EVIDENCE FOR TRANSFORMATION:

FRAMING A RESEARCH AGENDA IN AGRICULTURE FOR DEVELOPMENT

PART I: THE PUZZLE OF AFRICA'S AGRICULTURAL DEVELOPMENT

Agriculture remains central to the global fight to end extreme poverty and hunger by 2030. Nearly eighty percent of the world's extreme poor continue to work in agriculture, despite large demographic shifts toward urbanization. Yet, even after a decade of increased attention on agriculture as an important avenue for development from the international community[1] and significantly expanded Official Development Assistance (ODA) for agriculture, key indicators lag. Take for example Sub-Saharan Africa. The yield gap for cereals between Sub-Saharan Africa and other regions has only grown, along with an increasing gap in chemical fertilizer use and deficits in irrigation (FAOSTAT). Indeed, investment in agricultural R&D in Sub-Saharan Africa is by far the lowest in the world.[2] Similarly, of all agricultural growth in Sub-Saharan Africa between 1985 and 2012, 63 percent came from farmland area expansion, 8 percent from factor deepening, and 29 percent from productivity gains (Goyal and Nash 2016). This pathway to growth is not sustainable, in part due to land constraints: average farm size is already declining in countries that are slated for rapid population growth in the next 30 years. Instead, increasing farmer productivity and agricultural outputs per unit of land, labor, or capital is essential to realizing the potential of agriculture to reduce poverty.

Clearly, central to this path is the adoption of productivity-enhancing innovation. In the last decade, the evidence base on the pre-conditions and determinants for agricultural technology adoption has grown vastly, a significant share of which was part of the first phase of the Agricultural Technology Adoption Initiative ("ATAI 1.0") portfolio. This evidence—drawn primarily from Sub-Saharan Africa and South Asia—makes clear that there are productivity-enhancing innovations available today, and that financial, information, and market reforms can increase farmer adoption of these innovations. However, we do not see widespread adoption, suggesting that additional barriers constrain farmer decisions. The evidence also suggests a cautious assessment of the potential of existing technology: a broad evidence base aimed at inducing technology adoption by relaxing a menu of constraints suggests that, absent further market reforms, farmers do not have access to technologies that will sponsor transformative change (Magruder 2018).

Taken together, these insights from rigorous evidence generated by ATAI 1.0 suggest that a rethink of the productivity and process of agricultural development is critical. A useful framework for this purpose is agricultural transformation, which documents the process of farmers transitioning out of subsistence and

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[1] This attention coalesced around the publication of the 2008 *World Development Report* on "Agriculture for Development, alongside the concurrent food crisis. Meanwhile, the fifty-five member states of the African Union enacted the Comprehensive African Agricultural Development Program (CAADP), mandating increases in national budget allocations for agriculture by at least 10 percent. Unfortunately, by 2014, only two AU member countries (Malawi and Mozambique) had exceeded their CAADP targets.

[2] Progress toward CAADP's recommended target of spending 1 percent of agricultural GDP on research & development (R&D) is disappointing: only six countries so far have met this modest goal.

into expanding commercial enterprise through expanded output markets, crop diversification, and the deepening of value chains. As farmer productivity grows and farm income becomes more diversified, the same processes may, over a longer term, lead to "rural transformation", through the growth and diversification of rural non-farm employment. Accelerating and achieving these transitions represents a clear goal for governments focused on agricultural policy. Facilitating agricultural transformation for the purposes of poverty reduction has strong precedent: success has been achieved in countries such as China, Vietnam, Chile, and Brazil (for important macroeconomic research on Brazil, see Bustos et al. (2016, 2017)), though not in most of Sub-Saharan Africa nor parts of South Asia.

However, while the macroeconomic dynamics of transformation have been well-described elsewhere, there is a significant evidence gap on what works to *motivate* or *kick-start* agricultural transformations, particularly in the Sub-Saharan African context where few such transformations have been observed, much less rigorously evaluated. Rigorous causal evidence combined with detailed household data is critical to understanding the underpinnings of agricultural transformation, particularly given recent evidence suggesting that farming households in Sub-Saharan Africa are not climbing the steps in the ladder suggested by the agricultural transformation theory of change (Reynolds 2018).

At the same time, many of aspects of agricultural transformation entail meaningful microeconomic choices along the transition path, and force policy decisions in areas where rigorous causal research is limited. Examples of fundamental microeconomic policies where substantial evidence gaps exist include the choice of whether to grow market-oriented or subsistence crops; under which conditions different input value chains deliver reliable, affordable, and quality inputs; or whether to engage in contract farming (and how to respond to that contract). To our knowledge, no clear global research agenda has been formulated to address these knowledge gaps. Given this void in an evaluation and learning strategy that would probe the links in the relevant theories of change that generate transitions, the research agenda for the next phase of ATAI ("ATAI 2.0") must place its central focus on the interaction of farmers with markets; on input and output markets; and on contracts, value-added activities, and the diversification of production.

In this framing paper, we lay out an agenda for the ATAI 2.0 portfolio for our donors and our previous and future research collaborators. This framing paper does not endeavor to describe in detail the process of agricultural transformation, nor summarize existing relevant research. Rather, here we introduce a framework for ATAI 2.0 to develop our understanding of how specific microeconomic-level mechanisms may underlie some of the components of agricultural transformation in Sub-Saharan Africa and South Asia, thus unlocking the potential of agriculture to drive poverty reduction.

PART II: BRINGING AGRICULTURAL TRANSFORMATION UNDER THE RESEARCH LENS

DEFINING A RIGOROUS, ACTION-ORIENTED RESEARCH AGENDA

Many international donors and policy organizations have launched renewed efforts that emphasize the need to "transform" agricultural economies through increased productivity, greater commercialization, and inclusivity (DFID Economic Development Strategy 2017; DFID Research Review 2016; BMGF Agricultural Development 2017). Amid these policy commitments, the African Center for Economic Transformation

(ACET) provides a particularly useful outline of the steps required for an economic transformation in Sub-Saharan Africa as part of their *Africa Transformation Report 2017*. The policy recommendations in this report provides a useful starting point for our research agenda, as we describe in detail below.

In part thanks to the previous ATAI portfolio of research, there has been considerable progress with rigorous experimentation on how to use agricultural innovation to improve smallholder productivity. Hence, we know more today about how to use agriculture for development than we did 10 years ago (for a comprehensive summary of ATAI's first phase of work and key takeaways for policymakers, see Bridle et al. 2018, which summarizes the findings of ATAI-funded research amidst a broader summary of nearly 70 randomized evaluations). At the same time, the past decade of experimentation in developing-country agriculture has shown few 'quick wins' on the table, and the importance of pursuing multi-layered interventions rather than encouraging adoption of a single technology to achieve large-scale improvements. Interventions designed to overcome obstacles to technology adoption or to customize support services to smallholders will be limited when farmers operate in isolated or otherwise poorly functioning markets (in areas where markets function well and compensate for productivity increases or quality improvements, it is quite possible that technology alone could be key). To generate the transformative change required by many agricultural systems, questions of technology adoption need to be better connected to factors like larger-scale investments and mechanization, market linkages, value-added activities and the diversification of rural livelihoods, which is where ATAI 2.0 takes its starting point. The research agenda under this new phase of ATAI will place its central focus on the interaction of farmers with input and output markets; and on contracts, value-added activities, crop diversification, and the diversification of production—all under-researched areas where more rigorous evidence is needed.

Randomized control trials (RCTs), or field experiments, are critical because of their ability to identify clear causal relationships. This methodological rigor makes field experiments a central tool to understand both "what works" (and what *does not* work) for farmers.[3] Beyond this, RCTs can be a powerful tool for testing specific components of a program's theory of change identifying the mechanisms behind the success of specific interventions.[4] For this reason, donors investing in evidence-based policy have found RCTs to be a useful tool to identify promising cost-effective interventions.[5] The International Initiative for Impact Evaluation (3ie) tracks the contribution of RCTs and other impact evaluation methodologies to the state of knowledge around particular topics. In 2017 3ie released an evidence gap map on Agricultural Innovation—which incorporates existing ATAI studies among other work and covers many of the topics highlighted in this framing paper as potential areas of study under ATAI 2.0. This map concludes that "first,

[3] For more information on the effective design and use of randomized evaluations, we recommend J-PAL's Introduction to Evaluations found here. For discussion of applications in agriculture, we recommend "Field Experiments in Developing Country Agriculture" (de Janvry, Sadoulet, Suri 2016).

[4] For a discussion of the generalizability of findings from RCTs and a theory-based approach to their application, see "The Generalizability Puzzle" (Bates and Glennerster, 2017)

[5] For a discussion of the value of RCTs in the process of policymaking for development, we recommend "The Influence of Randomized Controlled Trials on Development Economics Research and on Development Policy" (Banerjee, Duflo, and Kremer 2016)

more evaluations using experimental methods are needed" as its primary recommendation.[6] ATAI 2.0 will help narrow this identified knowledge gap by supporting high-quality RCTs on key questions.

It is important to state explicitly, however, that the RCT toolkit will not be the right way to investigate the more macro dimensions of agricultural transformation. Examples of issues that should be considered 'out of scope' for ATAI research include cross-cutting agricultural transformation issues such as complementarities between national-level programs (which cannot conceivably be cross-randomized), the type of 'big push' dynamics such as urbanization or trade policy that operate only at the national level, or value chain development that operates at a very large-scale regional level. Nonetheless, many of the critical policy ingredients to agricultural transformation are more micro-level (such as access to local input and output markets, or local infrastructure improvements), and many of the links in the theory of agricultural transformation face significant evidence gaps. An expansion in the reach of experimental research has substantially broadened the scope of questions tackled while remaining true to the rigor of the technique. Statistically sound evaluations that can illuminate the functioning of value chains are ripe for further innovation, and studies currently in progress and forthcoming from ATAI may illustrate a path forward—both in terms of more cost-effective measurement methodology and policy direction. Since randomization is the most rigorous and transparent way to evaluate specific micro- and meso-level policies to promote agricultural transformation, RCTs will play a critical role in building an evidence base for informed policy-making.

By conducting research with the very highest internal validity, ATAI can play a driving role in building the evidence base underlying agricultural development and the role of agriculture for overall development. Further, because ATAI studies almost always collect detailed household-level data, our research can provide a critical evidence base for efforts to understand segmentation among individual actors in agricultural markets. We intend to collect coordinated household data across multiple contexts that will allow the ATAI portfolio to push the frontiers of the quantitative definition of farmer typologies. We will speak to the ways in which subsistence, pre-commercial, and commercial farmers differ from each other in their agricultural practices, but also to whether programs and policies differentially impact these groups. In sum, RCTs can deliver concrete evidence on the policies most effective at driving the household-level transitions identified as critical by AGRA (see Table 1.2 in the *Africa Agriculture Status Report 2017*, and Table III in the Annex of this document).

STRUCTURING RESEARCH AROUND A VISION OF AGRICULTURAL TRANSFORMATION

Under ATAI 1.0, we organized our research through a set of seven constraints that can act as barriers to the adoption of existing productivity-enhancing technologies: credit, risk, information, land, labor, input/output markets, and externalities. ATAI 1.0 achieved major successes in narrowing knowledge gaps around technology adoption, in particular in understanding the policies and programs that can be used to address risk, credit, information, and input/output constraints. Many of these findings are synthesized in our Emerging Insights briefs, attached as an appendix to this document, which also outline key research questions for individual constraint areas going forward. Our work also highlighted the extent to which in

[6] Agriculture Innovation: An Evidence Gap Map (3ie 2017)

order to be sustained, adoption of agricultural technology must be considered through the lens of the "business of smallholder agriculture." We must consider farm-level decisions within the broader context of the factors required to power an agricultural transformation in Africa and Asia, such as the access to markets and the access to large-scale investments (like mechanization and irrigation) and infrastructure. With this in mind, we propose an ATAI 2.0 that reconfigures our research agenda around testing some of the potential drivers of this transformation.

The structure for this new phase of ATAI research centers on the key steps in the theory of change towards agricultural transformation. Orienting ATAI 2.0 around a specific set of outcomes in this way will focus the ATAI research portfolio around the single unifying theme of agricultural transformation, unlike ATAI 1.0 that focused on a group of individual constraints to technology adoption. This makes ATAI 2.0 narrower in focus, but broader in the set of policies or interventions that could be studied to achieve agricultural transformation. In Table I in the Annex, we show a schematic illustration of how the previous ATAI constraints framework maps to the new framework. The schematic also provides examples of existing RCTs from the ATAI/J-PAL/CEGA network on some of the links in particular theories of change relevant to the topics articulated in the framework below.

Continuing to apply the rigor of RCTs to identify causal pathways, we would use additional research funding to promote RCTs that evaluate specific policies that promote inclusive agricultural transformation. Our RFPs, research projects, and policy outputs would be organized into five themes described in detail below, each corresponding to a step in the theory of change for agricultural transformation.

Agricultural transformation is by no means a short process. It is extremely unlikely that we will observe the process in full over the course of our research. To address this issue, we have identified key metrics that can indicate whether agricultural transformation is ramping up and whether the programs or policies tested are helping households move through the steps in the theory of change (please see Table II and III in the annex for more details on these outcomes of interest).

Below we describe each research area sequentially as it maps to the process of agricultural transformation, highlighting potential research questions. This information is additionally summarized in Table II in the Annex.

1. Improving access to factors of production*:* Access to the land, labor, and capital investments that promote agricultural productivity is critical for inclusive transformations, and previous ATAI research has shown that innovations such as asset-collateralized loans can be effective by enabling smallholders to purchase larger productive assets, including irrigation (Jack et al.2016). Factors of production such as labor and land are also crucial to profitable farming systems yet they are also under-researched, although recent field experiments have examined the impacts of land tenure reforms, which can induce greater capital investment by smallholders (Ali et al.2014).

   For experimental research, key areas for inquiry include:

- Enabling investments in productive agricultural assets that provide households with other key inputs such as water
- Contracts which facilitate access to shared productive assets for smallholders
- Land markets and the consolidation of property rights, e.g. titling programs (to drive more market participation)
- Efficient functioning of agricultural labor markets

2. Boosting agricultural productivity: Increasing yields is a critical first step in any movement toward agricultural transformation. According to LSMS-ISA data[7], some countries have made headway in increasing fertilizer use, albeit leaving them still with vastly lower rates than other regions of the world. Extensive work, including a large part of the existing ATAI portfolio, on boosting productivity has focused on the adoption of promising agricultural technologies, including innovations that increase yields (e.g. chemical fertilizers, high-yielding varieties) and conservation resources (e.g. pit planting, zero tilling) (see ATAI's Emerging Insights). The optimistic conclusion from this work is that it is possible to relax constraints to technology adoption and drive improvements in productivity - for example, through credit products tailored for smallholders, or by leveraging social networks to better target information and extension services. However, this portfolio of work also highlights there is not one specific constraint which, if alleviated, would provide the change that could lead to agricultural transformation. In part, this is due to the scarcity of technologies which are likely to be transformative; in part, it is likely attributable to the presence of multiple overlapping constraints, so that as soon as one key constraint (such as access to credit) is slackened, another constraint binds.

   The current state of knowledge suggests a number of priorities for research in this area:

   - Continue the tradition of ATAI in improving our understanding of the adoption of technological innovations (improved seeds and inputs, precision farming, etc.) with an initial focus on staple foods, but drawing the pathway to longer-term transformation-related activities, such as cash cropping and diversification.
     - Increased focus on changing farming systems toward higher-value crops that make more extensive use of family labor throughout the year
     - Linkages between improvements in agricultural productivity and farmer welfare. What are the forms of productivity enhancement that translate into the largest decreases in consumption poverty and food insecurity?
   - Access to local input markets, especially in contexts where reliable access to quality, context-attuned technologies is poor or uncertain
     - Contracts through the input value chain may be important policy levers
   - Interventions which relax multiple constraints simultaneously, or which relax individual constraints in the context of new, highly productive opportunities

[7] In drawing generalized conclusions, it is important to note that LSMS-ISA data is only available for 8 countries in sub-Saharan Africa.

- Prior research has largely stayed away from bundled interventions in part due to the complexity of associated evaluation design and the challenges in interpreting behavioral mechanisms that respond to a complex product.
- What packages or bundles of services (extension, seeds, fertilizers, credit) might be needed to relax multiple productivity constraints simultaneously? Evaluated interventions may relax financial constraints, risk constraints, and/or information constraints, and will focus on either relaxing multiple constraints, or focus within a single constraint on contexts where the evidence is poor (see ATAI's Emerging Insights for illustrative research questions)

- Understanding the role of farmer-level heterogeneity (both in terms of personal and plot characteristics) and customization in the diffusion of new technologies (e.g. rural advisory services or information communications technology (ICT)-related tools that break down information asymmetries)

3. Building output market linkages and domestic value chains: Market-level and infrastructure-level constraints are binding to transformative effects, and may be the most expensive to alleviate, with correspondingly less rigorous research. Similarly, existing rigorous micro-evidence suggests that small-scale producers often lack sufficient and sustained incentives to adopt productivity or quality-enhancing technologies under current output market structures.

   We anticipate ATAI 2.0 will focus on the following aspects around output markets and domestic value chains:

   - Understanding market intermediaries, market depth, and prices, (for example through the evaluation of market access information technologies, producer organization innovations, and the links between smallholders and commodity exchanges) and their effects on production decision-making, including crop choice and crop variety choice
   - Interventions that focus on post-harvest storage and processing that increase the value of sales and farmers' engagements with markets
   - Output contracts and quality recognition in output markets
     - Access to value chains and contract farming arrangements (and their terms) that guarantee famers' purchases
     - Other channels for smallholder aggregation and access to markets (e.g. via producers' organizations)
   - Access to domestic output markets or domestic market trading systems
     - Alleviating risk in domestic output markets (through, for example, price insurance) and access to deeper markets
     - Role of domestic value chains in inducing changes in crop choice and production practices

4. Adding value, mechanization, and agroindustry: Once assets, agricultural productivity and markets are better functioning, they should be followed by value addition in agriculture, mechanization that can release labor and further increase productivity and investments in agroindustry. However, this is an area with even less research.

   Relevant research priorities in this area will include:

   - The adoption and impacts of labor-saving technological change through mechanization
   - Agroindustry:
     - Value- added activities (agro-processing, crop certification, and exporting)
     - Effects of agroindustry on transitions to more sales based and ultimately commercial farming
     - Producers' organizations, public-private partnerships, private outgrowing contracts and other institutional contracting frameworks that enable smallholders to take advantage of agroindustry infrastructure

5. Promoting local economic diversification: This describes the start of the process of moving farmers away from livelihoods grounded entirely in agriculture and towards having a foot in the rural non-farm economy. Of key importance will be crop diversification as an initial step towards agricultural income diversification, greater commercialization of agriculture and ultimately some participation in the rural non-farm economy and potentially, migration.

   Research priorities will include:

   - Specific strategies of agricultural diversification away from subsistence staple production into high value crops
   - Seasonality of labor, smoothing labor calendars:
     - Agricultural diversification, may include mechanization (to add new harvest seasons)
   - Commercialization of agriculture and moving beyond productivity gains in staple crop
   - Ultimately, the use of revenues from agricultural activity to finance off-farm investments, diversification of income away from agriculture, and increased use of labor outside of farm work.

The first three thematic areas within our research agenda (improving access to productive assets, boosting productivity, and building market linkages and value chains) embody pre-conditions for agricultural transformation. Without access to land, boosted agricultural productivity, and linked output markets, transitions out of subsistence agriculture towards commercialization and from off-farm sales towards commercial enterprise would not be possible. When each of these preconditions is met, the fourth and fifth themes generate agricultural transformation through changes in wealth, wages, and the demand for on-farm and off-farm labor. Effective policymaking demands research that provides rigorous, causal evidence on which policy levers are effective at inducing agricultural transformation across these five dimensions. This new round of ATAI funding will therefore place its central focus on the interaction of farmers with markets. In addition, generating evidence for policymaking will require the measurement of outcomes

beyond farm-level productivity that signal a successful agricultural transformation: not only economic changes such as crop and income diversification, migration, etc., but also core welfare indicators such as consumption, food security, and nutrition that indicate success in lifting the condition of the rural poor.

In addition to the five categories in the continuum above, we propose two cross-cutting themes that would be emphasized at each stage in the agricultural transformation research process. These are:

1. Promoting gender equity[8]. For example:
    a. Evaluating and promoting inclusion in the commercialization and contracting process
    b. Considering the role of gender differences in asset control, including access to land, and intra-household bargaining in evaluating welfare impacts of transformation interventions
    c. Understanding the role of gender differentiation in labor markets and how this can be harnessed to produce effective household-level income diversification
2. Promoting food security and nutrition. For example:
    a. A decease in the meals missed by households.
    b. An improvement in dietary diversity.

[8] As discussed in the accompanying proposal, ATAI will communicate with the Bill & Melinda Gates Foundation to understand their ongoing efforts to encourage gender-relevant data collection and analysis given the broad related evidence gaps

ANNEXES

TABLE I

The research agenda of ATAI 2.0 builds on the findings of research already seeded by our previous portfolio. In the table on the following page, we map our previous research framework to our proposed direction; specifically, we identify which of seven theoretical constraints to technology adoption bear relevance at each of the five steps towards agricultural transformation. We additionally include reference to specific studies funded under ATAI 1.0 as examples of RCTs that speak to each of these stages. Under ATAI 1.0, rigorous testing of programs to relax one or more of these constraints to technology adoption has developed our understanding of which constraints on smallholders may bind at each of the steps towards agricultural transformation. Taken together, this mapping demonstrates that RCTS are not only feasible, but a valuable tool for this research agenda; the foundational work under ATAI 1.0 positions well us to meet the demand for evidence on strategies to promote agricultural transformation.

MAPPING ATAI 1.0 TO A RESEARCH FRAMEWORK FOR AGRICULTURAL TRANSFORMATION (AT) AND RURAL TRANSFORMATION (RT)

Steps toward AT / RT	1 Improving Access to Productive Assets	2 Boosting Agricultural Productivity	3 Building Output Markets and Domestic Value Chains	4 Agricultural Transformation	5 Rural Transformation
Constraints to technology adoption	Land				
	Labor				Labor
	Input Markets		Output Markets		
	Smallholder Credit			Small Enterprise Credit	
		Agricultural Risk (adaptation, mitigation)			
		Agricultural Information	Contractual Information		Labor Market Information
Examples of research & evaluations relevant to steps in AT & RT framework	Land markets and the consolidation of property rights Goldstein et al., 2015*; land tenure	Farm-level adoption of improved inputs and practices Aker and Jack, ongoing**; demi-lunes for rainwater harvesting	Market intermediaries, market depth, prices, and production decision-making*, includes: Casaburi and Reed, 2017**; intermediary pass-through	Contract farming Casaburi, Kremer, and Mullainathan, 2012**; credit and info for contract farmers	SMEs in rural contexts Social Networks and Payments, Risk-Sharing
	Functioning agricultural labor markets Breza and Kaur, ongoing**; wage floors Jeong and Robinson, ongoing**; job opportunities information	Financial access and protection from risk* J-PAL, 2016**; weather index insurance Improved agricultural advisory systems Cole and Fernando, 2018**; mobile extension Cohen et al., forthcoming**; nutrition-focused extension	Contracts and quality recognition de Janvry et al., 2017**; market reforms Domestic market trading systems Bergquist et al., ongoing**; market linkages	Agro-processing Hoffmann et al., ongoing**; aflatoxin control Certification & exporting Ashraf, Giné, and Karlan, 2009*; export assistance	Suri and Jack, 2016; mobile money Migration, and/or Employment Kleemans and Magruder, forthcoming; weathershocks and migration Payment for Environmental Services Jayachandran et al., 2017*; payments to maintain tree cover
		Improved post-harvest storage Aggarwal, Francis, and Robinson, 2018**; savings clubs and storage			**Key** * Randomized Evaluation ** Randomized Evaluation funded by ATAI

TABLE II

In Table II, below, we summarize the research agenda as described in depth in the section titled "Structuring Research Around A Vision Of Agricultural Transformation"; namely, we list example research areas that would develop our understanding of each of the five steps towards agricultural transformation. In addition, we list intermediate "transformation" metrics that may indicate whether agricultural transformation is occurring and whether the programs or policies tested are helping households move through the steps in the theory of change. Collection of data on four of these metrics (identified below) will be required for all projects and all funded proposals must convince reviewers that they will move at least one metric through their research. We will share a fuller list of these metrics within our RFPs. In this way, we address a potential concern around research on agricultural transformation: that it is extremely unlikely that we will observe the process in full over the course of any one study or even the ATAI 2.0 portfolio. An added benefit of encouraging harmonized outcome measures will position us to look at cost-effectiveness across studies.

ATAI 2.0: BUILDING THE EVIDENCE BASE ON AGRICULTURAL TRANSFORMATION (AT)

Steps toward AT / RT	1 Improving Access to Productive Assets	2 Boosting Agricultural Productivity	3 Building Output Markets and Domestic Value Chains	4 Adding Value, Mechanization, and Agroindustry	5 Promoting Local Economic Diversification
Potential research themes	Land titling programs	Input markets Productivity-enhancing investments Post-harvest storage	Contracts & quality recognition Certification & exporting Intermediary markets	Agro-processing Public-private partnerships	SMEs in rural contexts Migration
Metrics and outcome measures to assess impact and progress towards AT / RT	**ALL PROJECTS REQUIRE COLLECTION OF ONE OR MORE:** Indicators for the adoption of agricultural assets/capital; Any production of high value crops (crop diversification); Sales as a fraction of total output; Yields per hectare				
	Share of land titled	Indicator for the adoption of irrigation systems	Indicator for the purchase of inputs on credit	Indicator for working as agricultural labor for wages	Share of non-farm income in total income
	Indicator for household renting in/out land	Indicator for the adoption of contracts for productive asset services (incl. mechanization)	Cereal prices (rel to urban markets)	Hours of labor hired-in by season	Share of households with migrants
	Indicator for the adoption inorganic fertilizer	Share of farmers adopting post-harvest storage technologies	Membership in farmers' organizations with value-added contracts	Share of processed crop sales to total value of production	Agricultural revenue from livestock, net of nonlabor input costs
	Indicator for the adoption high value cereal seed	Share of processed crop sales to total value of production	Indicator for the adoption of value added services	Membership in farmers' organizations with value-added contracts	Number of land sales transaction in past year

TABLE III

The table below identifies agricultural transformation-relevant outcomes of interest for ATAI. We hope that providing a list of outcomes will encourage some degree of harmonization around data collection design and provide further detail that supports researchers as they adjust to the new agricultural transformation framework.

In particular, we require all full-scale RCT proposals to commit to collecting data on the following four outcomes of interest for ATAI, and outline in their proposal how they intend to measure the underlying indicators as relevant to their context:

- **The adoption of productive agricultural assets or capital**
- **Any production of high-value crops (measures of crop diversification)**
- **Sales as fraction of total output**
- **Yields per hectare**

The RFP provides detailed proposal guidelines, and related data collection expectations for teams funded by ATAI.

We anticipate that ATAI researchers will collect data on a subset of the following short-term outcomes that can conceivably be shifted over the course of a funded project. We recognize that shifts in the longer-term outcomes below will unlikely be measurable within the timeframe of most evaluations.

Dimensions of Agricultural Transformation	Short Term Household-Level Indicators	Longer Term Household-Level Indicators
Improving Access to Factors of Production		
Enabling investments in productive agricultural assets that provide households with other key inputs such as water	Indicator for the adoption of durable agricultural assets Yields/productivity per hectare	Poverty status Consumption/income Prevalence of stunting among children Dietary diversity
Contracts which facilitate access to shared productive assets for smallholders	Indicator for the adoption of contracts for productive assets (including mechanization) Access to shared assets	
Land markets and the consolidation of property rights, e.g. titling programs (to drive more market participation)	Fraction of land titled Investments in land Indicator for household renting in/out land	
Efficient functioning of agricultural labor markets	Wage rates by activity and season Indicator for hiring in labor by season Hours of hired-in labor by season	

	Indicator for selling labor by season Sold labor hours by season	
Boosting agricultural productivity		
Adoption of technological innovations (improved seeds and inputs, precision farming, etc.) with an initial focus on staple foods, but drawing the pathway to longer term transformation-related activities, such as cash cropping and diversification.	Adoption of improved technologies Yields/productivity Switch to higher value crops or any production of high value crops (crop diversification) Use of labor throughout the year Food security and dietary diversity Crop income Livestock ownership Agricultural revenue from livestock, net of non-labor input costs	Poverty status Consumption/income Prevalence of stunting among children Dietary diversity
Access to local input markets, especially in contexts where reliable access to quality, context-attuned technologies is poor or uncertain	Purchases of inputs by quality of input Use of contracts for input supply Indicator for using credit to purchase inputs Crop income Agricultural revenue from livestock, net of non-labor input costs	
Interventions which relax multiple constraints simultaneously, or which relax individual constraints in the context of new, highly productive opportunities	Adoption of packages Yields/productivity Food security and dietary diversity Crop income Agricultural revenue from livestock, net of non-labor input costs	
Building output market linkages and domestic value chains		
Understanding market intermediaries, market depth, and prices, and their effects on production decision-making, including crop choice	Sales of crops (extensive and intensive margins) and livestock products Sale prices by type of sale intermediary Other services provided by intermediaries	

	Switch to higher value crops or Any production of high value crops (crop diversification) Crop income Agricultural revenue from livestock, net of non-labor input costs	Poverty status Consumption/income Prevalence of stunting among children Dietary diversity
Interventions that focus on post-harvest storage and processing that increase sales and farmers' engagements with markets	Use of post-harvest storage Use of practices to reduce crop loss Amount of crop processed Sale of processed crop	
Output contracts and quality recognition in output markets; Other channels for smallholder aggregation and access to markets (e.g. via producers' organizations)	Sales of crops (extensive and intensive margins) and livestock products Sale prices by type of sale intermediary Sale prices by quality Food security and dietary diversity	
Access to domestic output markets or domestic market trading systems; Role of domestic value chains in inducing changes in crop choice and production practices	Sales of crops (extensive and intensive margins) and livestock products Food security and dietary diversity Crop income Agricultural revenue from livestock, net of non-labor input costs	
Adding value, mechanization, and agroindustry		
The adoption and impacts of labor saving technological change through mechanization	Indicator for adoption of mechanization services	Wealth Poverty status Consumption/income
Agroindustry: Value-add activities (agro-processing, crop certification, and exporting) Producers' organizations, public-private partnerships, private outgrowing contracts and other institutional contracting frameworks that enable smallholders to take advantage of agroindustry infrastructure	Indicator for use of value-added activities by activity Indicator for contractual arrangements for farming organization Sales of crops (extensive and intensive margins) and livestock products Food security and dietary diversity Crop income	

	Agricultural revenue from livestock, net of non-labor input costs	
Promoting local economic diversification		
Specific strategies of agricultural diversification away from subsistence staple production into high value crops	Any production of high value crops (crop diversification) Yields/productivity Sales of crops (extensive and intensive margins) and livestock products Food security and dietary diversity Crop income Agricultural revenue from livestock, net of non-labor input costs	Income diversification Land consolidation Consumption/income Poverty status Prevalence of stunting among children Dietary diversity
Seasonality of labor, smoothing labor calendars: Agricultural diversification, may include mechanization (to add new harvest seasons)	Indicator for use of mechanization Any production of high value crops (crop diversification) Food security and dietary diversity Crop income Agricultural revenue from livestock, net of non-labor input costs Number of income sources, including off farm income activities	
Commercialization of agriculture and moving beyond productivity gains in staple crops	Any production of high value crops (crop diversification) Yields/productivity Sales of crops (extensive and intensive margins) and livestock products Food security and dietary diversity Crop income Livestock income	

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