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## Assessing the Impacts of International Agricultural Research on Nutrition and Health in Africa and Asia

SPIA TECHNICAL NOTE

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## Summary

The multifaceted agriculture-health-nutrition nexus contains many linkages, suggesting wide scope for leveraging agriculture to improve nutrition and health outcomes. Levers may range from changing crops to reforming national policies. Impacts may be direct, such as through dietary changes or changes in the nutritional value of food consumed. They can also be indirect, such as through changes in income or food prices. In the past, for example, much of CGIAR research targeted interventions aimed at raising farm-level productivity, which, when adopted at a sufficient scale, helped increase the overall supply of food and thereby lowered food prices. It is understood that the nature of the agriculture, nutrition, and health nexus varies from one region to the next, and that cross-sectoral links are mediated by conditional factors such as local infrastructure, market structures, women's empowerment, and the distribution of assets (including land).

## Scope of the Call: Assessing the Impacts of International Agricultural Research on Nutrition and Health in sub-Saharan Africa and South Asia<sup>1</sup>

The July 2013 call for proposals, under [ISPC-SPIA's Strengthening Impact Assessment in the CGIAR \(SIAC\) 2013-2017 program](#), was motivated by the desire to broaden and deepen the evidence base regarding the potential for agricultural research-based interventions to generate health and nutrition benefits. The objective was to complement—not duplicate—work in CGIAR's Agriculture for Nutrition and Health (A4NH) research program. The call focused on two themes:

- *Theme 1: Changes in crops, varieties, technologies, and farm practices.* This theme focused on agricultural production modalities, such as the adoption of improved crop varieties, and their impacts on nutrition through relative prices, income, gender, and other effects.
- *Theme 2: Changes in markets, value chains, and consumer demand.* This theme sought to examine the impact of international agricultural research on health and nutrition through changes in marketing channels and governance of those channels.

For both themes, the call for proposals encouraged studies that would go beyond identifying average treatment effects and that would explore heterogeneous treatment effects across social groups and explicitly consider the pathways through which agriculture affects health and nutrition, as well as the mediating factors that may affect impact (such as sanitation interventions). Potential pathways identified in the literature include: agriculture as a direct and indirect (through income from production) source of food; macro-level agricultural policy as a driver of prices; altered nutrition knowledge and norms; improved natural resource management; and, agriculture as an entry point for enhancing women's control over resources.

While the call emphasized the importance of proper attribution, it was flexible with respect to the research methodologies used to identify causal effects. As the call document stated, "We are seeking a portfolio of complementary and mixed methodologies to show plausible health and nutrition impacts from research-contributed agricultural development initiatives and to enhance our understanding of impacts."

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<sup>1</sup> <https://ispc.cgiar.org/workstreams/impact-assessment/impacts/assessing-impacts-international-agricultural-research>

## Summaries of Funded Studies

From an initial submission of 56 pre-proposals, we selected 12 pre-proposals for elaboration into full proposals. Eventually, five proposals were selected for funding. What follows is a list of funded studies and brief descriptions of their objectives and findings.

**1. *Adoption of high-iron bean varieties in Rwanda*** (*International Center for Tropical Agriculture [CIAT], Harvest Plus, Virginia Tech, Rwanda Agriculture Board*)

This study aimed to combine an adoption study of high-iron bean (HIB) varieties in Rwanda with measurement of nutritional outcomes, based on full dietary intake data. The study focused on areas where adoption was expected to be high, but it found that adoption rates and intensity of adoption were lower than expected. Only 21 percent of bean-producing households grew any high-iron beans, and adopting households planted an average of only 7.7 kg of high-iron bean seeds in the 2015 season B (the median was just 3 kg). Such low adoption levels implied that the study would be unlikely to show any effect on micronutrient intake or impacts on nutrition (through other pathways), and the nutrition module, which included full dietary intake, was dropped.

**2. *Shortening the hungry season through NERICA in Sierra Leone*** (*Innovations for Poverty Action [IPA], MIT, Sierra Leone Agricultural Research Institute*)

This randomized control trial of a New Rice for Africa (NERICA) variety had different treatment arms offering rice seeds at three different subsidy levels (of 0 percent, 50 percent, and 100 percent), crossed with a training intervention on how to adjust production practices to the requirements of the new seed. Take-up for NERICA variety was 21 percent in the no-subsidy treatment group (who paid market price), 62 percent in the 50 percent subsidy treatment group, and 97 percent in the 100 percent subsidy group (who received NERICA free of charge). The NERICA treatment did not change the planting week, but the onset of harvest came five weeks earlier for both the “treated-only” and the “treated-and-trained” groups. Yields for the treated-and-trained group increased 23 percent relative to the control group, whereas the group that received NERICA seed but no training did not experience a yield benefit.

The research team measured anthropometric indicators of nutritional status in children in treated and control households. In comparing outcomes for the 100 percent subsidy treatment group with those for the control group, the study found strong positive impacts on anthropometric measures—weight-for-height (wasting indicator) and body mass index (BMI)-for-age Z-scores—that persisted up to the beginning of the next hungry season, although it found no statistically significant impact on mid-upper-arm circumference (MUAC). At the end of the hungry season, impacts for the treated-only group were positive but not statistically significant, and much smaller than for the treated-and-trained group, in line with the yield results. Importantly, the endline results showed that the gains in anthropometric outcomes for treated-and-trained households increased over time, perhaps indicating that households expanded area under NERICA-6.

**3. *Crop diversification for food and nutrition security in Malawi and Ethiopia*** (*International Maize and Wheat Improvement Center [CIMMYT], Lilongwe University, Georg-August-University of Gottingen, Ethiopian Institute for Agricultural Research*)

This study aimed to look at the effects of diversification of the cropping system—specifically maize-legume intercropping—on nutrition indicators in Malawi and Ethiopia. The methodological approach

was quasi-experimental; in Malawi, the study applied a multinomial endogenous switching regression approach to cross-sectional data, and in Ethiopia, it applied a fixed-effects panel structure (with data from 2010 and 2013) to control for selection bias. In the Malawian case, the authors found that more diversified farming systems were associated with more diverse diets, but the correlations were weak. In Ethiopia, the adoption of Cropping System Diversification (CSD) and improved maize varieties was associated with reduced child stunting; higher per capita consumption of calories, protein, and iron; and greater household dietary diversity. The study reported 15 percent less stunting for children in households that adopted both CSD and improved maize varieties, compared with 2 percent less stunting in households that adopted only CSD, and 12 percent less stunting rates in households that adopted only improved maize varieties. The authors argue that these findings are consistent because hybrid maize growers are able to purchase highly diversified diets.

**4. *Looking beyond income: Impact of dairy hubs on nutrition in Tanzania* (International Livestock Research Institute [ILRI], Emory University, Tanzania NARS)**

This study applied difference-in-difference and propensity-score matching together to examine the impact of dairy hubs in Tanzania. The study found a negative association between household participation in a dairy hub and women’s dietary diversity score, however concerns related to endogenous dairy hub placement and low statistical power limit the interpretation of the quantitative results.

**5. *Nutritional impacts of irrigated horticulture in Senegal* (Columbia University, George Washington University, MDG Center)**

This study aimed to piggyback on a project to extend a combination of drip irrigation, nutrition messaging, and specific packages of technical inputs to women in Senegal for growing vegetables in small-scale gardens. Baseline data were collected and summarized, and a trial of the nutrition messaging was completed. However, the underlying project, which was to be the subject of the evaluation, stalled owing to delays in coordination between the Senegalese Government and donors.

The first three studies focus on on-farm interventions and fit under Theme 1. Studies 4 and 5 focus primarily on interventions that seek to alter the context within which production takes place, but ultimately also aim to affect the type of production that takes place (by changing incentives). These studies therefore fit better under Theme 2. Studies 1, 3, and 4 proposed using econometric techniques to study patterns in observational data, and studies 2 and 5 were based on an experimental design.

## **Contributions of the Studies**

Taken together, the Theme 1 studies sketch the contours of a rather optimistic picture. Interventions aimed at changing on-farm production modalities appear to have the potential to contribute to improved nutrition and perhaps even the health status of producers. This was found for the two interventions that looked at improved cereal varieties in context of changes in the production system (crop diversification, early maturation). There is also some evidence on adoption and diffusion of innovations, and the potential to achieve “scale” suggests that consumer markets may be affected. However, it is important to acknowledge that uptake of NERICA rice, and the modest adoption of high-iron beans were both facilitated by additional incentives. The treatment arm that led to statistically significant nutrition outcomes in the NERICA study featured fully subsidized rice and free training – features that may not be universally replicable. The mechanism for these positive nutritional outcomes is unclear, but presumably

relates to increased calories from staples. There was no effort to identify health effects (or anthropometrics) through diet quality.

The Theme 2 studies do not allow us to draw conclusive lessons. While there is no reason to believe such interventions will necessarily be less effective, the studies included in the portfolio did not provide convincing evidence of impact within the timeframe of this call. The following sections elaborate on several of the challenges faced by researchers from the various teams.

## **Concerns and Challenges**

While it is difficult to generalize across the five studies, it is possible to identify a number of factors that limit the ability to draw firm conclusions from the body of commissioned research.

### ***Overly optimistic planning***

Two studies failed to deliver on the promises made in their proposals because these proposals were based on overly optimistic planning. Implementation of the irrigated horticulture project in Senegal required coordination between three different national governments. This caused massive delays in implementation relative to the proposed timeline, and eventually resulted in the unsatisfactory situation that the main intervention had yet to commence by the time the SIAC program closed the books on this set of studies. The project on high-iron beans was based on overly optimistic assumptions about the evolving adoption rate of the improved variety studied. Even as high-iron bean varieties were being adopted, farmers continued to grow traditional varieties. Since nutrition impacts for producers had to materialize through consumption of own-produced food (because there were no measurable income effects through either quantities or prices), and farmers produced different varieties—with and without high-iron content—it was concluded that no measurable impact on nutrition status could have occurred. The results on adoption have important lessons for the HIB dissemination efforts.

### ***Attribution***

To what extent can any measured nutritional gains or improvements in health be attributed to specific agricultural innovations? Persistent attribution concerns remain about analyses based on observational data, which have motivated the use of Randomized Control Trials (RCTs). In RCTs, treatment status is orthogonal to characteristics of experimental subjects—purging concerns about self-selection and unobserved heterogeneity. The evidence that the adoption of NERICA produces particular nutritional gains is therefore credible – internal validity is assured. The same may not be true for other studies. The decisions of individual farmers to adopt intercropping or high-iron beans may be correlated with unobserved factors that also correlate with nutrition outcomes. The Ethiopia diversification study seeks to mitigate such endogeneity concerns by using advanced econometric models—endogenous switching panel models. Claims about causality in that study rely on the plausibility of additional assumptions, and hence should be made with care. Future work, studying cropping system diversification for which exogenous sources of variation in adoption can be explicitly identified, could help strengthen the evidence base.

The dairy hub study in Tanzania suffered from additional weaknesses: both the placement of hubs and farmers' decisions to join a nearby hub are evidently non-random. The study attempts to address the latter concern using an instrumental variable strategy, but in doing so, relies on strong assumptions whose plausibility can be debated. This study is probably also underpowered and does not control for

Intra-Cluster Correlation (ICC). In light of these concerns and others, it is best to regard the outcomes of this empirical exercise as a set of correlations only—not as indicative of causal effects.

### ***Measurement of nutrition-related outcomes***

Most—but not all—studies seek to measure nutritional- and health-related outcomes in various ways. Food intake and diet-related measures include (1) food expenditures, (2) consumption of specific food items (beans and milk), (3) caloric intake, (4) protein or iron intake, (5) a Simpson measure of dietary diversity, and (6) food-item count measures of dietary diversity. Data for calculating these measures are based on recall periods of varying length (e.g., 12 months, 7 days, 24 hours). The plethora of measures hampers comparison across studies. Because not all measurement approaches are equally reliable—compare a 12-month recall period with a 24-hour recall period—some measurements (and hence results) are more credible than others (Herforth & Ballard, 2016). Additional measures of nutrition used are (7) weight-for-height (wasting), (8) BMI-for-age, (9) mid-upper-arm circumference, and (10) height-for-age (stunting). The choice of stunting for the Ethiopian crop diversity project seems surprising, as one would expect small effects on height-for-age for this type of intervention given the rather short timeframe of the project. None of the studies consider additional health outcomes. The high-iron bean study proposed to look at anaemia, but dropped this idea because of lack of statistical power. From a health perspective, the evidence produced in this series of studies is therefore rather thin.

### ***Gender and vulnerable groups***

The high-iron bean study explains variation in bean consumption per adult equivalent without distinguishing between different consumers in the household. Other studies try to use more disaggregate measures of nutrition, as recommended by nutritionists. For example, the NERICA study focuses on impacts on children, and the dairy hub project seeks to zoom in on the diets and nutritional status of women. The crop diversification studies distinguish between households, women, and children (sub-group analysis). To reach conclusions about the food and nutrition security of household members, it is imperative to open the black box of the household (and most studies had the ambition to do this).

### ***Producers and consumers***

All studies focus on outcomes for smallholder producers themselves, and some pay attention to spillover effects in the form of diffusion. None consider wider societal impacts on nutrition and health mediated through markets—that is, effects materializing owing to the increased availability or affordability of high-quality food.<sup>2</sup> From the perspective of econometric identification of causal effects, such a focus on individual producers makes perfect sense. To the extent that spillover effects through markets occur, they may improve nutritional and health outcomes of non-adopters and bias estimates of the treatment effect downward. Future work focusing on promising new crops or production technologies could consider taking into account general equilibrium effects, and include estimates of nutritional gains for non-adopters and consumers.

### ***Timeframe***

The implementation timeframe of the studies was relatively short. Many health outcomes may be detectable only if behavioral change is kept up over an extended period. Several important impact

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<sup>2</sup> Within the Strengthening Impact Assessment in the CGIAR (SIAC) 2013-2017 portfolio of impact studies, both [the UC San Diego & George Washington University study](#) and Gollin, Hansen, & Wingender (2016) examine such wider-scale, longer-term outcomes and impacts.

channels, such as those based on market-mediated outcomes, require scale and the development of new value chains. Change of this type takes time to organize and materialize.

Finally, several important impediments identified in these short-term studies may lose their relevance over time. For example, these studies do not reflect farmer learning and adapting. The NERICA study finds that along with subsidized access to improved seed, development agencies must provide training to farmers and invest in knowledge transfer. An important insight was that in the absence of training, yields of improved varieties were poor. Although this factor could limit the scalability of improved seed interventions, it is also possible that in time farmers will figure out appropriate management by themselves and learn from each other (social learning). Without additional information, it is difficult to speculate about these long-term effects, but it is evident that short-term impacts may differ substantially from the impacts that will eventually materialize.

## Reflections and Conclusions

There is much to like about the individual studies. The NERICA study uses a state-of-the-art identification strategy and focuses on an interesting yet understudied effect—the potential to achieve nutritional gains by using an early-maturing rice variety that helps households smooth production over time and deal with the lean season. It produced credible and important results, with relevant lessons for practitioners and planners (e.g., interventions should not only improve access to the new crop variety but also invest in knowledge transfer). The maize-legume cropping systems diversification study uses advanced econometrics, and suggests that diversification may hold promise for nutritional gains. One also expects that there might be interesting results from the high-iron bean study and the irrigated horticulture study, but these will not accrue until much further in the future.

Considering everything, we have learned a few useful things about the scope for achieving impact by changing crop varieties and production practices. At the same time, the evidence base certainly needs to be widened and broadened to nutrition and health impacts of market and governance interventions as well.

## References

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