Final Report 2016/2017

Project Title: **The Stabilization of Marginalized Communities in Guatemala via Food and Nutrition Security on Child Linear Growth: Employing Systems Thinking Tools**

Project Objectives and Methods

The primary objective of this project was to rank order return on investment among interventions to alleviate causal factors reducing child linear growth. A systems analysis, multi-methods approach was utilized to generate and evaluated hypothesized relationships among a set of complex factors. The project was executed by Lee Voth-Gaeddert as part of his doctoral dissertation research under the direction of Professor Daniel Oerther of the Missouri University of Science and Technology. The project included three primary activities, namely: 1) the analysis of three regionally representative datasets using machine learning algorithms to identify potential causal factors contributing to diminished child linear growth, 2) the execution of a field study to confirm the trends identified in activity (1) with an emphasis on enteric dysfunction and the levels of aflatoxin (fungal toxin) in maize, and 3) the development of a systems dynamics model to describe the relationships among causal factors dynamically. The long-term aims of this work include improved access to decision support to help marginalized communities as well as the US Mission to make wise investments to reduce child stunting (defined as severely diminished child linear growth) and prevent erosion in the long-term intellectual potential of target communities.

Key Activities

Partner engagement (beneficiaries: 3 organizations) – Supported partners on systems thinking methods and approaches to problems. Conducted health information flow analysis for USAID project.

Community engagement (beneficiaries: 4 communities; 500 women and children) – Supported health assemblies to promote proper maternal and child health practices. Held and participated in health meetings for both local staff and mothers.

Research and Development (beneficiaries: 3 organizations, 4 communities, 3 universities)

- Network analysis – in partnership with USAID, developed and applied network analysis algorithms to national level data to identify trends in chronic malnutrition (as measured by child linear growth) in relation to age and malnutrition severity.
- Field testing – partnered with local Peace Corps Volunteers and community members to test hypotheses developed from local community member knowledge, topical expert knowledge, literature reviews, field observations, and network analyses on community level factors associated with child linear growth. Additionally, exposure factors for aflatoxins in maize and diarrheal diseases were studied.

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- Systems dynamics – developed system dynamics models from above outputs and national data on child linear growth; compared models between Guatemala and Indonesia.

Dissemination of Outputs (beneficiaries: 4 communities, 3 local organizations, 3 international organizations, 3 universities)
Designed specific opportunities and engagement points for two-way feedback on collaborations with community, national, and international/academic partners.

Key Project Achievements
Partner engagement – Held three informal meetings on integrating systems thinking into project design and execution. Developed report on potential health information flow gaps at a municipal level. Identified potential intervention points and methods (see Figure 1).

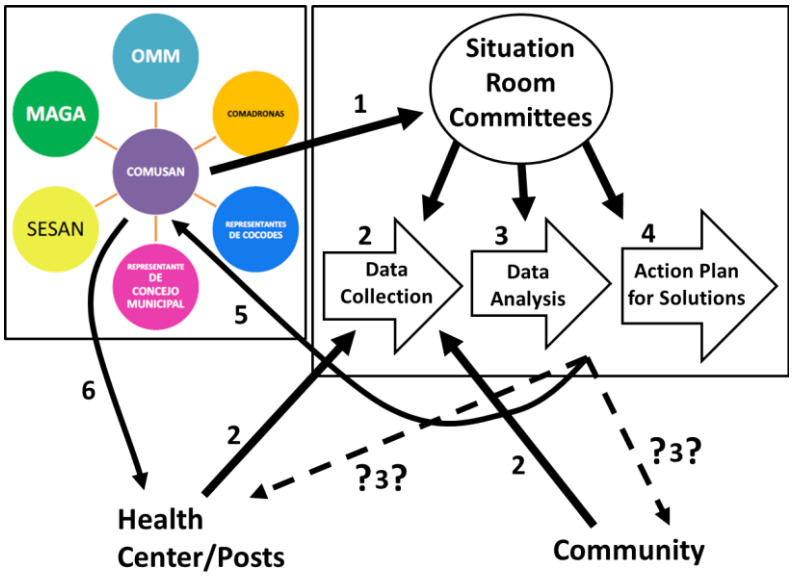

Figure 1. The COMUSAN is the group that focuses on malnutrition at the municipality (similar to US county) level. They have a sub team that focuses on data on malnutrition called the Situation Rooms. The information flow from the perspective of the health facility or community is long enough that health facilities say the information is useless when it gets back to them.

Community engagement – Supported six successful health assemblies among local communities on promoting healthy maternal and child practices (see Figure 2 photo). Exchanged constructive information in health meetings with both local staff as well as mothers.

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Figure 2. A health assembly taking place in a local community center.

Research and Development

- Network analysis – Identified key trends in data from the western highlands of Guatemala (region with highest prevalence of people living under poverty line) of factors associated with poor child linear growth (see Figure 3 and supplementary GHTC 2016 paper). These included prevalence of excessive diarrhea, limited dietary diversity, and factors related either to socio economic levels via farming or to farming practices related to crop health. Additionally, the presence of animals in the home were negatively associated with linear growth for children under one year of age, while hygiene was positively associated with linear growth for children between one and two years of age.

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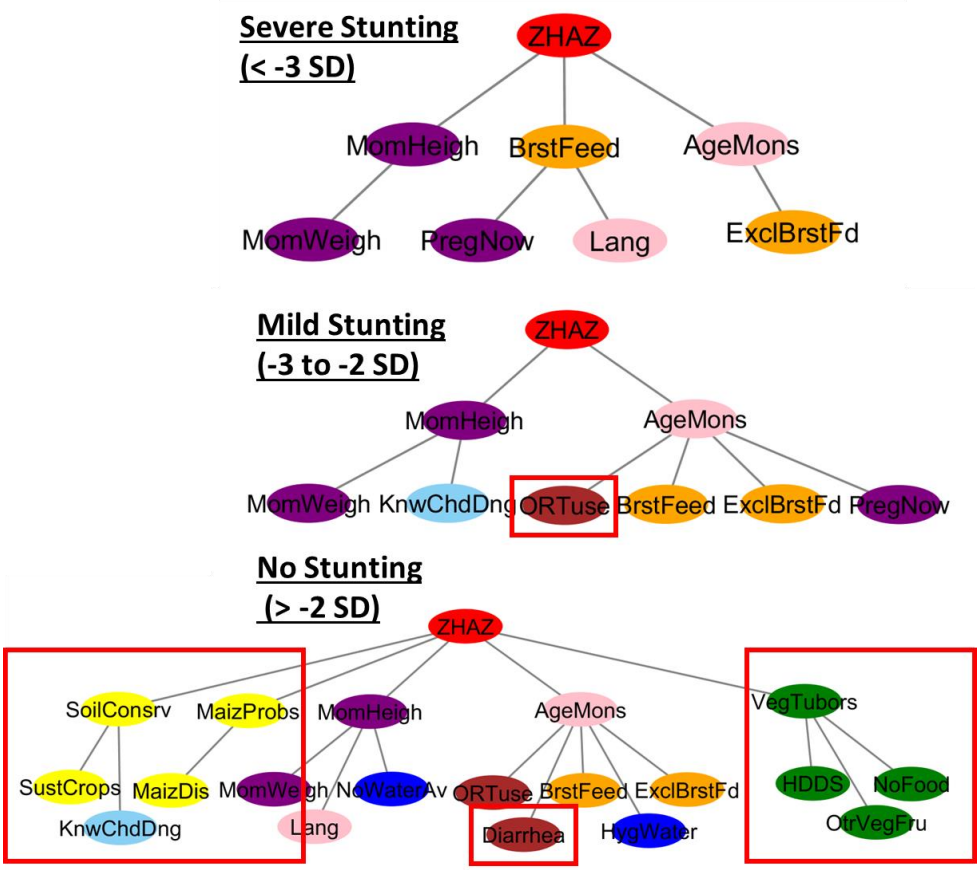

Figure 3. An example of an output from the network analysis. ZHAZ is the height-for-age z-score of the child. Ovals represent variables, and lines represent correlations. Proximity among ovals and the ZHAZ variable indicates a stronger direct correlation. Mild and severely stunted children have similar characteristics, while several new groups of variables are present in the healthy population.

- Field testing – Data supported several key hypotheses posed by the team and partners, both local and national. Aflatoxin (fungal toxin) exposure was negatively associated with child linear growth while enteric dysfunction was not associated. Prenatal health was positively associated with linear growth while the number of times the child was allowed to play on the ground in the home was negatively associated with linear growth. Additionally, exposure factors for aflatoxins included improved post-harvest practices and maize storage. Households had twice the odds of having aflatoxins in their household maize if they had obtained the maize from the local market as compared to subsistence farming. Improved water treatment was associated with reduced enteric dysfunction in the community as well. Furthermore, regional models were developed and used identify

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factors associated with diarrheal occurrences throughout the western highlands of Guatemala.

- Systems dynamics – Lastly, two system dynamic models were developed for Guatemala and Indonesia (as a comparison). Trends in the results of the models support the tentative conclusion that if significant and targeted investments are not made to improve child linear growth, only minimal gains would be obtained before 2030 (see Figure 4 and supplementary conference paper).

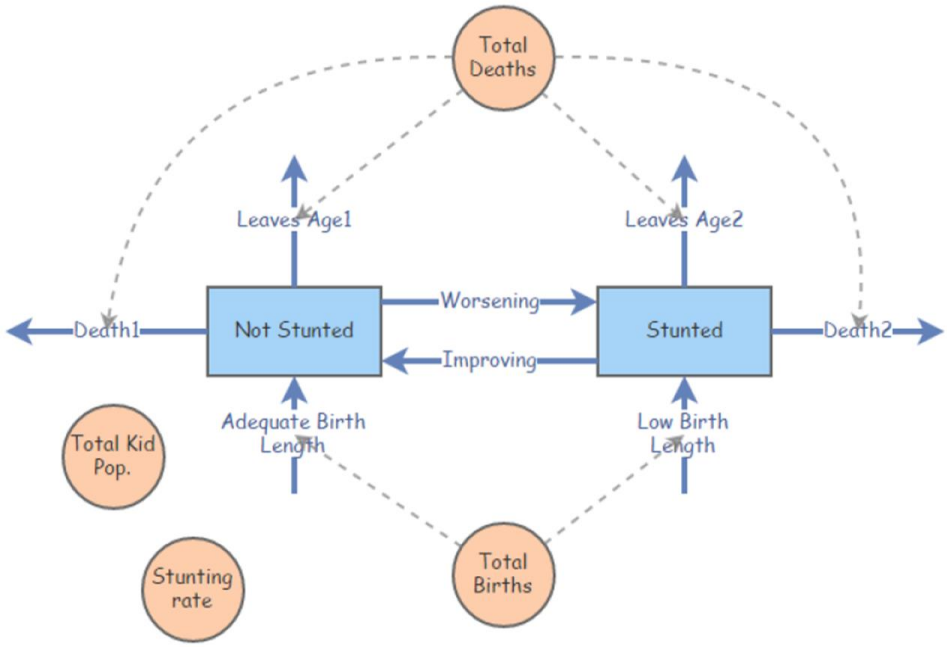

Figure 4. The set of differential equations that underlie the system dynamics model can be graphically represented via a stock and flow diagram. Rectangles represent stocks, solid arrows represent flows, circles represent factors that impact the rate at which flow occurs, and dotted arrows identify the flows (solid arrows) impacted by the factors (circles).

Dissemination of Outputs

The following achievements were obtained in regards to dissemination routes for project outputs;

- Long-term partnerships have been established to continue community engagement on this topic (Peace Corps volunteers)
- A local community level dissemination workshop was held where all information collected and outputs obtained were immediately shared with partners in the community.
- A final results presentation was held at the USAID mission in Guatemala City.

- Additionally, a second 'brainstorming session' meeting was held at the USAID mission in Guatemala City.
- A round table discussion was held at the USAID HQ in Washington, DC with partners from USAID and the US Department of State.
- A presentation and discussion was held in Geneva with the Scaling Up Nutrition Movement group.

Engagement of Partners and Other Actors

US Peace Corps – Provided the mechanism for employment and overall program framework. Voth-Gaeddert worked as a Response Volunteer in Guatemala for Peace Corps and was housed in a USAID funded, Development Alternatives Inc. run, project.

USDA FAS – Provided guidance on country-specific knowledge gaps for USDA and partners in regards to food security and food safety, specifically on aflatoxin contamination in Guatemala. Advised on structuring the project to obtain actionable outputs for USDA and local partners.

FANTA FHI360 – Provided guidance on country-specific knowledge gaps for USA funded projects on nutrition and enteric infections, specifically in the western highlands of Guatemala. Advised on hypothesized mechanistic pathways and barriers that may influence child health.

Diagnosticos Molecular – Partnered on the aflatoxin analysis in maize.

Institute of Nutrition for Central America and Panama (INCAP) – advised on project structure and local knowledge gaps in enteric dysfunction.

Harvard University – Partnered with a medical doctor to advise on Project structure around intestinal health of children.

USAID Engagement

Mission Guatemala (1. Health, 2. Food Security, and 3. Monitoring and Eval Offices) – 1. advised on country-specific knowledge gaps for office on enteric dysfunction and chronic malnutrition. 2. Advised on country-specific knowledge gaps and methodology limitations for office on food security and safety, specifically in aflatoxins. 3. Provided support on data access and analysis, advised on both knowledge and methodology gaps/limitations within the office. Held four joint meetings/presentations with offices; one on project development, two updates, and one final presentation and next steps. Results for USAID included information for both improved understanding of the system (to improve project development) and evidence to support their work with the Government of Guatemala on specific topics and foci.

Washington HQ (1. Bureau of Food Security and 2. Bureau for Global Health) – 1. Advised on initial concept for food security and malnutrition portion of the project and provided key contacts in Guatemala for proper execution and dissemination of results. 2. Advised on initial concept for enteric dysfunction and diarrheal disease portions of the project.

Lessons Learned

Community level – improved water treatment at a household level is associated with reduced diarrheal problems. Improved market purchase habits in regards to fungus awareness is associated with reduced exposure to maize-based aflatoxins. Improved post-harvest practices and proper maize storage at the household level is associated with reduced exposure to maize-based aflatoxins. The sanitary conditions where children play (i.e., 'dirty floors') may be negatively associated with child linear growth. Improved prenatal health is positively associated with child linear growth. Aflatoxin exposure is negatively associated with child linear growth.

National level – health information flows and feedback loops are large and slow, reducing effectiveness of data and the incentive to report accurate and timely data. Increasing the negative value customers and buyers at the market have for fungus laden maize may reduce exposure in household as well as improve incentives for farmers to use improved farming practices. Understanding regional trends is critical to improve interventions to reduce diarrheal occurrence including interventions such as water, sanitation, and hygiene as well as the cleanliness of floors where children play.

General/Academic level – In addition to the lessons learned above, the project demonstrated the applicability of systems tools (network analyses, complex statistical modeling, and system dynamics) to complex problems in international development.

Future Activities

Practitioner Recommendations:

- Target 'floor' based infectious disease transmission pathways for Western Highlands (sanitation, animal pens, improved flooring, etc.)
- Target prenatal health and healthy child play (sanitary locations) programs for mothers
- Target information based interventions that highlight resources locally available
- Target public health communication on fungus to improve customer and farmer recognition for poor economic value in fungal laden maize

Next Research Steps:

- Community level information intervention – bringing the 21st century information economy to the households of the western highlands of Guatemala. While only in concept phase; the premise behind this potential intervention is that there are always resources available, however, the key barriers (as partly identified in this study) are related to 1) the

motivation for users to want the information and 2) the ability for users to obtain the information. How do we design information products instead of another water filter?

- Improve regional health system information loops – once the development of municipal level committees is completed by the USAID partner, the hope is that improving the return on investment in regards to data and information for health posts, centers, and hospitals will have a positive impact on the effectiveness of the health care system as well as improved health metrics in communities. These points of potential intervention were mentioned above in Figure 1.
- Improve monitoring of maize/fungal toxin flows – potentially in collaboration with USDA or other partners, the strategic combination of cheap sensors can provide a national level monitoring system of maize flows and conditions for which fungus is most prevalent.

Risk Mitigation

To mitigate as much risk as possible (realizing there is always some risk), the design of the project and primary engagement points with end users was only observationally based. This reduces expectations and dependencies on externally sourced handouts. During local engagement, the project worked with local contacts with long term relationships in communities. The project aimed to approach all partners with the mindset of engaging to learn and exchanging ideas (this was also the aim primary objectives of the Peace Corps).

Environmental Monitoring

As a significant portion of this project was focused on improving monitoring of environmental factors, no degradation or harm of the environment from activities supported in this project was observed.

We thank the gracious support of the Center on Conflict and Development at Texas A&M University, the Conflict and Development Foundation as well as USAID and all the partners listed above. We are excited for the next steps.

Sincerely,

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