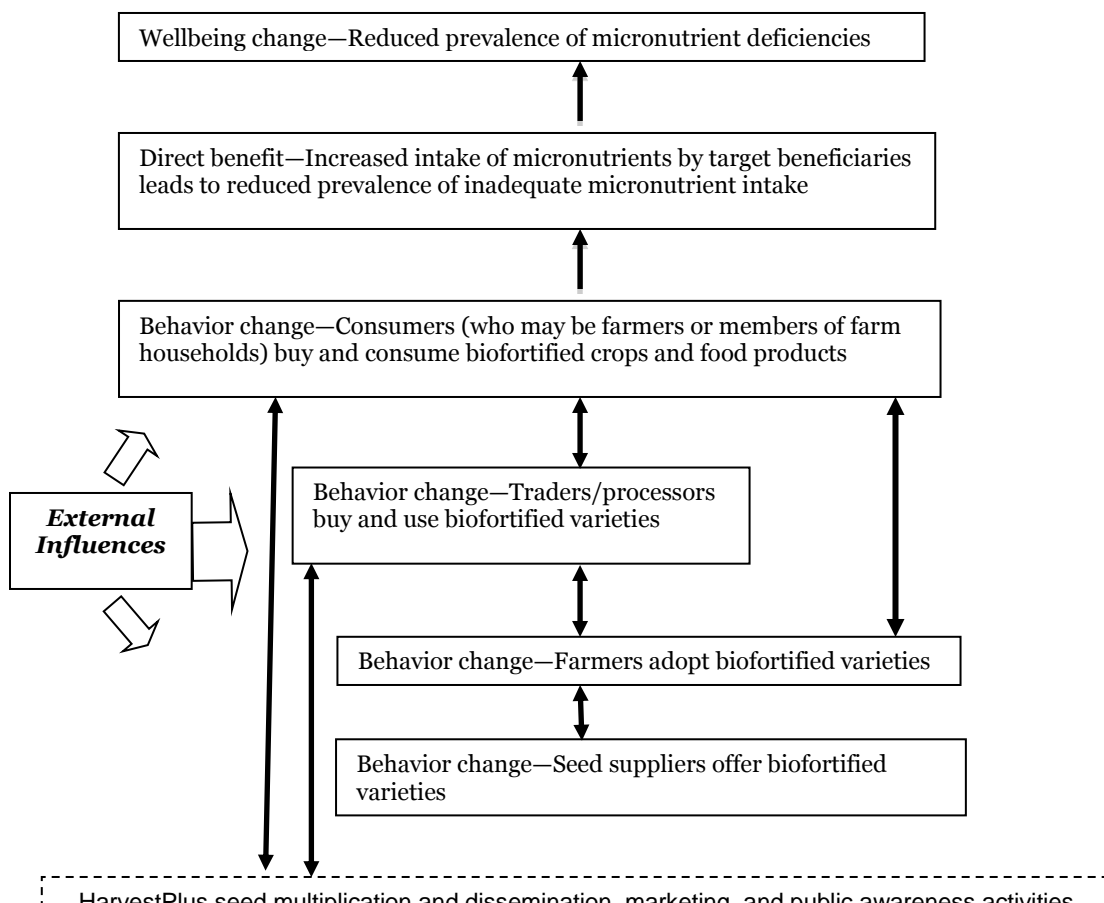
for women and children.

The third and more detailed version of a theory of change is usually a diagram model such as

those shown in Figures 1 through 4, showing the impact pathways and the causal link

assumptions behind the rationale assumptions at play.

For many interventions, displaying all of the elements of their impact pathway or theory of

change in a single diagram can be cumbersome, resulting in a too complex diagram of arrows and

boxes. One way to simplify a diagram is to show only the behavior changes. This is often tempting

to do since it is the Behavioral Changes that are thought to be the key outcomes along the impact

pathway. In developing it as a theory of change, it needs to be remembered that the Reach and

Capacity Change aspects are not explicitly shown, but rather need to be included in the

assumptions behind the causal link between the activities/outputs to Behaviour Change. So while

simplified, the same causal packages are at play.

An example of such a pathway is shown in Figure 5 that depicts the generic impact pathway for

HarvestPlus delivery in target countries (Johnson et al., 2015). HarvestPlus is a multi-institutional program dedicated to reducing micronutrient malnutrition through enhancing micronutrient content of staple crops. High micronutrient varieties have been developed and tested for nutritional efficacy and are now being disseminated in 9 target countries in Africa and South Asia.

In the figure, in addition to the HarvestPlus activities and two Direct Benefits, only the various Behavioral Changes in the pathway are shown. Identifying those boxes explicitly as Behavioral Change boxes is intended to make it clear that Reach and Capacity Change aspects of the pathway are not explicitly shown but are acknowledged. And it is clear that bringing about behavioral change in the beneficiaries and intermediaries is not straightforward and some care will be needed to think through the reach and capacity changes stages for each reach group. A further simplification in Figure 6 is the grouping of the activities of both HarvestPlus and its partners. In fact there is a nested ToC for each partner—for example, seed company, NGO, extension agency, rural health clinic, public relations agencies—showing how HarvestPlus engages and works with the partner to change the partner's behavior so that the behavior changes of the beneficiaries are realized.

Wellbeing change—Reduced prevalence of micronutrient deficiencies

Direct benefit—Increased intake of micronutrients by target beneficiaries leads to reduced prevalence of inadequate micronutrient intake

Behavior change—Consumers (who may be farmers or members of farm households) buy and consume biofortified crops and food products

External Influences

Behavior change—Traders/processors buy and use biofortified varieties

Behavior change—Farmers adopt biofortified varieties

Behavior change—Seed suppliers offer biofortified varieties

HarvestPlus seed multiplication and dissemination, marketing, and public awareness activities

$\updownarrow$

Figure 5. Generic impact pathway for HarvestPlus delivery in target countries

Source: Johnson et al., 2015

Using theories of change

Theories of change are models of how change is expected to happen (*ex ante* case) or how change has happened (*ex post* case). As such, theories of change have numerous uses in designing, managing and assessing interventions. Ten possible uses are listed and discussed below:

In designing/planning interventions

    a.   Designing interventions;

    b.   Understanding and agreeing on interventions with stakeholders;

    c.   Identifying and addressing equity, gender and empowerment issues;

    d.   Ex ante evaluation of proposed interventions;

In managing interventions

    e.   Designing monitoring systems; $\updownarrow$

    f.   Understanding implementation, managing adaptively and learning;

In assessing interventions

    g.   Designing evaluation questions, methods and tools;

    h.   Making causal claims about outcomes and impact;

    i.   Reporting performance;

In scaling

    j.   Generalizing to the theory, to other locations and for scaling up and out.

Of course to use a ToC, there has to be one. Ideally, they are developed during the planning stages

of an intervention in a participatory way. However, more frequently, ToC are developed after implementation and often, at least initially by the evaluator, hopefully then revised in a participatory manner and as new knowledge and understanding is acquired. A4NH is a newly-established program but builds on past research of partner organizations. The program is developing and using ToCs in all the ways described above.

Theories of change as tools for planning and designing interventions

As discussed above, developing a ToC involves gaining an understanding of just how the desired impacts are expected to be brought about as a result of the various activities of the intervention. In working this through, the set of sufficient activities are identified, de facto designing what is needed for the intervention to work. That is, in the case of A4NH, in addition to research outputs, considering the causal link assumptions and supporting evidence and the degree of control the intervention has or might have on them, identifies what kinds of complementary engagement activities with which partners are needed to raise the probability that the overall set of activities will be likely sufficient. If this ToC development process involves a variety of sources being able to challenge elements of the ToC, a more robust ToC will emerge and, if it is used as a basis for designing the intervention, a more robust and likely sufficient intervention.

The result will also be understanding and agreement among those involved in the process of how the intervention is expected to work. In large programs such as A4NH with multiple partners and components working on different aspects of a specific topic or issue, development of a ToC can help people see how pieces fit together—for example how the crop breeding, market analysis and consumer awareness parts of HarvestPlus work together to make the case for the intervention and how they work together on the ground to contribute (or not) to the higher level outcomes and impacts.

Consider the development of the ToC for traders involved in the supply milk in informal markets, noted earlier in Figure 3. This ToC is shown in Figure 6, from (Johnson et al., forthcoming). The

intervention depicted involves providing training to traders on safe food product handling procedures, introducing some form of certification program and unrolling a branding campaign aimed at consumers to stress the improvements being made on food safety in the value chain.

The sets of assumptions associated each causal link in the ToC can give rise to research issues. For example, consider the link from positive reach to changed knowledge, attitudes and skills and the associated A2 assumptions:

The training is intended to provide traders with the knowledge and skills to become certified. For this to happen (**A2a**) traders who have been reached with information need to be able to access the training and the training needs to be appropriate and effective. Cost, in time or cash, is an obvious potential barrier to participation, however other factors from social or gender norms to literacy and numeracy could influence who is able to attend. To stick with the training program, it is likely important that the traders relate well to the knowledge and practices being described.

On the consumer side, consumers have to take the time to learn about the branding (**A2b**). This they might do if they have concerns over the safety of the product, such as from past experience. If there are no current concerns about food safety, then consumers are not likely to pay much attention to the branding efforts in the absence of education on the importance of food safety.

Evidence for this causal link to work would include experience with similar training efforts elsewhere. In addition, evidence could include documented experience elsewhere showing, for instance, that when there are food safety concerns, consumers will pay attention to initiatives to improve safety and are willing to change their behavior for example buying from better quality suppliers or paying more for safer products. Where evidence is lacking, research may be necessary, for example to identify which incentives would work best to involve traders or to what extent low-income consumers are aware of a food safety issue or willing to pay more for branded food.

Undertaking this sort of analysis for each causal link will generate a useful list of issues for A4NH and its partners in planning research and for planning and designing the intervention. An integrated research agenda would include not only research to produce and validate technologies or other outputs but also research to test key casual assumptions for which evidence is lacking. Building the ToC may also identify key monitoring that should be undertaken once the intervention is implemented, as discussed later.
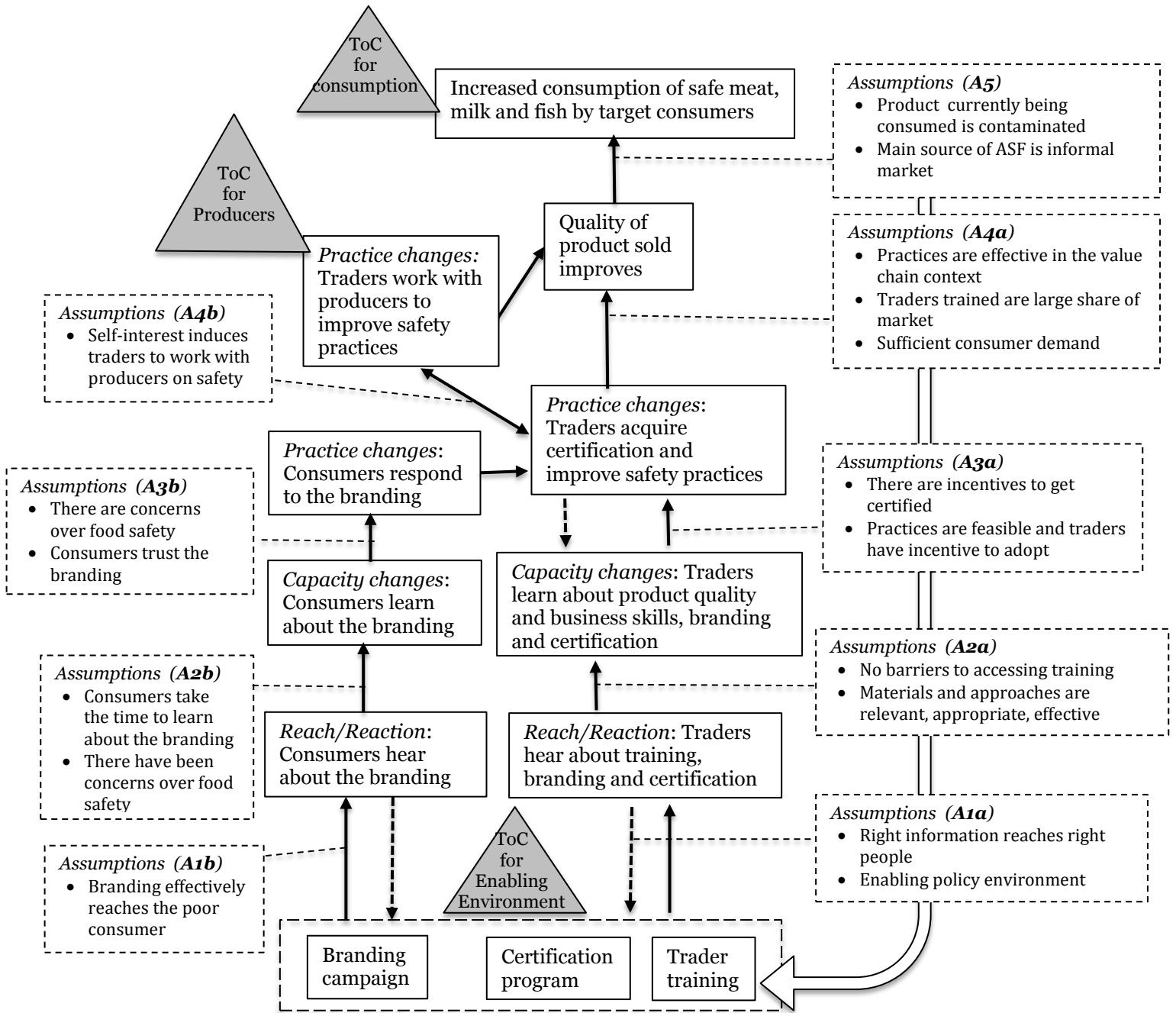
Figure 6: Generic trader ToC

One final note on using ToCs in a planning context. In some situations it can be beneficial to undertake an *ex-ante evaluation* of a proposed intervention to assess not only how big the potential benefits might be but also the likelihood that the intervention will work and the benefits shared appropriately. Approaches to do this based on logical analysis, look-alike interventions,

and synthesis of relevant intervention literature are being formalized by a number of authors (Brouselle et al., 2009; Brousselle and Champagne, 2011; Leeuw, 2012). This can be a cost-effective way to 'test' a planned intervention before large implementation investments are made. Such analyses can complement more traditional ex ante assessments that look at relative cost effectiveness as compared to alternatives, such as was done for HarvestPlus (Meenakshi et al., 2010).

Theories of change as tools for managing

ToC can be developed up front as an input to planning an intervention but then effectively ignored once implementation is underway. This is not good practice. Rather a ToC can be a valuable management tool to help in keeping the intervention on track and should be seen as an evolving model of the intervention.

This is especially the case for a multifaceted, long-term, complex intervention like A4NH. These interventions are not expected to remain static over time but to evolve as more is learned about the context and the emerging pathways. *Adaptive management* is often needed where reflective learning based on measurement is used to adjust implementation (Barder and Ramalingam, 2012; Andrews et al., 2013; Mbabu and Hall, 2012).

Whether in a development intervention or research program, to understand what is happening and if expected results (i.e., the ToC) are being or likely to be realized, a well thought out monitoring system is needed. The ToC identifies just what events and conditions should be tracked to understand how implementation is going. There is a need to monitor not only key results, but also key causal link assumptions. Monitoring information then can be used to adjust implementation and to revise the ToC. Hermans et al. (2012) and Ling (2012) discuss monitoring and evaluation of multifaceted complex interventions in this light.

A4NH and partners have successfully adapted a technology from the US to eliminate aflatoxins, naturally-occurring fungal toxins that contaminate maize and groundnuts and other crops and pose both acute and chronic risks to human health (Unnevehr and Grace, 2013), from farmers' fields in Africa (Bandyopadhyay and Cotty, 2013).   The technology has proven to be effective, and research has focused on profitability in farmer conditions. Because of its effectiveness in mitigating aflatoxin, the contribution to the goal of reducing consumer exposure to aflatoxin was assumed, and research efforts focused on making sure it was profitable for farmers to adopt it. Developing a ToC that explicitly included health outcomes revealed that some of the markets in which the technology is expected to be most cost-effective for farmers—export markets or domestic markets for animal feed—were unlikely to reduce exposure among consumers since exposure levels of consumers in those markets was already low. The insights from the ToC have contributed to a much more nuanced understanding of how farm-level technologies can contribute to improvement in human health and are being used to set priorities for aflatoxin research and policy engagement in A4NH.

Theories of change as tools for assessing impact

Theories of change are increasingly seen as key tools for evaluating interventions. Theory-based evaluations (Hansen and Vedung, 2010; Pawson and Sridharan, 2009; Rogers, 2007; Stame, 2004; Treasury Board Secretariat, 2012) are either used on their own to assess impact or in conjunction with experimental designs to explain why an intervention is working or not (White, 2009). ToC can help in identifying evaluation questions and in designing data collection tools.

A4NH interventions want to know and be able to show that they have made a difference, that they are a contributing cause to observed impacts. Where experimental designs are not possible, ToC are the basis for making credible contribution claims, using such approaches as contribution analysis (Stern et al., 2012; Mayne, 2012a). Biggs et al. (2014) discuss using contribution analysis to assess the impact of a nutrition intervention in New Zealand.

ToCs set out the framework for telling a credible performance story of an intervention. As such, a verified or partially verified ToC can be used as the basis for reporting on what contribution the intervention has made. In the case of HarvestPlus, a series of studies demonstrated the nutritional efficacy of the crops (Johnson et al., 2015), which provides strong evidence for the links between the top three boxes in Figure 5. Impact evaluations using RCTs have been conducted (Hotz et al., 2012a; Hotz et al., 2012b) or are planned for all crops to cover the full pathway from seed available through nutritional status in controlled conditions and for a small number of farmers and consumers. As part of monitoring process in the current delivery phase, activity and output indicators are being tracked for production and dissemination or planting materials, training of farmers, working with processors to develop products based on biofortified crops, and influencing consumer attitudes through activities as diverse as planting gardens at rural health clinics to integrating biofortification into local film plots (http://www.harvestplus.org/content/nollywood-premieres-star-studded-movies-improve-nutrition-across-nigeria) and song lyrics (http://www.rnw.nl/africa/article/biofortified-beans-fight-hidden-hunger-rwanda).

Development of the TOC for each country provided a framework for integrating these different pieces of evidence to make an impact story. It also highlighted the need for some attention to the outcomes in the middle of the pathway, between farmers deciding to plant seed and micronutrient-deficient consumers having access and choosing to consume biofortified foods in sufficient quantities throughout the year to have a meaningful impact on their diets.

Theories of change as tools for scaling

Scaling in agricultural research for development (AR4D) is an important and much discussed issue—see for example, Wigboldus and Leeuwis (2013); Hartmann (2012); Hartmann et al. (2013); Linn (2012b); Linn et al. (2010). Most A4NH interventions seek to bring benefits 'to scale'

through scaling up and scaling out. However, as a number of authors note, scaling terms are neither agreed nor well defined.

'Scaling up', in particular, means different things to different people (Wigboldus and Leeuwis, 2013). Anderson (2012) repeats an oft used definition that gives the sense of what scaling is "Scaling up means expanding, replicating, adapting and sustaining successful policies, programs or projects in geographic space and over time to reach a greater number of rural poor ".

Wigboldus and Leeuwis (2013) argue there are at least four generic types of scaling models [italics added]:

> Uncomplicated or simple situations involving little uncertainty and disagreement may be suitable for what we call a '*push'* approach: We have something that we would like to go to scale and we will work hard to make that happen. In more technically complicated situations, a '*pull'* approach may be a better fit: we have an aspired future in mind and seek to scale up and out that which we think will help make that future reality. A socially complicated situation may call for a '*plant'* approach: we have something we would like to see go to scale, but such scaling can only happen if we connect other factors and work with other (development) actors. And then there are situations which we may call 'wicked problems' in which there is a lot of uncertainty and disagreement. In such situations we want to opt for the '*probe'* approach: we have an aspired future in mind, but are unsure about what scaling processes would be involved in moving towards that future (p. v – vi).

From this literature, it is clear that when an A4NH intervention is discussing scaling, *it is essential that what is meant by 'scaling' in the context and how it is expected to be brought about is explicitly spelled out*. There is a need to be specific about the scaling pathways envisaged (Anderson, 2012: 12; Hartmann et al., 2013: 31). Is a more traditional 'push' approach being used or is the context such that a more complex 'probe' approach is to be used. In the former case, a separate scaling ToC can likely be developed. In probe approaches, the scaling ToC is likely to be part of the overall intervention ToC. Such an articulation provides the basis for developing an appropriate scaling theory of change for the case at hand.

For the examples used earlier, HarvestPlus is probably the closest to a push approach. As mentioned earlier, policy ToCs related to CODEX standardization could be considered scaling ToCs. The trader ToC is perhaps between a pull and probe case. A scaling ToC would focus on identifying and engaging with the actor(s) that would have the capacity and incentive to implement the training, certification, branding schemes at scale.

The idea that for the probe approach, the scaling ToC is part of the intervention ToC is very consistent with A4NH's approach to policy-oriented ToCs. Researchers and partners are very engaged in ongoing processes of policy development or in design and implementation of programs with other organizations. The goal is to feed evidence (and possibly also specific technological interventions) into the process, and given the dynamic nature of the contexts, the A4NH individual/teams need to be very aware of and responsive to changes.

Earlier, the enabling environment for an intervention (especially more complex interventions) was discussed as an essential element of a ToC. A similar concept is used when discussing scaling; there is a need for conducive 'spaces' for scaling to occur (Wigboldus and Leeuwis, 2013). In summarizing a series of briefs on scaling in AR4D, Linn (2012a) discusses a number of 'spaces': institutional spaces, policy space, fiscal and financial space, political space, partnership space, learning space, and other spaces such as environmental and social spaces. These can all comprise the enabling environment.

The scaling literature also identifies numerous barriers to scaling. Hartmann (2012: 1), for example mentions "a lack of infrastructure, access to financing, access to markets, knowledge of appropriate technology, and the inability to deliver products at sufficient quantity and quality". Others provide similar lists. The barriers are all the inverse of building the enabling environment, issues that need to be addressed for successful scaling.

Although ToC are mentioned in some of the scaling literature, there is usually no real discussion nor focus on developing a scaling ToC. The suggestion here is that developing a scaling ToC would be very beneficial in articulating just how scaling is envisaged in the case at hand and in developing a scaling implementation strategy. It would force out what is meant by 'scaling'.

Characteristics of a theory of change

The concept and application of theories of change can appear complicated, but only because 'theory of change' is not one thing per se. This is similar to the concept of 'evaluation' that can be many things, depending on a variety of situations. The following are characteristics or issues that are useful to be kept in mind or decided on when thinking about ToCs generally and for a specific purpose related to an intervention. Theories of change:

Are time dependent. They are set out at a point in time. Hence they

- Reflect understanding and knowledge up to that point
- Will and should evolve over time to reflect current thinking, as the ISPC report has noted (Independent Science and Partnership Council, 2012)

Have different purposes. They can be developed for different purposes and hence likely be different: Key purposes are:

- To communicate with others on how and why an intervention works
- To help design an intervention
- To developed a common understanding of how and why an intervention works
- To set out a hypothesis for change that will be tested by the intervention
- To provide a basis for a monitoring system
- To provide a basis for designing an impact evaluation and for making causal claims

Need to recognize uncertainties. ToC are models of causal sufficiency (Mayne and Stern, 2013: 23). If the intervention activities take place and if the assumptions embedded in the ToC occur, then the expected outcomes and impacts will be realized. As just set out, the model is deterministic. In fact, more realistically ToC need to be thought of in probabilistic terms: that the ToC model is *likely sufficient* (Mayne and Stern, 2013: 15-16). That is, the causal model is most likely produced the observed results. This suggests the need to identify and monitor key areas of uncertainty.

Can be either ex ante or ex post. ToC can be envisaged both ex ante before the intervention has been implemented and also ex post, after the intervention has been in place for some time.

Building impact pathways and theories of change

There are now numerous sources available for guidance on developing theories of change. Vogel (2012a) and Barnett and Gregorowski (2013) discusses ToCs in relation to research interventions. There is an extensive web site on theories of change at www.theoryofchange.org with references to many other guides and relevant literature.

Based on our work in A4NH, the following points can be noted:

Can start with a blank page or with a straw IP/ToC. In a participatory manner, one can start with a blank page and a facilitator who proceeds to tease out the way participants (stakeholders) imagine that the intervention is to work and the implicit assumptions behind their thinking. By continually asking 'why?' and challenging the ideas put forth, an IP/ToC will emerge. A key advantage in this approach is that there will likely be considerable buy-in the resulting IP/ToC. It may, however, take some time for an agreed IP/ToC to emerge.

Alternatively, a few people can draw up a seemingly reasonable IP/ToC and offer it as a starting point for debate and discussion. Stakeholders typically have strong views about how they think the intervention is to work, so a lively debate usually follows. This approach usually results in a more efficient process but may not get the same level of buy-in as quickly as the blank page approach. It has another advantage though. It may be easier to bring relevant prior research and evaluation findings to bear to buttress the IP/ToC.

Include explicitly or implicitly all the IP/ToC elements. The suggestion here is that in most interventions each of the ToC components (reach, capacity changes, behavioral change, direct benefits, livelihood change) can be, and should be, identified, as building blocks of a ToC. As was illustrated earlier, some elements may be implicit and captured in the associated causal link assumptions. But the discipline of thinking through each element for each pathway will result in a considerably more robust IP/ToC.

ToCs should be seen as a process, evolving over time as more insight is gained.
Both Vogel (2012a) and Barnett and Gregorowski (2013) stress the importance of seeing and using ToCs as a tool throughout the life of an intervention. The ToC can be a useful tool for reflecting on the implementation of the intervention. Of course, one might conclude that results are not occurring as expected at all and decide completely rethink the ToC or indeed stop the intervention.

Good enough IP/ToC. There is a risk in developing an IP/ToC of trying to get it 'perfect', especially at the outset. IP/ToC are models of often quite complex settings and interventions. They need to set out key aspects of the intervention, but if they seek to include all possible links among variables run the risk of becoming a 'spaghetti' model that few will understand and fewer will be able to use. Identifying nested ToCs is one way to reduce the complexity. As noted earlier, IP/ToC should be seen models that evolve as understanding and knowledge is acquired. The level of the complexity in the pathway and detail in the summary of evidence for causal links will also depend on the purpose of developing the TOC and the target audience.

Key are often the capacity and behavioral changes. Sometimes too much attention is spent building the higher levels of the ToC discussing and debating just how impacts will happen. This can be an interesting area for discussion, but may be far removed from changes that the intervention can more directly affect. Certainly at the outset, getting a good handle on the areas that the intervention can reasonably be expected to directly influence is important in designing and tacking implementation and early results.

Are based on prior research and stakeholder views. A good IP/ToC is not just the agreed views and beliefs of stakeholders. It should also be as much as possible evidence-based, using research and evaluation findings on previous like interventions to identify likely linkages, rationale and causal link assumptions and risks (Vaessen and Leeuw, 2009; Stern et al., 2012). All of the A4NH interventions and the corresponding ToCs developed, are based on previous research and on evidence from pilot interventions which should be used to inform current efforts.

Since ToCs are based on a combination of prior social science research, experience and on stakeholder views, a number of possible ToCs for a given intervention be generated. Hence the need to see a ToC as a model hypothesis at a point in time which is developed to be tested:

- One might want to test a funder's ToC about how things are supposed to work, or an hypothesis about underlying social processes.
- Often one develops a ToC based on both stakeholder views and relevant research findings.
- There may be cases where there are quite different views on how an intervention is to work. One may then need more than one ToC and each get challenged and tested (Hansen and Vedung, 2010). In the trader TOC case, there are definitely differences among stakeholders about the approach to regulation. There are still people who think it is the only way to deal with food safety while others are convinced by the evidence that

regulation can do more harm than good where it can't be enforced and/or where the (economic) costs of enforcement outweigh the (public health) benefits.

Finally, in the A4NH case, this use of prior research has proven beneficial in bringing different research teams together and getting buy-in.

Can be set out at different levels of detail. A key challenge in developing an IP/ToC is to decide on what level of detail is most useful, which usually depends on the purpose:

- From a sentence or two ToC narrative for communicating basics ideas about the intervention, to more detailed ToC which can be useful for detailed operational planning. But highly elaborated a detailed 'spaghetti' chart logic models are usually not very helpful.
- In many cases one should aim for less complex depictions of a ToC, such as using nested ToCs, discussed below. Some ways of displaying a ToC are better than others at doing this.

As suggested earlier in anything but the most simple interventions, it will probably be useful to have a number of IP/ToC models for use for different purposes. Trying to have a single IP/ToC to tell both the big-picture story and be useful for managing is not usually practical.

Can be displayed in a variety of ways. Usually some form of a chain of results is the basis for depicting the ToC, such as shown above in the various figures. But some authors have used a more narrative form composed of a series of "If, … the" statements. See, for example, Leeuw (2003). How to best display a ToC depends significantly on the intended purpose.

Generic IP/ToC can be quite useful. A large program such as A4NH will typically have a wide range of interventions. But there still may be a smaller set of types of interventions for which generic IP/ToC can be developed, such as for advocacy and capacity building, and different value

chains. These can then be helpful starting points for developing specific IP/ToC around specific outputs, or in specific country or field offices, who then have a solid and researched basis on which to build their own IP/ToC.

Nested IP/ToC can be quite useful. Many A4NH interventions are quite complex making it difficult to capture in a single diagram key aspects. One way of dealing with this is, as suggested earlier, to develop sub- or nested-IP/ToC. Several of the earlier figures suggested such nested theories of change. Nested-IP/ToC are also useful to more clearly model the engagement with A4NH partners.

Nested IP/ToC might be developed around:

Types of strategies being used. These could be around the various types of engagement or capacity development efforts undertaken across projects and the specific results sought through research activities.

By target groups. This can be a very useful perspective to take for nested ToCs, focusing on the behavioral changes required by different intermediary groups to achieve the aims of the intervention (such as researchers, NARS, private sector, NGOs, women's groups). This offers a way to disaggregate a more complicated pathway, namely by developing IP/ToC for different actor groups (including partners, intermediaries and beneficiaries) who need to be 'reached' by the intervention. For each an IP/ToC could be readily developed and used as the basis for the engaging with each group.

Concluding remarks

The A4NH research program is building theories of change for the range of its interventions. Doing should allow for

- better designed interventions;

- strong and more realistic monitoring;

- an ongoing tool for adaptive management;

- a strong base for demonstrating accomplishments.

Key to these benefits is seeing theories of change not as something done once and then forgotten, but rather as a tool that is used and revised regularly during the life of the intervention:

> In short, while a theory of change provides a means by which the complexity of the intervention and change process can be better articulated, this very complexity means that it cannot be done in one easy step. In other words, a theory of change does not provide a single set of objectives and indicators against which all the monitoring and evaluation can then be developed and rolled-out, but rather it establishes an initial understanding against which questions, hypotheses and evidence can be used to test and revisit the initial understanding of complexity – and for the programme to adapt accordingly. For this to occur, a theory of change needs to be accompanied by a commitment to continually revisit and review the theory of change – and this requires addressing the incentives for staff (and stakeholders) to regularly collect evidence and reflect upon the research-policy interface in their particular context (Barnett and Gregorowski, 2013: 9).

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