Seeds for a Future
Food Security + Nutrition Solutions

The INCAP Clincial Study of the Seeds for a Future Program

WWW.SEEDSFORAFUTURE.ORG

GUIDELINES FOR

INTERMEDIARY AND FINAL REPORTS

TO THE NESTLE FOUNDATION

FINAL REPORT (February 1, 2014 thru May 30, 2017)

PROJECT : Behavior Change and Nutrition Associated With Integrated Maternal/Child Health, Nutrition & Agriculture Program (Guatemala)

By:
Manolo Mazariegos, MD
Principal Investigator
Institute of Nutrition for Central América and Panamá –INCAP-
December, 2017

NESTLE FOUNDATION
For the Study of Problems of Nutrition in the World

4, place de la Gare
PO BOX 581
1001 Lausanne / Switzerland
Phone: 0041-21-320 33 51
Fax: 0041-21-320 33 92
e-mail: nf@nestlefoundation.org
Website: www.nestlefoundation.org

Personnel involved in the implementation of the Project

Seeds for the Future (SFF), Semillas para el Futuro, Headquarters in Chocolá, San Pablo Jocopilas, Suchitepequez

President,	Suzanne De Berge
Vice President	Earl De Berge
Field Operations:	Ing. Agronomist. Armando Astorga
Field Coordinator & Administration Assistance:	MEPU Clelia Ixquiatap García
Supervisor & Project Assistant:	Bach. Informatics Cristhian Ruiz Herrera
Project Assistants:	Kharla Marisol Vides Rodas Dulce Melissa López
Nutrition supervisor of extensionists, San Pablo Jocopilas:	MEPU Irma Rosalinda Robles Soto
Nutrition supervisor of extensionist, Santo Tomás la Unión:	T. S. Ingrid Elizabeth Gómez
Nutrition extensionists, San Pablo Jocopilas:	Isaura Carolina Ixquiatap García Sonia Ixquiatap Canil Julio César López Yax Candelaria Zapón Pastor
Nutrition extensionists, Santo Tomás la Unión:	Sindi Vicente Xivi Antonia Álvarez Catarina Rosales Felisa Juárez
Agriculture extensionist (home gardens):	Lucio Zapón Pastor Juan Carlos Joj
Animal raising extensionist:	Juan José Vásquez de León
Encargada de los alimentos:	Bernarda de López

(*) Some listed field staff did not participated in all phases of Project implementation.

INCAP

Principal investigator	Manolo Mazariegos, MD
Consultant	Ana Victoria Roman, PhD
Nutritionists	Licda. Vanessa Echeverría Licda. Vivian Tomás
Agronomist	Agr. Rudy Guzmán
Data manager	Rudi Roquel
Diet analyst	Lic. Humberto Mendez

We would like to thank and recognize the dedication shown for the families of San Pablo Jocopilas y Santo Tomas la Union, Suchitepequez, during their participating in this study

project. They were the main focus of the project and they will be the beneficiary of the results and lessons learned during the implementation. It was a very enriching experience.

REPORT TO THE NESTLE FOUNDATION

Intermediary Report ■ Final Report

Project title	
Behavior Change and Nutrition Associated With Integrated Maternal/Child Health, Nutrition & Agriculture Program (Guatemala)	
Date of Submission of this Report	**(December /2017)**
This report covers the period from (dd/mm/yy) t**o** (dd/mm/yy)	**Actual study launching date: Feb 1, 2014** **Finalization of field activities: May-2017** **#4 REPORT (FINAL REPORT)** **February 2014 thru May 2017**

Name(s) of person(s) responsible for grant application and report	**Manolo Mazariegos, MD**
Institution	**Institute of Nutrition for Central America and Panama –INCAP--**
Exact Address	**INCAP** Carretera Roosevelt #6-25, zona 11, Guatemala City, Guatemala, GUATEMALA, 01011
Phone (including country code)	**PBX INCAP:** 502- 2315-7900, ext. # 1190: **Office:** 502-2315-7906; Cel: 502-5203-4707
FAX (including country code)	502-24736529
e-mail	mmazariegos@incap.int

I. Summary of the present status of the study

(Preliminary results) (10-20 lines or till bottom of page 1)

1. This the final report for the funded project by Nestlé Foundation. This was a randomized controlled trial, to compare two models of household food production integrated within a comprehensive health, nutrition and agriculture intervention. The study intervention included training activities, through group education sessions and counseling at household level, by agriculture and nutrition extensionists, food production (home gardens and animal raising), improved health and nutrition/feeding practices for mother, children and families.
2. The study completed all implementation phases with a duration of 34 months, since it was launched in February 2014. Final assessment was completed by Dec 2016 and Feb 2017, and closing activities were completed in May 2017.
3. The study included 259 pairs of women and children in two clusters, San Pablo Jocopilas and Santo Tomás La Unión, department of Suchitepéquez, in the South West of country.
4. At the end of the study, there was an improvement for hematological status respect to baseline assessment, as determined by hemoglobin mean levels (HB, study outcome variable). At second interim assessment there was a significant greater mean difference in children of SPJ (<0.05), however, although there was a trend of greater changes in SPJ with full intervention, the mean values were comparable at the end ($p>0.05$). Anemia rates fell for women and children in both clusters. The observed improvement was supported by additional biomarkers for iron status biomarkers (ferritin and transferrin). In conclusion, this is one of few first comprehensive studies on health, nutrition and agriculture showing a positive impact in hematological / iron status in a maternal and infant population.

Contenido

TABLE INDEX

FIGURE INDEX

How the project advances please mention the most important activities so far, if available mention and discuss preliminary results

Introduction and general overview:

This corresponds to the *final* technical report submitted to Nestlé Foundation for the project "Behavior Change and Nutrition Associated With Integrated Maternal/Child Health, Nutrition & Agriculture Program », which covers the study period in all its phases from February 2014 thru May 2017.

This project was a 3-yr investigation conducted in two rural communities located in tropical South West/Low Lands of Guatemala by a consortium of two institutions, the Institute of Nutrition for Central America and Panama (INCAP) and the Non-Government Organization, Seeds for the Future (SFF). Although both Institutions collaborated and exchanged mutually in order to meet the project goals, the study team was organized in such a way that INCAP provided the technical and scientific support to the project, while SFF –our partner locally established in the research target area-- was mostly responsible for the field implementation of the project at local level.

Overall aims and objectives of the project

This project prioritized "the window of opportunity of the 1000 days" proposed by the Scaling Up Nutrition (SUN) Initiative to reduce chronic child malnutrition, and took into account nutrition interventions with proven evidence in addressing chronic malnutrition as proposed by the SUN Initiative (Bezanzon, 2010).

The overall objective of this study was to contribute to the improvement of the nutrition status and food security through an integrated program of food and nutrition security, home gardening, small livestock, education on nutrition, maternal health and care practices, water, sanitation and hygiene in a population composed by young children and pregnant and lactating women of families of a rural agrarian region with high rates of chronic child malnutrition and very low levels of development.

The package of interventions was supported by a methodology of group education and counseling sessions at the household level designed to promote behavioral change toward the use of health services, education of school-aged children, and education of the mother, improved feeding practices, home hygiene and health practices and household food production.

The Primary objective is to determine if after a period of about 30 months of exposure to the integrated intervention, there was a difference in nutritional status as assessed by hematologic status of young children, pregnant or lactating mothers among families belonging to the group that receives the intervention package (health/nutrition training, gardening and livestock production) compared to those who receive only the basic package (health/nutrition training and gardening, but without livestock production support).

Specific Objectives of the intervention in both clusters:

1. To increase the availability of food at the household level, from both, gardening through the production of the native plants with high nutrition value promoted; and from small livestock production.
2. To improve the dietary intake of foods and nutrients, assessed by dietary assessment and the diet diversification scores, both at household level and individually for children under 24 months old and for the pregnant and lactating mothers (FAO/FHI 2016; WHO, 2011).
3. To improve the nutritional status of pregnant or lactating women and young children as assessed by anthropometric indicators
5. To improve the hematologic iron status (hemoglobin) of pregnant and lactating mothers and young children.
6. To improve health / hygienic practices at household level.

METHODS

PROJECT IMPLEMENTATION

LEVEL OF PARTICIPATION

Organization of research team

Seeds for the future (SFF) is a community based Non-Government organization located in Chocolá, in the Municipality of San Pablo Jocopilas, Department of Suchitepéquez, South West low lands of Guatemala. SFF has been working in the region for almost 15 years in projects focused on education, nutrition and agriculture, targeting women and children of vulnerable families. SFF is the research project partner of INCAP in the implementation of the study in the selected research area. SFF has a core team in the field who were responsible for the implementation of the project, according to the protocol, the guidelines and companionship of INCAP.

The implementation plan included the following:

Phased Implementation: The implementation of the project had several phases, including (a) the preparatory phase at the institutional and community level, (b) the baseline assessment, (c) implementation of local level interventions and (d) monitoring, follow up and final evaluation.

a) The preparation phase lasted about three months, included local coordination for recruitment activities, selection of participating families within the two clusters, randomly assigning the two intervention packages, one for each cluster; preparing the implementation of baseline assessment (baseline indicators socio-demographic, nutrition and health (including bio - markers), and agriculture and livestock production). Other activities included:
   - Preparation of didactic materials for use in training and in field visits to participating households.
   - Training of field staff (nutrition/health workers and agriculture/livestock extensionists) that would deliver the education component oriented to behavior change (group and individual counseling in F&N Security and agricultural / livestock production).
   - Conduct awareness activities with pertinent agencies and groups.
   - Conduct socialization activities and obtain participant household informed consent.
b) Conduct baseline assessments for required indicators.
c) Implementation of gardening and household-level counseling and monitoring by field staff in the group of participating families of STU community.

d) Secure initial supplies and materials needed for both gardens and animal raising activities.
e) Implementation of home gardens, livestock production including minor species, and household-level counseling and monitoring by field staff in the group of participating families of SPJ community.
f) Community Organization: Inter-institutional coordination and establishment of the Community Committee on F&N Security (COSAN)
g) Interim and final evaluations and monitoring activities about the intervention.

Description of interventions

Methods: training field staff (extensionists)

Field staff training: Intensive training in maternal/child health and nutrition was conducted by INCAP specialists to implementing field staff during the preparation phase, focusing on research aspects of the study and the interventions. Respect to intervention, emphasis was made respect to nutrition and feeding practices of women and children through group education and individual counseling at home. The field staff was trained to deal with mainly - but not limited to- women heads of household. The training curriculum prioritized the evidence based interventions for the "First 1000 days Window of Opportunity" of child nutrition, including food and nutrition practices especially for pregnant / breastfeeding women and infants and young children, breastfeeding exclusively and continued for two years, beginning infant complementary feeding after six months of age, good hygiene practices in the home, food handling, safe water, use of government health services and programs (including pre and postnatal monitoring, child growth and development, vaccine, micronutrient, etc.), which are considered very important to promote a healthy growth in infants (Bhutta, 2008). The training modules implemented in this project took into account and adapted educational materials recently developed by INCAP for other regions of the country. Emphasis was also placed on importance of community organization, entrepreneurship, etc.

The field staff was trained to deliver the education material by using specific key messages. Special emphasis was paid to child feeding practices (complementary feeding), through the use of the key messages promoted by PAHO/WHO Guidelines (PAHO/WHO). At each home visit, a specific set of key messages were delivered to the household women.

An important innovation of the study intervention was that most of the training activities to participating families (health, nutrition, family gardens, and as appropriate, animal husbandry), were delivered at the household level.

Special attention was paid to the training given to the field staff in charge of the home visits and extension services to assure an adequate delivery of the key messages within a climate of warm and supportive interaction with the family members. Accordingly, the first training workshop conducted by INCAP focused on the methodological aspects of adult education, meaningful knowledge (relevance and pertinence of knowledge), learn by doing and practical exercises (role playing, dramas, storytelling). The training workshops aimed to empower field staff as to be able to approach the participating families and deliver the key messages toward promoting behavior change. Training activities at household level were supported by the use of didactic materials.

Family training in health, nutrition and agriculture

Implementation model: All study participants were divided in groups or sub-clusters based on their location. One health & nutrition field staff or one agriculture/livestock extensionist was in charge of project activities in 20-25 families located in a study site sector of a given community. Every community had 4 nutrition sectors and each had one health & nutrition field staff and one agriculture/livestock extensionist. According to a weekly/monthly agenda, the field staff was responsible for the group education sessions (every other week at first, then monthly) and the home visits (every other week first and then once a month), as to be able to cover all health, nutrition and agriculture topics (including animal raising). This was a very important component of the project, as this provided the training methodology at household level, to facilitate the adoption by the families of the promoted behaviors. (Figure 1)

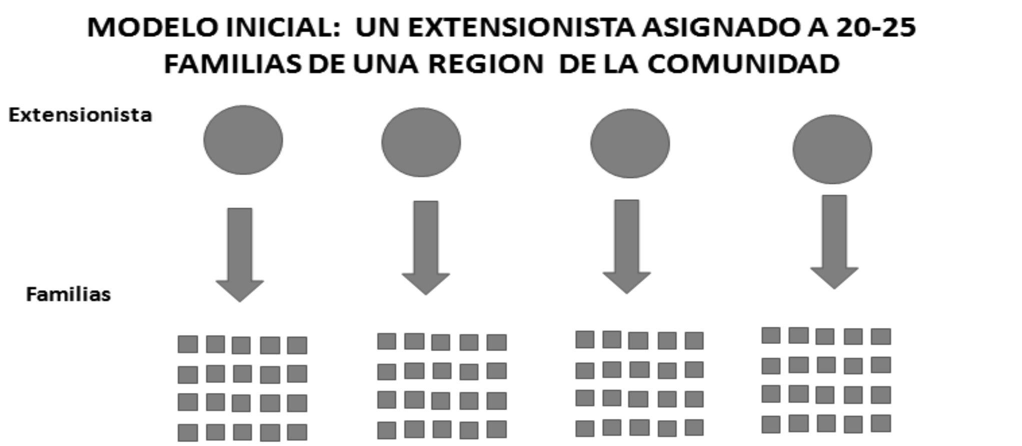


Figure 1. *Study training model at community level for health, nutrition and agriculture*. One field staff/extensionist covered training education activities for a group of about 20-25 families located nearby of a sector (group education and individual counseling). The field staff/extensionists were trained and supervised by community specialists in health, nutrition, agriculture (home gardens) and in animal raising

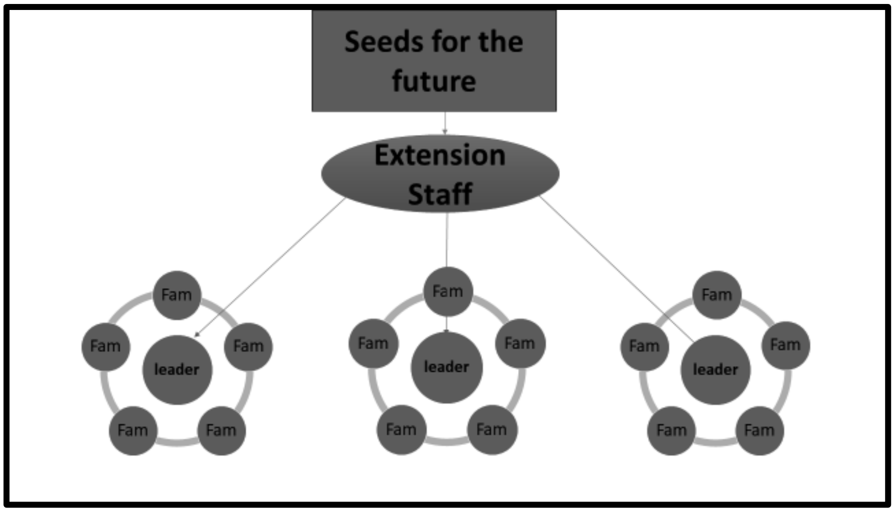


Figure 2. Sustainability training model at community level for health, nutrition and agriculture, at the end of the study. One field staff extensionist covered training education and supervision activities for a group of about four or five "local leaders" (community promoters/"Actoras Sociales", located at center in diagram with a 5 family cluster). At their turn, each community promoter/local leader provides training (extension services) activities of 5-10 families (peers) located nearby of a sector. The local leaders are trained and supervised by community specialists in health and nutrition, in agriculture (home gardens) and in animal raising.

Individual counseling at the household level in maternal/child health and nutrition education: Regular and frequent counseling over the duration of the intervention at the individual household level was considered one of the most effective methods to promote health and to encourage behavior change towards adopting good health, food and nutrition practices. A monthly planning of home visits was carried by each extensionist and a supervisor was responsible for overseeing the activities.

Group education sessions: Counselling at individual level was also supported by monthly group meetings with participating families to reinforce the goals of the study, the key study messages and to discuss the progress of the project. The group meetings were in the format of social gatherings in which families interacted each other, shared experiences around the central topic in discussion, and also, shared roles in the preparation of meetings, and in the performance of the practical exercises, such as the preparation of nutritionally improved meals using the promoted foods.

Methods: Study intervention on *household food production*

a) family gardens

The study implemented a home garden in each participating household to increase food production. Each family received training in the methodologies and key supplies needed for the planting and cultivation of local native and other plants which had been selected both for their high nutritional value and for their acceptance within the general population of the area. Among the plants emphasized were Chipilín (*Crotalaria longirostrata), Nightshade (*Spanish and scientific name for several varieties, respectively*:* Hierba mora; *Solanum spp; ,* Quilete, *Solanum negrecen;,* Macuy, *Solanum americanum;* Quixtán, *Solanum wendlandii); but also*

Amaranth (Spanish namie: Bledo; *Amaranthus spp),* Chaya or Mayan Spinach (*Cnidoscolus chayamansa).* Among other plants with nutritional interest *are acelga (Beta vulgaris var. cicla (L.), spinach (Spinacea oleracea* L*),* flor amarilla o mostaza *(Brassica nigra L.),* malanga *(Colocasia esculenta o Xanthosoma sagittifolium (*L*)* Schott); and sweet potatoe *(Ipamoeba batata).* All these plants are important sources of protein and also contains minerals, such as iron and zinc and vitamins.

Thus, garden implementation began almost immediately after enrollment and completion of baseline assessment. A special trained field staff provided support to all families in the selection of the place and in the implementation of the gardens. Man power for the performance of the chores related to design, soil preparation and planting was provided by project field staff and the families. The initial phase of planting the gardens and the resulting crops came into reality in a matter of four to eight weeks, which made families to gain positive feelings of satisfaction and a motivation to continue working. Given the climate tropical conditions of the research site (warm temperature, abundance of sunlight and relative abundance of rain during the season of implementation), it provided positive results and satisfaction to both, the families and the field staff. However, this initial positive results faced the challenges of severe weather conditions --frequent tropical storms in June-August 2014, with excess of rain--, which caused important damage to the infrastructure and to the crops by flooding, erosion or excess of humidity in soil with root destruction. On the other hand, during the dry season, the challenge was in terms of takin care of the gardens with irrigation to keep the garden productive and in good conditions. These challenges motivated defining new models of family food production taking into account the extreme variability of weather. For instance, some plant species –specially native plants--were more resilient to excess of rain or drought, while other were identified as more susceptible. Therefore, the new plan contemplated planting only some species according to the extremes of rain or droughts. In addition, for some time the research team explored and gained experience with different types of garden protection from heavy rain, lack of rain or excess of sunlight using plastic sheet covers or shade nets (like small green houses) along elevated planting beds, soil protection with mulching and borders. Prototype models were developed and installed in a small number of families and although good results were observed, this type of innovation could not be taken to scale, given the logistical and budgetary constraints of project.

Among the technologies transferred were agricultural best practices in soil management and conservation, watering, preparation and use of compost, biological pest control, harvesting and postharvest handling. First and foremost, the gardens were designed to address the food and nutritional security of the family. However, in addition of the latter, some of the families were able to generate some income out of home gardens.

In addition to the family garden activities at household level, other activities were carried out to enhance its potential, such as an agriculture demonstration center, extension services and seedling gardens.

b) Agricultural demonstration centers. Seeds for the Future created several demonstration garden facilities in the research area using models of “farm households”, which proposes an organized and efficient cultivation plot with multiple food plants (diversity) in an intensive but sustainable manner in a relatively small area of land, and integrated with small species animal raising. This demonstration model can be adapted to household levels with small plot areas with about 20-50 m2. The technologies are oriented to assure food and nutrition security, and designed for their adaptability to home use by participating families, taking into consideration their economic status. The demonstration garden also included a nursery for the generation of vegetable and tree seedlings.

The demonstration center was used as a training methodology to work with groups of families to reinforce good practices for hygiene and food handling (WHO Five Keys for food handling), food preparation and cooking, nutrition improved recipes for all the family, improved complementary feeding practices in children (perceptive feeding) through the use of the nutritious foods promoted by the study and produced in the home gardens, etc.

c) Agricultural Extension: Trained field staff guided by the Project Manager (Agronomist, Armando Astorga), provided the transfer of agricultural and livestock production technologies at the household level through regularly scheduled visits. These visits provided critically important follow up, to support and to coach the participants, ensuring that the technologies and information have been absorbed and were being appropriately adopted and applied by the participant family. Perhaps even more important, the visits gave families assistance in problem-solving and the encouragement needed for them to become comfortable with their new skills. This approach strengthened the capacity of families to produce their own food with quality, efficiency, and safety, with a minimum cost, and in addition, it enhanced the long term sustainability of the activities. It is important to note that at each visit the extentionists recorded data on family participation, about indicators of gardening and animal husbandry success, and other observed data.

d) Seedling gardens: Special gardens was dedicated to the production of seedlings of native plants with high nutritional value. This strategy was oriented to reduce dependence on external inputs and thus to help to ensure the sustainability of the intervention. Initially the project supplied seedlings and other plant materials, but after the second year, responsibility for seedling gardens was being transferred to selected groups of families with leadership and a sense of community social action (Local leaders, Actoras Sociales). This was carried out with the intention to facilitate the creation of seed production sources where other families could get their seeds at local level at a low cost.

e) Household livestock production intervention. A great effort was given to **livestock production,** especially of minor animal species with the aim to improve access of animal food which are important sources of protein of high quality and micronutrients, especially of key minerals such as iron and zinc. Households in SPJ received support in the production of small animal species such as rabbits and chicken. These species were selected for their ease of raise, rapid reproduction and relatively low cost.

Two species were implemented in the participating families. Although most families were comfortable receiving support and were encouraged to raise rabbits, one group found it cumbersome and manifested to be more comfortable raising chicken.

Animal production was designed to supplement household food to improve food security, however, as the animals reproduced, a portion of their offspring was oriented to be shared with other participating families. There was the potential that those exceeding families could sell the additional animals to others in the community.

Although one of the study arms did not receive direct support for livestock production, it is important to note that this arm was encouraged to initiate or to enhance animal rising on their own, as a way to increase food animal sources. The education/counseling sessions at household level highlighted the importance of food animal sources to combat micronutrient deficiencies in young children and pregnant/lactating women (especially iron and zinc).

Livestock production was supported by two major components:

e.1) A demonstrative agricultural and livestock center. The demonstration center mentioned above for home gardens served several purposes, including animal husbandry of small animals, which supported the training of families. Families had access to this center mostly during the field days gathering.

In addition, the Demonstrative Center, supported the family training in cooking and preparing nutrition improved recipes.

e.2) Animal health: Trained field staff was in charge of promoting good animal husbandry practices, including cages, sanitation, food/nutrition, safe water, vaccination, and treatment of common illnesses in animals (including zoonosis).

e.3) Animal feed: Families were encouraged to cultivate appropriate fodder for the animals, using controlled areas around the family garden, and above all, taking advantage of living fences pathway areas, as to ensure the availability of quality nutritious food throughout the year and encourage non-dependence on external inputs. According to the experience, an important group of families expressed some inconveniencies raising rabbits: some families reported that the daily chores for cleaning the cages and recollecting fodder for the animals were time consuming. Many families declined raising rabbits and asked for chicken.

Intervention on Community organization oriented to promote health and food & nutrition security.

This component is an important strategy for making sustainable the processes of community development. As the project progressed, at the end of second year, leaders from among participating families conformed a support group for the local activities of the project (Committee on Food and Nutrition Security). This Committee was trained in the practical aspects of health and food security and nutrition and how to tackle these problems through community action principles. This Committee would not replace any government structure with common goal already in place in the community, but will prioritize its actions within the circle of families participating in this project. In addition, this Committee was intended to keep close coordination with the government structures related to health and nutrition at local level. This component is very important, as it would enhance the sustainability of the intervention proposed here, after this project completed its objectives.

METHODS: BASELINE, FOLLOW UP AND FINAL STUDY ASSESSMENTS

After socialization and awareness activities were completed, the baseline assessment was conducted in each of the community clusters. The baseline evaluation took place at household level at around the spring of 2014 (march-April 2014). An INCAP specialized assessment staff was trained and standardized to conduct al component of the baseline survey, which was independent of the local field staff in charge of the implementation of the intervention. Prior to complete the assessments all recruited participants had completed a process of informed consent and had signed the informed consent form approved by the INCAP Ethics Committee.

Socio-demographic, health and agriculture interview: This assessment obtained information about socio-demographics (including household living conditions), economics, agriculture practices including gardening and livestock, sanitation, maternal and child health, household and individual diet diversification (FAO 2011), dietary intake (FFQ) and child feeding index. The interviews were taken at household level.

Nutrition status by anthropometrics: nutritional status (anthropometrics) for both, mothers and children were assessed before the beginning of the interventions. A technical evaluation group of INCAP (independent of implementation field staff), was responsible for carrying out this assessment. The anthropometrics methodology for children followed WHO anthropometric guidelines (WHO 2007).

Dietary intake assessment: Trained dieticians evaluated the dietary intake of the mother and child of previous day through INCAP´s 24h diet recall methodology. The informant was the mother. The evaluation included all food items consumed by the mother and the child the day before. By using standardized household food measures, it was estimated the portion size served and consumed. All food items were coded accordingly by using the INCAP´s Food Composition Table. A supervisor and editor reviewed all questionnaires for blanks or incomplete information before this was taken for data entry. All food items recorded in data form with pencil were coded the same day before being reviewed by the supervisors and sent to data entry. A specific software was created for dietary data entry and data management. The amount of food reported was converted from household measures to grams and then converted into nutrients by a diet specialist using the INCAP´s Food Composition Table (INCAP-FCT, 2010).

Biological markers of iron status: Hemoglobin was determined by finger stick method and using the Hemocue equipment (Hb201). Anemia status was determined for children and women using the WHO standards (WHO 2011).

Interim assessments: during the duration of the study, two interim assessment were carried out, one in 2015 and one in 2016. Although the interim assessment was similar in several aspects to the baseline assessment, it mostly focused on tracking the advances of the project. It included anthropometrics for the children and also included hematological / iron status biomarkers for the children.

Final assessment: The final evaluation was carried out approximately 34 months after the baseline assessment. The main component of the final assessment was carried out in December 2016 and completed in February 2017. There were additional collection of data in May 2017. The final evaluation focused on indicators of impacts on health and nutrition associated with the interventions in education, gardening, livestock production and iron status biomarkers. The final evaluation was conducted with the same format as the baseline, and the technical evaluation group of INCAP visited the families at household level.

Monitoring process: As part of the monitoring of the intervention, during home visits, the field staff systematically recorded the visit events in specific forms that allowed them to guide the observation´s visit and to evaluate the proper implementation of the intervention at the household level. Periodic review of this information by INCAP and Seeds personnel allowed adjustments to the initial plan, as necessary to ensure proper administration of the interventions and proper collection of data. Field staff was also be able to observe the adoption of best practices as regards food and nutritional food, household sanitation, food handling, safe water, gardening and livestock, etc., promoted by the project. This component was vital to provide support to families in implementation and sustainability of the gardens and livestock and reduce the possibility that families might quit the program because of lack of support or inexperience.

Additional iron status biomarkers: for the second interim and for the final evaluations, hematological status as determined by hemoglobin was complemented with measurements of biomarkers for iron status such as ferritin, transferrin receptors, along acute phase protein reactants (retinol binding protein, C reactive protein and Alpha Glycoprotein). These tests were not originally planned for the study, but given the importance of having a full profile of the iron status of the study population respect to the integrated health/nutrition/agriculture intervention, these biomarkers were added. No additional procedure for blood sampling was required as the blood sample was obtained from the same sampling procedure for hemoglobin. The samples were processed and kept under frozen condition in the field by a lab technician. Samples were transported for storage under frozen conditions (-20ºC) at the INCAP´s laboratory facilities until shipping in March 2017 to the VitMin Laboratory of Dr. Juergen Erhardt, in Germany. Biomarker results were reported by June 2017.

OUTCOME RESULTS

STUDY POPULATION

San Pablo Jocopilas SPJ and Santo Tomas la Union STU description: the study was located in two municipalities of the department of Suchitepéquez, low lands of South West region of the country. The altitude of the region is between 900-1000 meters above sea level, with an annual average temperature of 28-34 C degrees and rainfall average of about 2000mm. While San Pablo Jocopilas is mostly rural, Santo Tomás la Unión is semi-rural with a larger township (more urbanized). These region was selected for the study given this was the working area of SfF, our partner organization, and because, the health and demographic statistics (ENSMI 2008-9) showed them to be a vulnerable population with high rates of chronic malnutrition and anemia in children. (Figure 3)

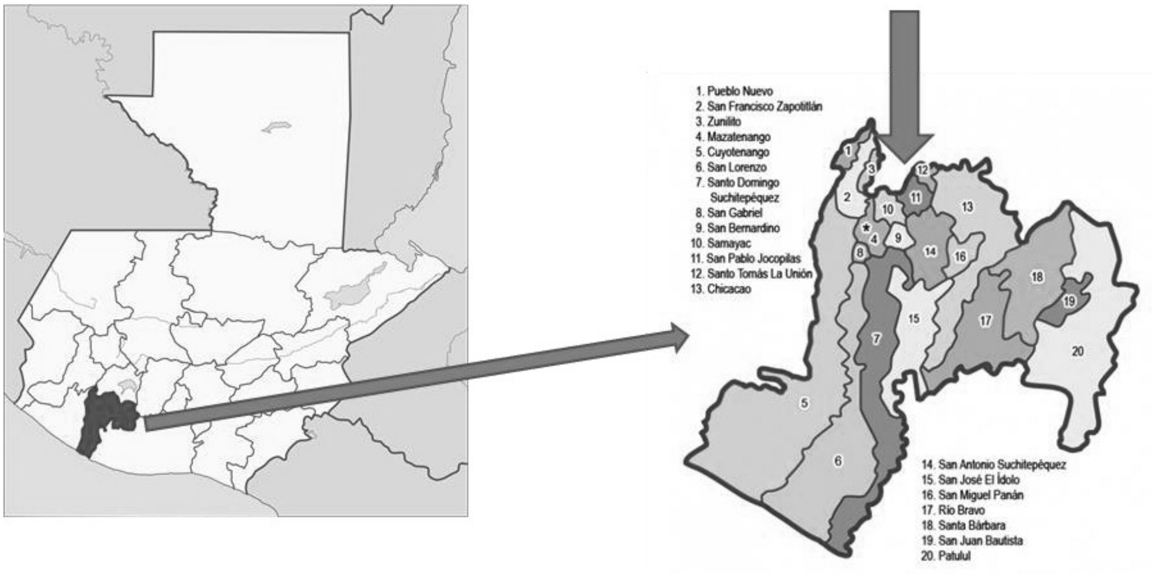


Figure 3. Map of Guatemala, highlighting the department of Suchitepéquez *(in red) located in South West region by the Pacific coast, where the study sites are located (municipalities of San Pablo Jocopilas (#11) y Santo Tomás (#12)).*

RECRUITMENT RATES 2014 AND 2015

By February 2014, full recruitment activities were deployed in both clusters. The study recruited a total of 205 mothers with their children or pregnant women in the third trimester, split in two clusters. According to sample size calculations and the assumptions taken before the beginning of the study, the minimum sample size was 84 families per cluster and therefore, we intended to recruit at least100 mothers/children per cluster. This number of recruited families allowed for an attrition of about 15% for the duration of study (more than 30 months).

The Table 1, shows the number of participants from the beginning to the end of the study. The data shows that the study began with 205 participants, being 104 in community of San Pablo Jocopilas (SPJ), the intervention cluster and 101 in Santo Tomás la Unión (STU), the control cluster.

During the first year --but mostly at the end of 2014 and beginning of 2015--, there was an unexpected high rate of early withdrawals. A group of 43 participants withdrew from the study (30 and 13, for SPJ and STU, respectively), which caused a great challenge for the study implementation plan. Several reasons were reported, being the most important that the study demands were too high and the lack of interest in participating in the training activities (education group sessions or counseling sessions at home) or lack of interest in carrying out food production activities (like taking care of the home garden or the animals). The number of withdrawals was comparable among clusters (37 vs 36).

To compensate for this high rate of early withdrawals, a new cohort of participants was enrolled at the beginning of 2015: 54 new participating families (mother/child pairs), being 29 in SPJ and 25 in STU. This second cohort was enrolled almost 10 months later respect to study launching time and about 6-8 months after beginning the implementation of the study interventions in the original cohort. This decision was made to replace the withdrawals and keep intact the sample size. This change had implications for the study design: The new group would have to complete all the process carried out by the original cohort, such as screening, informed consent, baseline assessment and to accomplish the agenda of training sessions already completed by their peers during the previous 6-8 months, and begin immediately with the interventions with home garden and animal raising. In addition, SFF and INCAP would have to commit to allow the new cohort of participants to be involved in the study for at least 18 months (exposure time) to consider it meaningful, all of which represented to extend the study for another 6 months respect the original plan. On this regard, with the new 54 participants enrolled as part of a second cohort, the new sample size of active participants became 216 families, with 103 for the community of Chocolá and 113 for Santo Tomás la Unión. These figures were considered appropriate for the goals of the study and also provided some cushion for new withdrawals in the remaining time of the study. This decision had important budget implications, but SFF and INCAP agreed to optimize the funds available and to seek additional resources to complete this additional follow up period to assure the appropriate completion of the study. At the end, it turned out to be a good decision as we were able to complete the study with a proper sample size.

At the end of the study, 186 participants completed the study, with 96 in SPJ and 90 in STU. The total population who did not complete the study was of 73, which corresponds to a 28.2%.

TABLE 1. POPULATION AT BASELINE AND AT THE END OF THE STUDY BY CLUSTER

Community Intervention vs control	**Participants recruited in 2014 (N)**	**New participants recruited in 2015 (N)**	**Total N of participants (N)**	**Early Withdrawals 2014 – 2016 (N)**	**Participants at the end of the study Dec-2016-Feb 2017 (N)**
San Pablo Jocopilas (Intervention)	104	29	133	37	96
Santo Tomás la Unión (Control)	101	25	126	36	90
Totals	205	54	259	73 (28.2%)	186

CHARACTERISTICS OF THE POPULATION AT BASELINE (SES / LIVING CONDITIONS)

Household characteristics:

Participating women were young and lived under limited socio-economic conditions common to the populations living the low lands of South West region of the country.

The Table 2, shows the specific characteristics of the two study populations. In general, both populations showed to be comparable among most indicators, such as home women´s age, home building materials, electricity, water supply by household connection and family assets. However, it was obvious, STU was more urbanized and had more access to better public services such as toilet connected to public system, used less wood for cooking fuel and had more refrigerators.

In terms of having a garden to produce food for consumption and raising animals, both clusters were comparable (20.5 vs 25% and 49.2 vs 44.9%, for SPJ vs STU, respectively). SPJ had more participants with access to a household space as to implement a home garden.

Most women were married or lived with a partner, and were Mayan descent but were Spanish speaking (although a great proportion speaks a local Mayan language (Quiché)).

More than half women completed primary education ad had at least one child under five years of age and about a third of the husbands worked in agriculture (Table 3).

Regarding the children, the mean age at enrollment was about 6 months of age. Most children were currently breastfed. At least one third of children did not have received their vaccines according to their age. On the other hand, important groups of children have had either fever, cough or diarrhea during the previous two weeks. However, it was reported that more than a half of children have had any to the three illness investigated (Table 4).

TABLE 2. BASELINE HOUSEHOLD CHARACTERISTICS OF STUDY POPULATION IN BOTH MUNICIPALITIES (STUDY CLUSTERS)

	SPJ (N / %)	STU (N / %)	Total (N / %)
Women respondents	133	126	259
Mean age (years)	25.7	25.6	25.7
House floor is made of cement or similar material (%, yes)	59.8	72.4	66
House roof is made of metal sheet (%, yes)	95.5	89.0	92.3
House walls main materials (building block, % yes)	62.1	78.0	69.9
Electricity at home (% yes)	97.7	90.6	94.2
Family assets (% yes)			
Radio	56.1	48.8	52.5
Tv	50.0	58.3	54.1
Cell phone	77.3	75.6	76.4
Refrigerator	27.3	37.0	32.0
Saving energy stove	9.8	13.4	11.6
Water filter	6.1	5.5	5.8
Water supply by household conexion (%, yes)	91.7	94.5	92.7
Use method to treat drinkable water by boiling (% yes)	62.9	81.1	71.8
Private toilet connected to public service	59.8	81.9	70.7
Use of wood as fuel for cooking (%, yes)	90.9	76.4	83.8
People living in household (n)			
2 a 5	51.5	55.1	53.3
6 +	48.5	44.9	46.7
N of bedrooms			
1 to 2	72.0	81.9	76.8
3	17.4	9.4	13.5
Family has a home garden to produce food for consumption (%, yes)	20.5	25.2	22.8
Family has a space to implement a home garden for vegetables (%,yes)	69.7	57.5	63.7
Family raises small animals (%, yes)	49.2	44.9	47.1

TABLE 3. CHARACTERISTICS OF THE POPULATION AT BASELINE (SES/LIVING CONDITONS)

	SPJ (%)	STU (%)	Total (%)
Women respondents			
Women married or living with a partner (%, yes)	91.7	92.9	92.3
Ethnic group (%, yes)			
Mayan descent	67.4	84.3	75.7
Ladino	32.6	15.7	24.3
Spanish speaking (%, yes)	98.5	99.2	98.8
Work for a salary (%, yes)	6.8	7.9	7.3
Primary education (%, yes)	64.4	51.2	57.9
Wife or husband work in agriculture (%, yes)	34.1	28.3	31.3
N of children under 5 years			
1 child	57.6	60.6	59.1
2 children	22.0	19.7	20.8
N of pregnant women	29	23	52
N of lactating women	49	53	102

TABLE 4. BREASTFEEDING AND HEALTH STATUS OF PARTICIPATING CHILDREN, AT BASELINE AND FINAL ASSESSMENT

	Base Line			Final		
Children	**SPJ**	**STU**	**Total**	**SPJ**	**STU**	**Total**
N children	104	103	207	88	90	178
Mean age (months)	6.2	6	6.1	34.2	34.8	34.5
Child currently being breast fed (%)	100	98.1	99.0	35.2	55.6	45.5
Have received vaccination at health services (according to age) (% yes)	70.5	65.4	68	96.6	100.0	98.3
Children with fever during last two weeks (% yes)	17.4	23.6	20.5	15.9	15.6	15.7
Children with cough during last two weeks (% yes)	28.8	34.6	31.7	27.3	42.2	34.8
Children with diarrhea during last two weeks (% yes)	16.7	25.2	20.8	21.6	24.4	23.0
Children with any fever, cough or diarrhea during last two weeks	52.9	60.2	56.5	44.3	53.3	48.9

RESULTS OF IMPLEMENTATION ACTIVITIES

1.1 TRAINING ACTIVITIES:

1.1.1 Family training activities and health and nutrition:

The methodology to deliver the intervention included group education sessions and home visits to provide individual counseling by trained field staff.

A total of 504 group education sessions were carried out during the duration of the intervention, which shows the intensity of the activity (Table 5). Likewise, the Table 6 shows the number of household visits carried out by trained extensionists with the purpose to provide counselling to families. On this regard, 7581 visits were carried out, with an estimated average of about 2 home visits per month per family, which is very intensive as well. According to the training planning, the extensionists scheduled one group education session and one home visit session to provide individual counseling every other week. At the beginning, there were more home visits scheduled as to rapidly gain a momentum. As the study progressed, only one group session a month was carried out. This activity was one of the more visible components and most challenging at the beginning of the study, given the logistics involved and the manpower required to keep close interaction with the families. However, it turned out to be one of the most satisfying activities, not just for the extensionists but for the families themselves. The close interaction during almost three years with families created a very strong bond that opened up a good trust, an essential component to encourage behavior change and thence, the adoption of the improved practices promoted by the project.

The topics covered during the group education sessions and home visits included health (access to health services, vaccination, child growth monitoring, prenatal care, danger signs, hygiene, hand washing and safe water) and nutrition (maternal / child nutrition, breastfeeding, improved feeding practices for women and children, best food sources of nutrients, nutritionally improved recipes using food produced at home or foods locally available). In addition, this component was instrumental for fostering food production models carried out by the extensionists team in charge of home gardens and animal raising. The health and nutrition extensionists were able to reinforce the food production message, to early detect any problem with the garden or animals and to report them to the supervisors, for a rapid response.

TABLE 5. GROUP EDUCATION SESIONS WITH STUDY PARTICIPANTS PER YEAR AND BY COMMUNITY

CLUSTER	NUMBER OF EDUCATION SESSIONS		
	2014	**2015**	**2016**
San Pablo Jocopilas	67	142	50
Santo Tomás la Unión	57	131	57
Totales	124	273	107
TOTAL:	**504**		

TABLE 6. HOME VISITS TO DELIVER COUNSELING ON HEALTH AND NUTRITION, BY YEAR AND COMMUNITY

Month	Cluster	2014	2015	2016	Total
1.January	SPJ	INCAP training Preparatory phase	182	105	287
	STU		196	114	310
	Total		378	219	597
2.February	SPJ	INCAP training Preparatory phase	223	103	326
	STU		224	111	335
	Total		447	214	661
3.March	SPJ	Preparatory phase	112	103	215
	STU		125	112	237
	Total		237	215	452
4.April	SPJ	INCAP Base line	INCAP follow up evaluation 65	103	168
	STU		55	105	160
	Total		120	208	328
5.May	SPJ	INCAP Base line	227	INCAP Follow up Evaluation	227
	STU	9	245		254
	Total	9	472		481
6.June	SPJ	162	228	100	490
	STU	154	232	121	507
	Total	316	460	221	997
7.July	SPJ	93	211	0	304
	STU	201	246	68	515
	Total	294	457	68	819
8.August	SPJ	INCAP training	164	0	164
	STU		246	37	283
	Total		410	37	447
9.September	SPJ	137	211		348
	STU	193	234		427
	Total	330	445		775
10.October	SPJ	172	173	97	442
	STU	190	201	98	489
	Total	362	374	195	931
11.November	SPJ	152	105		257
	STU	200	228	Final Evaluation	428
	Total	352	333		685
12.December	SPJ	87	105	Final Evaluation	192
	STU	103	113		216
	Total	190	218		408
Total	SPJ	803	2006	611	3420

	STU	1050	2345	766	4161
	Total	1853	4351	1377	7581

1.1.2 Training activities on home gardens

A group of trained extensionists was responsible of providing training on the different aspects of food production in the kitchen gardens. The field staff supported the families building the home gardens, provided the seeds or seedling, trained the families about the techniques to keep the garden clean, green, watered and about harvesting. There were several plant species promoted, including native plants. Because of the climate conditions of the research site, with temperatures around 30-34oC and rainfall of about 2000 mm a year (spread over 8 months a year), some crops grew up rapidly while others suffered the high temperatures or the excess of rain. During the time frame of the study, there were several meteorological events, such as tropical storms or droughts that caused severe damage to crops and in many cases, destroyed the gardens, due to erosion, flooding or wind. In one occasion most study gardens were destroyed and needed to be rebuilt completely. Consequently, several strategies were implemented to protect the gardens from the strong weather, including soil protection (mulching with several types of materials), but also with rudimentary removable plastic ceilings or simplified greenhouses ("techitos made of bamboo and plastic sheets"). Obviously, even when these approaches were promising in protecting the home gardens and assured food production, it required investing in a good design, materials and manpower. Luckily, a group of students from a university in the USA visited the site and proposed designing appropriate for the region, which were then complemented with several local more simplified designs by SFF staff. However, for limited financial reasons, the project was able to support with this type of measures a small group of families. On the other hand, complementarily, several models of gardening were implemented as to select the plant species that were more resilient under different climate conditions (raining season, dry season).

Figure. Home garden upgraded with a plastic sheet cover for heavy raining protection

Regarding home gardens, 6698 home visits were carried out as to provide extension services to families, in both communities. A ranking scale was developed to score the staging of development of the garden and a scale to rank the “status of wellbeing” of the gardens at each visit. For the development scoring, three stages were categorized, including a) preparation/implementation/replanting, b) development/growth stage, and c) production stage.

Given a home garden usually had different plant species, each of which may have different life cycles, it becomes very dynamic. In a given moment, a garden may show two or three stages of development. In other words, while some plant species have just being harvested, other may still be in the development/growth stage, or just being planted. Table 7, describes the stages of the gardens for all visits performed. A total of 6698 visits were carried out to monitor the gardens and to provide support to families, out of which 3194 (47.6%) corresponded to gardens undergoing development / growth or harvesting. There were slightly more visits in SPJ respect to STU (46.9 vs 53.1%).

Table 8, for the scale of “garden status of wellbeing”, a three-category scoring system based on the observation of some characteristics of the gardens, was: Excellent, good, regular or bad. The importance of the scoring was that it allowed the field extensionist to support the families discussing the problems found and the best ways to implement a solution. Table 8 shows that 76.8% of visits, the garden were found in excellent and good status (77% vs 76.7%, for SPJ and STU, respectively). Only a 13.1 % and 3.7% of visits the gardens were reported as “regular” or “bad”, respectively, being comparable across communities.

Perceived satisfaction of families with home gardens: In general, the home garden component was implemented in a satisfactory way. A great proportion of families were able to take care of the garden during most the time of the study. During the second interim and final assessment, 86% (SPJ) and 91% (STU), and 84% (SPJ) and 79% (STU), respectively, of families reported to have a kitchen garden, which compared with the baseline rate (average about 22%), evidences the great impact of the study respect to the adoption of this agriculture intervention. On the other hand, families found satisfaction gardening, as 99% (SPJ) and 100% (STU) out of these families, reported they would continue gardening after the end of the project. 93% (SPJ) and 89% (STU) reported that the required care was relatively easy. Almost all of families reported, as advantages, that gardening facilitated the availability and access to fresh vegetables at home (100%, improved the availability of nutritious vegetables for the children and the family (100%), and there were savings associated with producing their own food at home (90%). Only about 13% reported that gardening could have the income generation potential that women could use to cover other home needs.

In some families, because of the lack of space at home, they implemented very small gardens, or planted a garden away home or worked collaboratively with other families with better access to land space. In addition, some families were able to produce a surplus and sold the product to their neighbors, generating some income.

TABLE 7. MONITORING OF HOME GARDEN PRODUCTIVE ACTIVITIES PER YEAR

Year	Garden stage during home visit	Community		Total, monitoring home visits
		SPJ	STU	
2014	Preparation, implementation, re-planting	397	492	889
	Development/growth	97	71	168
	Production	13	33	46
	TOTAL	507	596	1103
2015	Preparation, implementation, re-planting	1134	899	2033
	Development/growth	432	640	1072
	Production	638	855	1493
	TOTAL	2204	2394	4598
2016	Preparation, implementation, re-planting	275	307	582
	Development & growth	68	127	195
	Production	87	133	220
	TOTAL	430	567	997
Total	Preparation, implementation, re-planting	1806	1698	3504
	Development/growing	597	838	1435
	Production	738	1021	1759
	TOTAL	3141	3557	6698

TABLE 8. HOME GARDEN STATUS DURING EXTENSION VISITS.

Home garden status (Wellbeing score)	San Pablo Jocopilas			Santo Tomás la Unión			ALL		
	N	%raw	%column	N	%raw	%column	N	%row	%column
2014									
1.Excelent	204	43.90%	40.20%	261	56.10%	43.80%	465	100.00%	42.20%
2.Good	266	56.10%	52.50%	208	43.90%	34.90%	474	100.00%	43.00%
3. Regular	20	21.70%	3.90%	72	78.30%	12.10%	92	100.00%	8.30%
4. Bad	5	16.10%	1.00%	26	83.90%	4.40%	31	100.00%	2.80%
NA	12	29.30%	2.40%	29	70.70%	4.90%	41	100.00%	3.70%
Total	507		100.00%	596		100.10%	1103		100.00%
2015									
1.Excelent	1016	47.70%	46.10%	1116	52.30%	46.60%	2132	100.00%	46.40%
2.Good	692	44.30%	31.40%	869	55.70%	36.30%	1561	100.00%	33.90%
3. Regular	322	56.60%	14.60%	247	43.40%	10.30%	569	100.00%	12.40%
4. Bad	75	50.70%	3.40%	73	49.30%	3.00%	148	100.00%	3.20%
NA	99	52.70%	4.50%	89	47.30%	3.70%	188	100.00%	4.10%
Total	2204		100.00%	2394		99.90%	4598		100.00%
2016									
1.Excelent	59	32.60%	13.70%	122	67.40%	21.50%	181	100.00%	18.20%
2.Good	183	56.00%	42.60%	144	44.00%	25.40%	327	100.00%	32.80%
3. Regular	76	35.30%	17.70%	139	64.70%	24.50%	215	100.00%	21.60%
4. Bad	19	26.40%	4.40%	53	73.60%	9.30%	72	100.00%	7.20%
NA	93	46.00%	21.60%	109	54.00%	19.20%	202	100.00%	20.30%
Total	430		100.00%	567		99.90%	997		100.10%
Summary 2014-2016									
1.Excelent	1279	46.00%	40.70%	1499	54.00%	42.10%	2778	100.00%	41.50%
2.Good	1141	48.30%	36.30%	1221	51.70%	34.30%	2362	100.00%	35.30%
3. Regular	418	47.70%	13.30%	458	52.30%	12.90%	876	100.00%	13.10%
4. Bad	99	39.40%	3.20%	152	60.60%	4.30%	251	100.00%	3.70%
NA	204	47.30%	6.50%	227	52.70%	6.40%	431	100.00%	6.40%
Total	3141		100.00%	3557		100.00%	6698		100.00%

1.1.3 Animal raising component: Training and monitoring

In the community with full intervention (gardens and animal raising), field staff trained on animal raising carried out home visits every other week (or weekly, if necessary) to provide first hand training and to monitor the family activities related to take care of the animals. Rabbit raising was selected as the study animal intervention because there was some early experience on behalf SFF in this community and because of the potential benefits (relatively easy to take care, rapid growth, good availability of fodder and not having competition for food with the family (i.e. as it happens with chicken fed with grains consumed by the family)).

Families were trained on basic practices, such as feeding the animals with forages locally available, the use of clean water, how to clean the cages, how to use the excretes for composting, the importance of protection from excessive temperature or sunlight, and about the reproduction.

A total of 119 out of 133 families received rabbits to initiate the raising practices in SPJ. A total of 289 rabbits were delivered to families (Table 9). Table 10. Describes the number of rabbits delivered per family, which shows that 75 families received 1 or 2 rabbits. However, for several reasons (mortality in most cases) about 44 families received more than two rabbits, as an effort to support the families to continue participating.

At the end of the study only 28 (23%) families that received support for rabbit raising, were still working with rabbits. Interestingly, most of families (92 and 100%, of families at second interim and final assessment, respectively), who were still raising rabbits expressed their intention to continue with this practice after the project ends. Interestingly, there was a small group of families who were successful to reproduce significantly the animals, to eat rabbits and even to sell.

The field staff dedicated a great effort to provide extension services to the families. Table 11 shows the number of home visits performed to provide support to families to raise rabbits. A total of 5163 visits were recorded, which can be considered a very intensive activity. This table represents an average of about 2 visits per month per each family along the duration of the study.

Some of the participant´s arguments for stopping raising rabbits were the lack of time to take care the animals, the study demands were to high (every day care) and not being able to commit to carry out the activity for a long time. This was a challenging situation for the study, which in spite of the efforts of field staff and the implementation of several strategies, the rates of acceptance of the intervention did not reach the aimed results. In order to strengthen the intervention, we were able to bring the support of an international consultant from US (Mr. Robert Spencer), who visited twice the project for almost a week each time. To reinforce the local training, Mr. Spencer met the participating families, conducted home visits and observed the living conditions of the animals, performed practical exercises and even carried out cooking sessions.

However, we could not see the reproductive results we have planned. During the first year, we recorded a high mortality rate of the delivered animals and of their siblings. In addition, In 2015 there was a strong attack of a rabbit disease that caused the mortality of a great amount of animals. To solve this situation and to prevent future attacks we consulted experts in the country and also experts in the USA. These events may have caused some negative impact in the participating families.

Another aspect that affected the implementation was the insufficient number of cages the project provided or the family was able to provide. The project provided each family with one cage made with local materials (for two female animals and for their first breed of siblings), but it was expected that as the implementation progresses and more animals were available, the families were able to build more cages. However, the low reproductive indices and the lack of interest on behalf the families in building new rabbit cages, affected the optimal implementation of this intervention.

Practice of raising other animals than rabbits: The project also supported 14 families interested in raising other animals than rabbits, such a chicken or ducks, for which they felt more comfortable. During the study there was an increase in the percentage of families raising animals from baseline (49.6% for SPJ and 44.4% for STU, respectively) to final assessment (61.4% for SPJ and 58.9% for STU). In SPJ, 45.1% and in STU 42.6% of families reported to raise animals such as chicken and ducks, being comparable among communities. Pork was the third type of raising animal, although less commonly (0.75% for SPJ) and 5.6% (for STU) at baseline and at the end it was 6.8% (SPJ) and 5.6% (STU). In general, the practice of raising animals was common but it was of a low scale.

Combination of home gardens and raising animals: At the end of the study, although in general most families had a home garden, there was a group of families who raised animals and also had a home garden: Out of 54 families raising animals in SPJ, 81% also had a home garden; while in STU, out of 53, 86.8% also had a home garden. On the other hand, at the end of the study there was a 22.7% of families in SPJ who neither had a home garden nor raised animals; while in STU, it was 16.7%.

In summary, the rabbit raising activity was intense, but only with a moderate success, as about a quarter of the participating families continued with the practice at the end of the study. However, an important group of families, either had rabbits or other type of animals.

TABLE 9. RABBITS DELIVERED TO PARTICIPATING FAMILIES OF SPJ

Total rabbits delivered, including replacements		
Sectors of SPJ	**N families**	**N rabbits delivered**
Alfarero	2	3
Calvario	4	11
Cerro Grande	6	16
Cerro Partido	12	32
Choacrúz	4	8
Chocolá	2	2
El Socorro	1	4
Escuela Vieja	3	7
IAN Casitas	5	14
IAN Tarrales	2	4
Iglesia Romana	4	8
Ixcanalero	7	22
Las Piedrecitas	22	52
Las Piedrecitas, Sector Iglesia Católica	2	4
Naznzal	1	1
Pacamaché	22	43
Pacocó	2	5
San Pablito	3	7
San Pablo Jocopilas	1	2
Sector Centro	1	3
Sector Lolemí	1	2
Sector Mercado	3	10
Tarrales	5	16
Toronjal	4	13
Total	119	289

TABLE 10. MONITORING OF RABBIT RAISING ACTIVITIES IN PARTICIPATING HOUSEHOLDS

Number of rabbits delivered, including replacements		
Number of rabbits delivered to each family at beginning of study	**N families**	**Total rabbits delivered**
1	16	16
2	59	118
3	27	81
4	12	48
5	4	20
6	1	6
Total	**119**	**289**

TABLE 11. MONITORING OF RABBIT RAISING ACTIVITIES IN PARTICIPATING HOUSEHOLDS, BY EXTENSION HOUSEHOLD VISITS

	Home visits by rabbit extensionist			
	N Visits per month and year			Total Visits
	2014	2015	2016	
January		126	147	273
February		225	253	478
March		190	309	499
April		185	213	398
May		192	203	395
June	58	256	161	475
July	40	288	123	451
August	98	212	153	463
September	133	177	154	464
October	185	118	140	443
November	282	153	118	553
December	157	114		271
Total	953	2236	1974	5163

NUTRITION STATUS BY ANTHROPOMETRY IN MOTHERS AND CHILDREN

BASELINE AND FINAL ANTHROPOMETRICS IN WOMEN

At baseline assessment, about one third of women showed to have a normal weight as assessed by body mass index (BMI)(Table 12 and Graph1). However, it is very interesting so see that a great proportion of women were either overweight or obese, which all combined made up about 52%; with a slightly greater proportion of overweight in STU cluster respect to SPJ (40.4 vs 37.0%). At baseline, only a small group of women in both communities had low weight (6 %). At final, the proportion of women with overweight was lower respect to baseline (about 30 and 35%, for SPJ and STU, respectively); but there was a higher proportion of women with obesity.

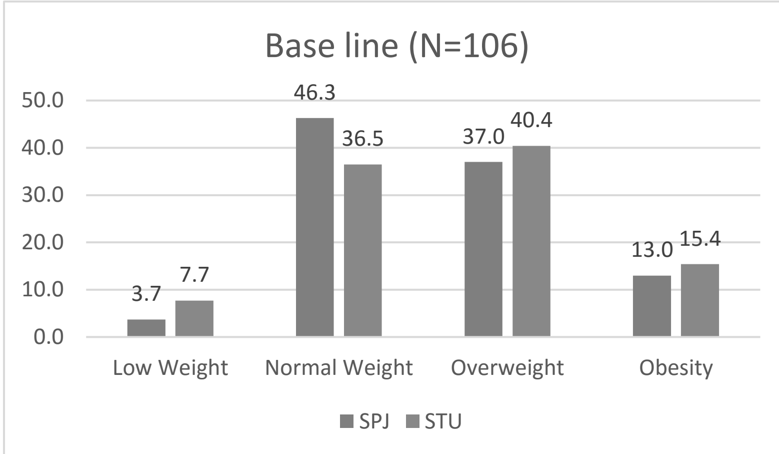
Table 13, shows de means of body mass index of women, at baseline and final assessment by physiological status and by community. The means tended to be a little higher for STU women and for pregnant and lactating women, respect to non-pregnant /non-lactating women. In addition, for non-pregnant/non-lactating women, BMI means were somehow higher at the end of the study.

TABLE 12. NUTRITIONAL STATUS IN PREGNANT AND LACTATING WOMEN DETERMINED BY ANTHROPOMETRICS, ACCORDING TO COMMUNITIES, BASELINE AND FINAL ASSESSMENT

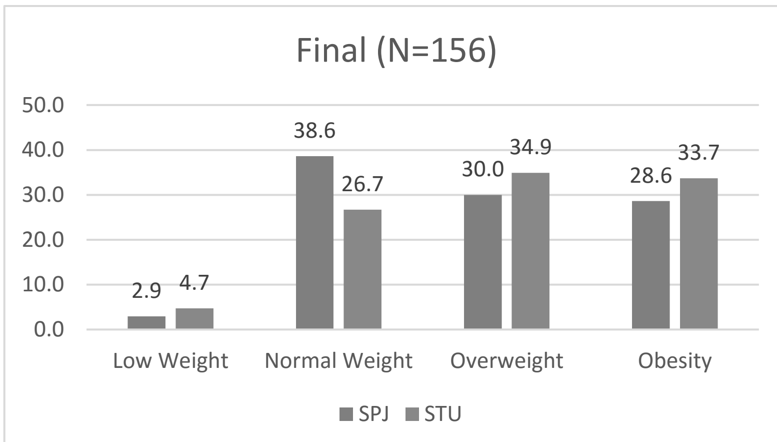
Baseline	SPJ		STU		Total	
	N	%	N	%	N	%
Low Weight	2	3.7%	4	7.7%	6	5.6%
Normal weight	25	46.3%	19	36.5%	44	41.1%
Overweight	20	37.0%	21	40.4%	41	38.3%
Obesity	7	13.0%	8	15.4%	15	14.0%

Final	SPJ		STU		Total	
	N	%	N	%	N	%
Low Weight	2	2.9%	4	4.7%	6	3.8%
Normal weight	27	38.6%	23	26.7%	50	32.1%
Overweight	21	30.0%	30	34.9%	51	32.7%
Obesity	20	28.6%	29	33.7%	49	31.4%

BASE LINE



FINAL



GRAPH 1. Baseline and final assessments: Percent of low weight, normal weight, overweight and obesity in pregnant and lactating women by using BMI, according to community

TABLE 13. BODY MASS INDEX (KG7M^2) IN WOMEN BY COMMUNITY AN PHYSIOLOGICAL STATUS AT BASELINE (BL) AND FINAL *(FL) ASSESSMENT*

Assessment	SPJ									STU								
	Pregnant			Lactating			Non Pregnant/Non Lactating			Pregnant			Lactating			Non Pregnant/Non Lactating		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
Baseline	29	27.2	3.9	49	26.3	4.9	55	25.9	3.9	23	28	3.8	51	27	4.6	52	25.8	3.9
Final	4	28.8	5.4	4	28.2	4.4	88	26.8	4.4	2	32.9	4.8	3	26	0.9	94	27.6	4.7

CHILDREN GROWTH AT BASELINE ASSESSMENT:

Baseline: For the purpose of this analysis, only cases with complete information were included. To estimate differences between clusters, mean comparisons (t-test for independent samples) were carried out at baseline and final assessment. To estimate changes between baseline and final assessment, paired wise mean comparisons were carried out by using a paired t-test and for comparing changes between clusters a t-test for independent samples was used. For mean values, confidence intervals at 95% were calculated. A $p<0.05$ was considered significant.

Table 14 A and B, show the children baseline and final anthropometric characteristics by cluster in terms of age, weight, height and z scores for weight-for-age, length/height-for-age and weight-for-length/height. As it can be seen, the mean values for age, weight and length were comparable across clusters at both, baseline and final. Regarding age, the baseline mean was around 7 months and at the end, it was 34 months of age, reflecting that the study observation period was about 27 months, as an average.

For length/height changes, Tables 15 and 16 show that the mean change from baseline to final assessment (pairwise) ranged from 22.6 to 23.7 cm for both clusters and the mean Z scores for length/height-for-age (HAZ) at baseline were around -1.30; and at the end of the study, it reached -1.97 and -1.78, for SPJ and STU, respectively. The changes across time were statistically significant in both clusters ($p<0.001$) and the difference of difference (change) between clusters was not significant ($p>0.05$)

Table 17 show the overall baseline and final rates of chronic malnutrition in children (short stature defined as z scores (HAZ < -2.0). Overall rate at baseline was 21.8% (mean ages of 7 months), being 19.0 and 23.8% for SPJ and STU, respectively; and at final of 48.9% and 41.8% (mean ages 34 months), for SPJ and STU, respectively. These findings show a continuous deterioration of linear growth during the duration of the study. However, at the end, STU showed a trend to be slightly better respect to SPJ. The results evidences that an important proportion of children at a young age (beginning as early as 6 months of age by the time of recruitment) were already at high risk of growth faltering (stunting). The overall rates in these two vulnerable study populations are comparable to national statistics for stunting in children under five years in the department of Suchitepéquez (39.5%) and also at national level (46.5%) (ENSMI, 2014-15). Furthermore, this pattern of increase of stunting from 6 months to five years of age –with a plateau at around 24 months--, is also in accordance with what has been reported in developing countries (Shrimpton, 2011; Victora, 2010).

Of interest, the recent national survey (ENSMI, 2014-15) reported a reduction rate of chronic malnutrition of about 0.4-0.5% per year for the period of 2008/08 a 2014/15, which shows the complex and multi-causal nature of stunting in Guatemala and the need of integrated health/nutrition interventions early in life. Therefore, it is not surprising the high rates of chronic malnutrition (stunting) found in children older than two years of age. In our study, stunting, the indicator of chronic malnutrition was a secondary study outcome

Regarding children weights, the prevalence of low weight-for-height (wasting) at baseline and final assessment was almost nonexistent in this population (with wasting of 0%). This finding was also confirmed by using body mass index z scores (BAZ scores) (Table 17.) We can say that although this population is predominantly stunted, it is weight proportionate. This feature is typical of the children in Guatemala, which contrasts with other regions, like Africa or Asia, where there are high rates of wasting. On the other hand, the mean weight change along the study was about 5 kg and the difference of change between clusters was about 0.23kg in favor of STU, which was not statistically different.

Graphs 6, 7, 8 and 9 (Annex), show the curve distribution of z scores for HAZ and WHZ, at baseline and final, and per community. While the study population curve of HAZ at baseline showed a modest skewedness toward the left respect to the WHO reference, at final assessment, there was a much marked deviation. This remarks the high prevalence of stunting in this study population. The WHZ curves shows overlapping of the study population respect to the WHO reference, which confirms this is a very well weight proportionate population.

Table 14. ANTHROPOMETRIC INDICATORS AT BASELINE AND FINAL ASSESMENTS IN CHILDREN: MEAN COPARISONS BETWEEN COMMUNITIES

14A. Baseline

Baseline, Mean comparisons between communities						Mean Difference between communities at baseline				
	Community	N	Mean	SD	SEE	Mean difference	SD of difference	CI 95% of difference		P value (bilateral)
								Lower	Upper	
Age (m)	SPJ	116	6.9	3.69	.34218	.20	.47	-.74	1.13	.676
	STU	122	6.7	3.62	.32815					
Weight (kg)	SPJ	116	7.2	1.74	.16196	.00	.22	-.44	.43	.984
	STU	122	7.2	1.66	.15056					
Height (cm)	SPJ	116	63.9	6.43	.59747	.13	.81	-1.48	1.73	.874
	STU	122	63.8	6.13	.55463					
WHZ	SPJ	116	0.60	0.96	.08895	-.05	.12	-.30	.19	.666
	STU	122	0.65	0.95	.08562					
HAZ	SPJ	116	-1.29	0.97	.08999	.05	.13	-.21	.30	.713
	STU	122	-1.34	1.01	.09166					
WAZ	SPJ	116	-0.37	0.96	.08914	.02	.13	-.23	.26	.904
	STU	122	-0.39	0.98	.08906					
BAZ	SPJ	116	0.51	0.93	.08632	-.02	.12	-.26	.23	.890
	STU	122	0.52	0.99	.09008					

14B. Final

Final, Mean comparisons between communities						Difference between communities at final				
	Community	N	Mean	SD	SEE	Mean difference	SD of difference	CI 95% of difference		P value (bilateral)
								Lower	Upper	
Age (m)	SPJ	92	34.2	5.82	.60688	-.06	.86	-1.76	1.64	.946
	STU	98	34.2	6.03	.60935					
Weight (kg)	SPJ	92	12.3	1.72	.17923	-.23	.26	-.74	.28	.383
	STU	98	12.5	1.84	.18602					
Height (cm)	SPJ	92	86.9	4.94	.51543	-.82	.74	-2.29	.64	.269
	STU	98	87.7	5.28	.53308					
WHZ	SPJ	92	0.17	0.85	.08844	-.01	.12	-.25	.24	.955
	STU	98	0.18	0.87	.08811					
HAZ	SPJ	92	-1.97	0.90	.09383	-.19	.13	-.45	.08	.163
	STU	98	-1.79	0.93	.09354					
WAZ	SPJ	92	-0.99	0.91	.09531	-.12	.13	-.38	.13	.343
	STU	98	-0.86	0.88	.08928					
BAZ	SPJ	92	0.43	0.83	.08640	.01	.12	-.24	.25	.945
	STU	98	0.42	0.88	.08840					

TABLE 15. COMPARISON OF ANTHROPOMETRIC INDICATORS AT BASELINE AND FINAL ASSESSMENT IN CHILDREN, ACCORDING TO COMMUNITY: Paired wise comparisons within each community

Final vs baseline paired wise means, per community					**Within community, final vs baseline paired wise mean comparisons**				
Community		Evaluation	Mean	SD.	Mean differences	SD of difference	CI 95% of difference		P value. (bilateral)
							Lower	Upper	
SPJ (N = 86)	Age (m)	Final	34.2	5.84	27.06	5.45	25.90	28.23	.000
		Baseline	7.1	3.72					
	Weight (kg)	Final	12.3	1.76	4.94	1.82	4.55	5.33	.000
		Baseline	7.3	1.71					
	Height (cm)	Final	86.9	5.05	22.65	6.06	21.35	23.95	.000
		Baseline	64.2	6.33					
	WHZ	Final	0.18	0.85	-0.44	0.95	-0.64	-0.24	.000
		Baseline	0.62	1.00					
	HAZ	Final	-1.97	0.91	-0.66	0.78	-0.83	-0.50	.000
		Baseline	-1.30	0.94					
	WAZ	Final	-0.98	0.93	-0.62	0.84	-0.80	-0.44	.000
		Baseline	-0.36	1.01					
	BAZ	Final	0.44	0.82	-0.10	0.88	-0.29	0.09	.298
		Baseline	0.54	0.96					
STU (N = 97)	Age (m)	Final	34.2	6.04	27.36	5.78	26.20	28.53	.000
		Baseline	6.8	3.70					
	Weight (kg)	Final	12.5	1.85	5.19	1.84	4.81	5.56	.000
		Baseline	7.3	1.62					
	Height (cm)	Final	87.7	5.30	23.66	6.26	22.40	24.92	.000
		Baseline	64.0	6.15					
	WHZ	Final	0.18	0.88	-0.49	1.01	-0.70	-0.29	.000
		Baseline	0.68	0.87					
	HAZ	Final	-1.78	0.93	-0.51	0.79	-0.67	-0.36	.000
		Baseline	-1.27	0.95					
	WAZ	Final	-0.86	0.89	-0.54	0.81	-0.70	-0.37	.000
		Baseline	-0.32	0.82					
	BAZ	Final	0.42	0.88	-0.14	0.96	-0.33	0.05	.155
		Baseline	0.56	0.88					

TABLE 16. COMPARISONS OF THE DIFFERENCE BETWEEN FINAL AND BASELINE DIFFERENCES IN EACH CLUSTER

Final vs baseline mean comparisons					Mean difference of differences between clusters				
	Community	N	Mean difference (change within clusters)	SD	Mean difference of differences between cluster	SD of difference	CI 95% of difference		P value (bilateral)
							Lower	Upper	
Age (m)	SPJ	86	27.06	5.45	-.30	.83	-1.94	1.35	.720
	STU	97	27.36	5.78					
Weight (kg)	SPJ	86	4.94	1.82	-.24	.27	-0.78	0.29	.368
	STU	97	5.19	1.84					
Height (cm)	SPJ	86	22.65	6.06	-1.01	.91	-2.81	0.79	.270
	STU	97	23.66	6.26					
WHZ	SPJ	86	-0.44	0.95	.05	.15	-.23	.34	.713
	STU	97	-0.49	1.01					
HAZ	SPJ	86	-0.66	0.78	-.15	.12	-.38	.08	.197
	STU	97	-0.51	0.79					
WAZ	SPJ	86	-0.62	0.84	-.08	.12	-.32	.16	.516
	STU	97	-0.54	0.81					
BAZ	SPJ	86	-0.10	0.88	.04	.14	-.23	.31	.771
	STU	97	-0.14	0.96					

TABLE 17. NUTRITIONAL STATUS BY ANTHROPOMETRICS, AT BASELINE AND FINAL ASSESSMENTS BY COMMUNITY

			SPJ		STU		Total	
			N	% column	N	% column	N	% column
Baseline	Weight for length/height z score (WHZ)	Normal weight	107	92.2%	112	91.80%	219	92.0%
		Overweight	9	7.8%	10	8.20%	19	8.0%
		Total	116	100.0%	122	100.00%	239	100.0%
	Length for age z score (HAZ)	Low stature	22	19.0%	29	23.80%	51	21.8%
		Normal	94	81.0%	93	76.20%	187	78.6%
		Total	116	100.0%	122	100.00%	239	100.0%
	Weight for age z score (WAZ)	Low weight	6	5.2%	7	5.70%	13	5.5%
		Normal weight	108	93.1%	114	93.40%	222	93.3%
		Overweight	2	1.7%	1	0.80%	3	1.3%
		Total	116	100.0%	122	100.00%	238	100.0%
	Body mass index Z score (BAZ)	Low weight	0	0.0%	2	1.60%	2	0.8%
		Normal weight	107	92.2%	111	91.00%	218	91.6%
		Overweight	9	7.8%	9	7.40%	18	7.6%
		Total	116	100.0%	122	100.00%	238	100.0%
Final	Weight for length/height z score (WHZ)	Normal weight	90	97.8%	96	98.00%	186	97.9%
		Overweight	2	2.2%	2	2.00%	4	2.1%
		Total	92	100.0%	98	100.00%	190	100.0%
	Length for age z score (HAZ)	Low stature	45	48.9%	41	41.80%	86	45.3%
		Normal	47	51.1%	57	58.20%	104	54.7%
		Total	92	100.0%	98	100.00%	190	100.0%
	Weight for age z score (WAZ)	Low weight	9	9.8%	7	7.10%	16	8.4%
		Normal weight	83	90.2%	91	92.90%	174	91.6%
		Total	92	100.0%	98	100.00%	190	100.0%
	Body mass index Z score (BAZ)	Normal weight	89	96.7%	95	96.90%	184	96.8%
		Overweight	3	3.3%	3	3.10%	6	3.2%
		Total	92	100.0%	98	100.00%	190	100.0%

SECTION ON NUTRIENT INTAKE AT BASELINE AND FINAL ASSESSMENT, FOR WOMEN AND CHILDREN

Nutrient intake for non-pregnant/non-lactating, lactating and pregnant women.

Dietary intake in women, baseline assessment:

Tables 18 and 19 show the distribution of dietary intake by using 24h recall methodology for the women study population at baseline assessment, according to community. A total of 259 women were assessed at baseline study. For nutrient intake analysis, a total of 247 women were included. The data of a group of 12 women were not included in the analysis because the diet records were incomplete or the nutrient intake calculation derived very extreme and unusual values in the upper end of distribution (>98th percentile for energy, protein or some micronutrients). The study population included non-pregnant/non lactating women (n=104), lactating women (n=93) and pregnant women (n=50). In this report, we present nutrient intake and adequacies at baseline assessment for the combined participating women. The nutrient adequacy assessment was carried out taking into account the physiological status.

Energy, protein, fat, vitamin and mineral intake was calculated by using INCAP methodology and INCAP Food Composition Tables. In general, mean nutrient intakes were comparable across women groups, and most of them were adequate. Women overall intake showed that the most important nutrient inadequacy corresponded to zinc, calcium and vitamin B_{12} . For zinc, the mean inadequacies ranged from 72-77%, being the lowest for the pregnant group. For calcium, mean ranged from 79 to 83%. For vitamin B12, it ranged from 80 – 83%, being the lowest for lactating women, which is the group with the highest needs. Of interest, dietary intake of iron in lactating and nonpregnant/non lactating women, ranged from 25mg to 30mg/d, with an overall mean of 29 and 28 mg/d for SPJ and STU, respectively, which is considered adequate for a diet of low (5%) bioavailability of minerals (INCAP RDDs). In general, nutrient intake was close to nutrient recommendations, considering a great proportion of women were either pregnant or lactating at baseline. Of interest, nutrient intake was comparable across clusters.

TABLE 18. DISTRIBUTION OF NUTRIENT INTAKE OF WOMEN AT BASELINE ASSESSMENT ACCORDING TO COMMUNITY

BASE LINE	SPJ ALL WOMEN[1]				STU ALL WOMEN			
	N (128)				N (119)			
NUTRIENT INTAKE	MEAN	PC25	PC50	PC75	MEAN	PC25	PC50	PC75
Energy kcal	2435.7	1908.4	2385.9	2950	2515.7	1866	2474	3140
Protein g	72.6	55.4	71.5	87.8	75.8	55.5	72.6	92.1
Fat g	50.5	28.6	43.3	61.6	51.4	31.5	43.9	63.8
Calcium mg	835.2	584.1	780.3	999.7	797.3	574.5	742.1	1016
Iron mg	29.4	19.2	26.3	35.8	27.7	18.2	24.8	34.6
Zinc mg	10.8	8.1	9.8	12.5	11.9	7.6	10.4	14
Vitamin c mg	131.4	52.8	92.6	181.6	100.2	41.6	77.2	122.4
Retinol equivalent RE	1100.1	637.8	917.3	1468.6	1088	599.2	895	1424
Thiamin mg	1.6	1.2	1.5	1.9	1.7	1.2	1.6	2
Riboflavin mg	1.5	1.1	1.4	1.8	1.4	1	1.3	1.8
Vitamin B6 mg	2.5	1.9	2.4	2.9	2.5	1.9	2.5	3.1
Vitamin B12 ug	1.7	0.7	1.3	2.1	1.8	0.7	1.4	2.7
Folate equivalent	478.5	250.4	384.4	645.3	436.6	258.5	396.9	542.6

[1]Note. Mean comparison between communities by t-test: except for vitamin C, mean intakes showed not differences ($p>0.05$)

TABLE 19. ADEQUACY OF NUTRIENT INTAKE OF WOMEN AT BASELINE ASSESSMENT ACCORDING TO COMMUNITY

BASE LINE	SPJ ALL WOMEN N (128)				STU ALL WOMEN N (119)			
NUTRIENTE ADEQUACY (%)	MEAN	PC25	PC50	PC75	MEAN	PC25	PC50	PC75
Energy	94.5	70.7	87.7	118.9	97.2	71.1	92.8	116.9
Protein	100	74.9	96.3	119.9	104	77	100	122.3
Calcium	83	58.4	76.7	98.5	79.2	57.4	73.7	101.6
Iron, low availability*	122.9	79.7	108	147	119.2	79.2	109	145.9
Zinc, medium availability	72.1	46.6	68.8	86.5	77.6	51.5	67.9	96.9
Vitamin C	202.3	70.6	141	284.8	152.7	58	108	195.1
Retinol EQ	199.6	93.4	178	261.4	190.8	100.4	160	250.9
Thiamin	158.3	114.1	153	195.9	162.9	115	149	194.5
Riboflavin	140.5	99	128	176.2	130.7	90.7	122	160.6
Vitamin B6	179.1	124.1	173	228.7	185.4	129	170	226
Vitamin B_{12}	79.7	29.2	63.6	97.2	83.2	31.8	60.1	114.4
Folate EQ	121.7	60.2	105	157.6	110.4	60.9	98.5	146.1
Energy from protein	12.1	10.4	11.9	13.3	12	10.1	11.7	13.4
Energy from fat	18.2	12.1	17.3	22.6	18.1	12.7	16	21.4
No. foods reported	27.9	22	26.5	32	30.4	24	30	36
* STU (N=97) SPJ (N=100), pregnant women excluded for adequacy analysis								

Dietary intake in women, at final assessment by cluster

A total of 175 women completed the diet component of the final assessment. Only 7 cases were excluded of final analysis for being incomplete or showing very unusual diets (nutrients with extreme values, >99th percentile were excluded). At the end of study most women were classified as nonpregnant/nonlactating women, therefore, the results are presented with all women combined. Tables 20 and 21 show the summary distribution of dietary intake and nutrient adequacies at final assessment (6 cases corresponded to pregnant women and were not included in the estimates of iron adequacies). In general, nutrient intake was adequate for most nutrients, except for zinc, calcium and vitamin B_{12}. The low intake key of these key nutrients is consistent with national micronutrient reports generated by biochemical methods (ENMICRON 2009-10) and consumption analysis (INCAP, 2013). Of interest, mean dietary intake of energy showed a tendency toward lower values at final assessment. Iron intake for all women (both clusters) was 23.5 ± 9 mg/d, which corresponds to an adequacy of about 98.5%, for a diet of low (5%) bioavailability of minerals (INCAP RDDs). On this regard, it is important to note that the mean intake of iron of women was lower at final assessment. One reason would be the fact that most women were either pregnant or lactating at baseline and therefore they tended to have higher dietary intakes of energy and hence, of iron; however, at the end, most women were non pregnant / non lactating, showing a tendency to have lower values (data not shown). In women of reproductive age, it is known that the physiological status of regulates the nutrient intake. However, even with lower values of iron intake at the final assessment, the absolute values are well within the recommended intake.

For zinc, the overall mean intake was about 9.5 mg for both clusters, which corresponds to a mean adequacy of 75%, which is considered low and it was comparable among communities. For vitamin B12, the adequacy intake was at about 84 y 88% respect to RDD, for SPJ and STU, respectively (Tables 20 y 21).

TABLE 20. NUTRIENT INTAKE OF WOMEN AT FINAL ASSESSMENT ACCORDING TO COMMUNITY

FINAL	SPJ LF ALL WOMEN				STU LF ALL WOMEN			
	N (82)				N (86)			
NUTRIENT INTAKE	MEAN	PC25	PC50	PC75	MEAN	PC25	PC50	PC75
Energy kcal	2360	1808	2260	2834	2430	1746	2269	2997
Protein g	69.8	51.8	66	87.6	72.1	50.8	68.6	92.1
Fat g	51.1	30.8	43.9	69.3	53.7	32.8	49.6	66.9
Calcium mg	747.5	547.3	680.2	910.9	792.7	540.8	693.7	858
Iron mg	23.7	16.8	22	28.9	23.3	17.2	20.6	28.4
Zinc mg	9.3	6.4	9.3	11.7	9.8	6.9	8.8	11.8
Vitamin C mg	143.1	50.7	90.7	167.4	106.5	37.2	66.9	127
Retinol EQ	1071	644	902.2	1436	1001.7	639.8	895.9	1374
Thiamin mg	1.5	1.1	1.5	1.8	1.5	1	1.4	1.7
Riboflavin mg	1.3	0.9	1.3	1.6	1.3	0.9	1.2	1.6
Vitamin B6 mg	2.2	1.8	2.1	2.8	2.4	1.6	2.1	2.7
Vitamin B12 ug	1.7	0.8	1.3	2.2	1.8	0.7	1.2	2.1
Folate equivalent	468.7	245.9	409.1	618.6	398.5	256.8	369.6	488

TABLE 21. ADEQUACY OF NUTRIENT INTAKE OF WOMEN AT FINAL ASSESSMENT, ACCORDING TO COMMUNITY

FINAL	SPJ ALL WOMEN				STU ALL WOMEN			
	N (82)				N(86)			
NUTRIENTE ADEQUACY (%)	MEAN	PC25	PC50	PC75	MEAN	PC25	PC50	PC75
Energy	100.5	77.6	97.5	121.3	104.5	75.9	98.7	125.3
Protein	110.6	84.9	105.5	138.7	116.6	82.9	112.1	143.8
Calcium	74.7	54.7	68	91.1	79	53.8	68.2	85.8
Iron, low availability*	99.4	70.4	92.8	120.3	97.9	72.9	86.6	118.9
Zinc, medium availability	73.8	51.9	70	93.2	78.7	56.3	70.8	95.5
Vitamin C	252.8	92.3	161	300.2	189.2	67.6	120	214.7
Retinol EQ	231.2	141	197.4	308.2	216.3	139.2	185.6	276.9
Thiamin	162.6	117.6	161	192.3	160.6	113.6	150.5	190.2
Riboflavin	137.5	98.6	140.9	173	139.1	103.1	126.5	170.3
Vitamin B_6	192	151.2	187.3	234.7	211.2	148.7	192.6	245.3
Vitamin B_{12}	84.3	36.2	64.5	110.7	88	37.1	57.4	104.4
Folate EQ	142.4	76.8	125.1	183.1	121.8	79.9	115	148.3
Energy of protein	11.8	10.3	11.6	13.3	12	10.2	11.4	13.2
Energy of fat	18.7	14.3	18.4	22	19.4	15	18.8	22.9
No. foods reported	29.7	24	28	34	30.9	25	30.5	36
* Iron, bioavailability SPJ (N=78); STU(N=84); pregnant women excluded for analysis								

Main food sources of nutrient intake in women

Tables 22-29, show the food sources of key nutrients in women, such as energy, protein, calcium, iron, zinc, vitamin A, folate and vitamin B_{12}.

Energy intake: Regarding energy intake, the main sources are tortilla and maize products, sugar, bread and beans, which sum up above 50% of energy intake (Table 22). The same pattern is seen between baseline and final assessment and across communities.

Protein intake: In terms of protein intake at baseline, the main sources are tortilla and maize products, beans and bread, which contributes with about one half of the intake (Table 23). Out of the five main protein sources, two animal sources such as chicken and eggs contributed with about 17%, a very important finding. For STU, beef was an important additional source of protein with about 6% contribution. At the end, within the top 5 food protein sources, chicken and eggs contributed with almost 20% in SPJ and 18.5% for STU. However, for STU, beef contributed additionally with 6%, summing up around 25% contribution from animal sources.

Table 22. Energy sources in women, at baseline and final assessment

Women, baseline, energy contribution (%)			
SPJ		STU	
Food source	%	Food source	%
Tortilla, and maize products	42.5	Tortilla, and maize products	44.5
Sugar, fortified	9.9	Sugar, fortified	9.7
Bread	7.4	Bread	6.8
Beans products	5.6	Beans products	4.2
Eggs	3.7	Eggs	2.8
Total	**69.1**	**Total**	**68**

Women, final, Energy contribution			
SPJ		STU	
Food source	%	Food source	%
Tortilla, and maize products	38.9	Tortilla, and maize products	42.1
Sugar, fortified	10	Sugar, fortified	9
Bread	8.5	Bread	8.2
Beans products	4.6	Beans products	4
Rice	3.6	Rice	3.3
Total	**65.6**	**Total**	**66.6**

TABLE 23. PROTEIN SOURCES IN WOMEN, AT BASELINE AND FINAL ASSESSMENT

Women, base line, Protein contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Tortilla, and maize products	33.9	Tortilla, and maize products	36.2
Beans products	11.6	Chicken	8.8
Eggs	10.6	Beans products	8.7
Chicken	6.7	Eggs	7.9
Bread	5.5	Beef	6.4
Total	**68.3**	**Total**	**68**

Final. Woman, Protein contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Tortilla, and maize products	31.7	Tortilla, and maize products	34.1
Eggs	9.8	Eggs	9.2
Chicken	9.6	Chicken	9.1
Beans products	9.5	Beans products	8
Bread	6.1	Beef	6.7
Total	**66.7**	**Total**	**67.1**

Iron intake: For baseline iron intake sources, tortilla and maize products were the predominant source of iron (non-hemic), with about one third of the intake. Other important plant sources were beans, potatoes, which contributed with about 13% in SPJ women and 12% in STU. Green vegetable contributed with 11% in SPJ and 6% in STU. Bread made of iron fortified flour contributed with about 8.5%. Of interest, out of the top 5, all food sources corresponded to plant products. These findings remark the very low contribution of animal sources to dietary iron (Table 24).

For final assessment, overall out of the top 5 foods, tortilla and maize products and beans contributed with about 47% of iron intake. Green leafy vegetables contributed with about 9.4% in SPJ and 4.8% in STU. Bread contributed with about 11% in both communities. Interestingly, out of the top 5 foods, at the end eggs constituted the only animal food source for iron, with 4% in SPJ, which was not present at baseline. The contribution of eggs to iron intake in SPJ constituted one of the main finding at the end of the study.

TABLE 24. IRON SOURCES IN WOMEN, AT BASELINE AND FINAL ASSESSMENT

Base line Women¸ Iron contribution	
SPJ	**STU**

Food source	%	Food source	%
Tortilla, and maize products	34.1	Tortilla, and maize products	37.9
Green leafy vegetables	10.8	Bread	8.6
Bread	8.6	Beans products	7.4
Beans products	8.4	Green leafy vegetables	5.7
Potatoes	4.8	Potatoes	4.5
TOTAL	**66.7**	**TOTAL**	**64.1**

Final Women, Iron contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Tortilla, and maize products	36.5	Tortilla, and maize products	39
Bread	10.8	Bread	11.3
Green leafy vegetables	9.4	Beans products	7
Beans products	7.9	Green leafy vegetables	4.8
Eggs	4.3	Potatoes	4.6
TOTAL	**68.9**	**TOTAL**	**66.7**

zinc intake: For baseline zinc intake sources, tortillas and maize products and beans were the predominant source of zinc, which contributed with about 58.5 and 56.8% of the intake, for SPJ and STU, respectively. Another important plant source was fortified blend flour (Incaparina) with about 5%. Interestingly, out of the top 5 sources, animal sources such as eggs and beef contributed with about 12% in both communities (Table 25). Looking at the dietary sources, it is shown that zinc is the most limiting nutrient in this population.

For final assessment, again, tortilla and maize products contributed with about half (49 and 52%, for SPJ and STU, respectively) of the zinc intake in both communities, followed by bean with 8 and 7%, for SPJ and STU, respectively. Out of the top 5 foods, animal sources, such as eggs, chicken and beef contributed with about 18% (SPJ) and 17% (STU). It is important to remark the increased contribution of animal sources in the study population at the end of the study.

TABLE 25. ZINC SOURCES IN WOMEN, AT BASELINE AND FINAL ASSESSMENT

Base line, women, Zinc contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Tortilla, and maize products	49.2	Tortilla, and maize products	49.4
Beans products	9.3	Beef	7.4
Eggs	7	Beans products	7
Beef	5.5	Incaparina (fortified blend flour)	6
Incaparina (fortified blend flour)	4.7	Eggs	5
Total	**75.7**	**Total**	**74.8**

Final, women, Zinc contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Tortilla, and maize products	48.6	Tortilla, and maize products	52
Beans products	8	Beans products	7.2
Eggs	6.8	Beef	6.1
Chicken	5.5	Eggs	5.9
Beef	5.2	Chicken	5.1
Total	**74.1**	**Total**	**76.3**

Vitamin A (VA) intake: For baseline and for both communities, fortified sugar (VA) was the main source of VA with almost 60% of intake. Eggs contributed with about 10% and 7% (SPJ and STU, respectively). Vegetable sources including carrots and tomatoes contributed with about 8 and 13%, for SPJ and STU respectively. Green leafy vegetables contributed with about 6% and 3%, for SPJ and STU, respectively.

For final assessment, again, fortified sugar was the main sources and was comparable with baseline contribution. Carrots was the second highest source with about 10% in both communities. Eggs were also an important source in both communities, with about 8%. Other plant sources, like green leafy vegetables and tomatoes, contributed each with about 3%. (Table 26)

TABLE 26. VITAMIN A SOURCES IN WOMEN, AT BASELINE AND FINAL ASSESSMENT

Base line, women, vitamin A contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Sugar, fortified	58.7	Sugar, fortified	58.7
Eggs	9.5	Carrots	9.8
Green leafy vegetables	6.2	Eggs	6.9
Carrots	4.8	Green leafy vegetables	2.9
Tomatoes	3.4	Tomatoes	2.8
Total	**82.6**	**Total**	**81.1**

Final woman, vitamin A contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Sugar, fortified	57.8	Sugar, fortified	57
Carrots	8.9	Carrots	9.3
Eggs	8	Eggs	8.7
Green leafy vegetables	3.2	Green leafy vegetables	3.5
Chicken	2.8	Tomatoes	3
Total	**80.7**	**Total**	**81.5**

Folate intake: For baseline folate intake, beans and tortilla and maize products contributed with 53.7% and 48.5%, for SPJ and STU, respectively. Pasta and eggs contributed with about 14% and 17%, for SPJ and STU, respectively. Other vegetable sources contributed with about 3%.

For final assessment, again, tortilla and maize products and beans contributed with 46% and 50%, for SPJ and STU, respectively. Likewise, pasta and eggs contributed with about 17 and 19%, for SPJ and STU, respectively. (Table 27)

TABLE 27. FOLATE SOURCES IN WOMEN, AT BASELINE AND FINAL ASSESSMENT

Base line, women, folate contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Beans products	28.9	Tortilla, and maize products	27
Tortilla, and maize products	24.8	Beans products	21.5
Eggs	7.4	Pasta	10.8
Pasta	7.4	Eggs	6.6
Tomatoes	3	Chayote	3.1
Total	**71.5**	**Total**	**69**

Final, women, folate contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Beans products	23.6	Tortilla, and maize products	27.5
Tortilla, and maize products	22.4	Beans products	22.4
Pasta	10	Pasta	11.5
Eggs	7	Eggs	7.4
Rice	6.5	maize products	3.1
Total	**69.5**	**Total**	**71.9**

Calcium intake: For baseline calcium intake, tortilla and maize products were the predominant sources of calcium, with about 49% and 55%, for SPJ and STU, respectively. Green leafy vegetables contributed with 9.3% and 4.3%, for SPJ and STU; beans contributed with about 6% in both communities. Eggs and bread, contributed each with about 4% or less.

For final assessment, out of the top 5 foods, tortilla and maize products was the most important source of calcium. Green leafy vegetables was an important source for SPJ with about 8%. For animal food sources, cheese and eggs, contributed each with about 4%, for SPJ and STU, respectively (Table 28).

TABLE 28. CALCIUM SOURCES IN WOMEN, AT BASELINE AND FINAL ASSESSMENT

Base line, women, calcium contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Tortilla, and maize products	49.4	Tortilla, and maize products	55.1
Green leafy vegetables	9.3	Beans products	5.5
Beans products	6.5	Green leafy vegetables	4.3
Eggs	4.4	Eggs	3.4
Bread	3.4	Bread	3.1
Total	**72.4**	**Total**	**70.2**

Final, women, calcium contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Tortilla, and maize products	48.7	Tortilla, and maize products	53.3
Green leafy vegetables	7.7	Beans products	5.4
Beans products	5.4	Bread	4.1
Bread	4.1	Eggs	3.9
Cheese	4.1	Green leafy vegetables	3.6
Total	**68.9**	**Total**	**69.4**

Vitamin B12: For baseline, as expected the animal food sources contributed the most, with about 72%, for SPJ and 67% for STU. Within the top five sources Incaparina, a fortified blend flour and a dehydrated soup (fortified with vitamin B12), were most important non-animal food sources.

For final assessment, Again, out of the top 5 foods, all sources were animal food sources, with eggs being the most important individual food source (about 44% for both communities). Chicken and beef were next, with about 27 %.(Table 29)

TABLE 29. VITAMIN B12 SOURCES IN WOMEN, AT BASELINE AND FINAL ASSESSMENT

Base line, women, vitamin B12 contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Eggs	44.4	Eggs	33.6
Beef	13.8	Beef	19.8
Soup, dehydrated	10.7	Chicken	13.4
Chicken	9.2	Soup, dehydrated	8.9
Milk	4.4	Incaparina (fortified blend flour)	5.5
Total	**82.5**	**Total**	**81.2**

Final, women, vitamin B12 contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Eggs	44.1	Eggs	43.7
Chicken	13.9	Beef	13.6
Beef	13.6	Chicken	13.2
Soup, dehydrated	9.4	Soup, dehydrated	7.1
Cheese	2.9	Cheese	4
Total	**83.9**	**Total**	**81.6**

Dietary intake in children, Baseline assessment:

At baseline study, a total of 110 children were assessed. This was due to the fact that a great part of the recruited women were either pregnant or lactating (<6 month postpartum). 18 children were not included because they were younger than six months of age and also, a small group of 2 cases of children of 6 months or older had not begun complementary feeding. For nutrient intake analysis at baseline, a total of 86 children were included. The study population was divided by three age groups, 6-8 months n= 32), 9-11 months (n=39) and 12-23 months (n= 15), however, given the distribution of these groups was comparable across communities, for the purpose of this report, the data is presented with all age groups of children combined and the nutrient intake adequacies take into account the recommended intakes according to age group. In general, nutrient intakes were comparable across children groups.

Taking into account only the nutrient intake reported in the diet (without including the contribution of the breastmilk), several micronutrients such a calcium, iron, zinc, vitamins A, B1, B2, B6, B12 and C, could be considered to be below the recommended intake. Of interest, dietary intake of iron ranged from 3.7 mg and 5.2 mg/d, for STU and SPJ, respectively, which is considered low for a diet of low or medium bio availability (5-10%) of minerals (INCAP RDDs) (Table 30 and 31). Zinc inadequacies was the most important finding, given only about one third of children showed and adequate intake.

TABLE 30. BASELINE NUTRIENT INTAKE IN CHILDREN, ALL COMBINED BY CLUSTER

Baseline	SPJ N (46)				STU N (40)			
Nutrient intake	**MEAN**	**PC25**	**PC50**	**PC75**	**MEAN**	**PC25**	**PC50**	**PC75**
Energy kcal	338.9	180.5	292.6	480.9	301.6	130	245.3	412
Protein g	10.9	6.1	8.8	15.2	8.4	4.1	6	11.2
Fat g	8	2.7	7.4	11.5	6.3	2.2	4.1	8.2
Calcium mg	126	49	98.3	170.4	112.7	31.3	70.3	151
Iron mg	5.2	2.2	4.2	6.5	3.7	1.5	2.8	4
Zinc mg	1.7	0.8	1.2	2.1	1.4	0.6	0.9	2.1
Vitamin C mg	34.1	7.5	19.1	52.7	23.2	5.8	10.2	22.5
Retinol equivalent	273.9	109.2	211.1	346.1	213.7	80.3	170.8	262
Thiamin mg	0.3	0.1	0.2	0.4	0.2	0.1	0.2	0.3
Riboflavin mg	0.3	0.1	0.3	0.5	0.3	0.1	0.2	0.3
Vitamin B6	0.3	0.2	0.3	0.4	0.3	0.1	0.2	0.3
Vitamin B12 ug	0.6	0.1	0.3	0.8	0.3	0	0.2	0.4
Folate equivalent	73.5	20.6	59.7	134.9	62.7	31	45.3	69

TABLE 31. ADEQUACY OF NUTRIENT INTAKE OF CHILDREN AT BASE LINE ASSESSMENT, ACCORDING TO COMMUNITY

NUTRIENTE ADEQUACY (%)	*SPJ* N (46)				*STU* N (40)			
	MEAN	**PC25**	**PC50**	**PC75**	**MEAN**	**PC25**	**PC50**	**PC75**
Energy	47.3	26.2	41.8	61.1	42.5	19.9	39.6	61.9
Protein	70	38.3	60.8	95	55.5	27.4	42.8	74.5
Calcium	32.3	13.9	21.8	42.6	30.3	8.6	17	42.4
Iron, low availability*	80	32.3	64.1	94.3	59.7	23	41.4	57.7
Iron, medium availability *	75.3	33.3	64.9	122	65.8	24.9	59.2	101.6
Zinc, medium availability	35.7	15.4	23	47.6	30.2	11.7	18.6	40.3
Vitamin C	113	17.8	39.9	122.5	81.4	14.7	23.9	86.8
Retinol EQ	79.9	24.3	46.9	103	69.4	19.5	38	65.6
Thiamin	79.2	35	63.4	118.9	65.2	28.4	51.6	88.6
Riboflavin	84.7	33.6	77.4	121.9	69.5	27	48.2	86.7
Vitamin B6	93	50.7	85.8	117.3	81	34.1	72.8	107.8
Vitamin B12	107.6	11.1	69.6	132.1	59.1	3.6	46.4	84.5
Folate EQ	87.7	27.4	69.6	122	74.6	40.2	49.4	91.5
Energy of protein	13.1	9.9	13.3	15.1	11.6	9.1	10.3	13.5
Energy of fat	19.6	10.3	19.2	24.9	17.8	8.5	13.9	26.7
No. foods	20.3	14	21	27	18.6	11	16.5	24

Final nutrient intake in children, all combined by cluster

At final assessment, a total of 178 children were assessed. For nutrient intake analysis, a total of 169 children were included. A total of 9 cases were not included in the analysis because the data was incomplete or because the generated nutrient intake was in the outlier range (>99 percentile), reflecting a very unusual diet. For the purpose of this report, the data is presented with all age groups of children combined. In general, nutrient intakes were comparable across communities.

For final assessment, only a small group of children were still breastfed. Taking into account only the nutrient intake reported in the diet (without including the contribution of any breastmilk), intakes were adequate or above the recommendations for most nutrients. However, with exception of calcium iron and zinc intakes could be considered to be about the recommended intake. Of interest, dietary intake of iron ranged from 10.3 mg and 10.0 mg/d, for SPJ and STU, respectively (Table 32), which is higher than that observed at baseline. Furthermore, the higher intakes of iron and zinc at final evaluation reached the recommended intakes for a diet of low (5%) bioavailability of minerals (INCAP RDDs). indicating that the study groups improved the iron and zinc intake. Finally, several other micronutrients exceeded the recommended intakes, such as vitamin A, C, B1, B2, B12 (Table 33)

The main sources of nutrient intake are shown in Tables 34-41

TABLE 32. NUTRIENT INTAKE IN CHILDREN AT FINAL ASSESSMENT, BY COMMUNITY

FINAL	*SPJ* N (83)				*STU* N (86)			
Nutrient intake	**MEAN**	**PC25**	**PC50**	**PC75**	**MEAN**	**PC25**	**PC50**	**PC75**
Energy	1050.2	832.9	1012	1251	1042.7	728.7	969.5	1319.6
Protein	32.9	24.9	32.4	41.1	31.7	22.4	29.6	39.2
Fat	28	18.1	26.3	36.5	28.2	16.7	25.1	36.7
Calcium	296.8	183.3	261.4	374.7	298.1	154.4	247.4	367
Iron	10.3	6.8	9.7	13.6	10	6.6	8.3	12.1
Zinc	3.5	2	3.2	4.7	3.7	2.1	3	4.7
Vitamin C	61.3	21.4	43.6	92.6	55.7	20.3	37.4	68.4
Retinol EQ	543.7	316.3	432.8	702.8	515.2	283	428.3	635.3
Thiamin	0.7	0.5	0.7	0.9	0.6	0.4	0.6	0.9
Riboflavin	0.8	0.5	0.7	0.9	0.8	0.5	0.7	1
Vitamin B6	0.8	0.6	0.8	1.1	0.9	0.5	0.8	1.1
Vitamin B_{12}	1.1	0.5	0.9	1.5	1	0.4	0.8	1.4
Folate EQ	261.8	132.9	230.7	346.2	240.8	127	213.9	305

TABLE 33. ADEQUACY OF NUTRIENT INTAKE OF CHILDREN AT FINAL ASSESSMENT, ACCORDING TO COMMUNITY

FINAL	SPJ				STU			
	N (83)				N (86)			
NUTRIENTE ADEQUACY (%)	MEAN	PC25	PC50	PC75	MEAN	PC25	PC50	PC75
Energy	93.9	74.3	87.9	114.1	94.2	65.9	91.6	121.1
Protein	189.2	141.3	180.7	238.5	183.1	128.6	172.4	229.8
Calcium	59.4	36.7	52.3	74.9	59.6	30.9	49.5	73.4
Iron, medium bio-availability*	190.1	125.6	180.1	251.5	185.6	122.7	153.2	224.8
Iron, low bio-availability*	95	62.8	90	125.7	92.8	61.3	76.6	112.4
Zinc, medium bio-availability	92.6	53.9	84.3	123.3	97.2	56.3	79.4	122.7
Vitamin C	471.6	164.7	335.6	712.6	428.2	156.2	287.9	526.3
Retinol EQ	258.9	150.6	206.1	334.7	245.3	134.7	203.9	302.5
Thiamin	174.3	118.3	164.9	215.7	159.5	88.6	153.5	215
Riboflavin	198.6	128.3	180.5	236.7	192.6	119.8	166.6	256
Vitamin B6	211.2	140.2	201.2	271.7	214.8	129.6	206.8	286
Vitamin B12	163.7	69.3	123.2	214.9	141.3	62	112.1	193
Folate EQ	218.2	110.7	192.2	288.5	200.7	105.9	178.2	254.1
Energy from protein (%)	13.3	11	12.9	14.9	13.3	10.6	12.5	14.8
Energy from fat (%)	22.3	16.8	22.7	27	23.1	18.3	21.6	28.3
No. foods reported	30	25	29	34	31.5	26	31	37

Main food sources of nutrient intake in Children

Tables 34-41 show the foods that contributed the most with main nutrients, according to community at both baseline and final assessment. For each food item, it is also presented the percent of its contribution to total intake of the nutrient. The key nutrients included energy, protein, folate, vitamin A, vitamin B12, iron, zinc and calcium.

Energy intake: Regarding energy intake for SPJ, six foods including tortilla and maize products, sugar, bread eggs, oil and rice summed up around 50% of energy intake (Table 34). For STU, two important food sources, such as infant formula and yogurt contributed with about 11%. At final assessment, the new important sources included chicken, rice, beans and both communities were comparable in terms of food sources.

TABLE 34. ENERGY SOURCES IN CHILDREN, AT BASELINE AND FINAL ASSESSMENT

Base Line, Children, Energy contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Sugar, fortified	14.4	Sugar, fortified	14.7
Tortilla, and maize products	13.7	Tortilla, and maize products	11.1
Eggs	8.3	Bread	10.7
Bread	7.3	Eggs	6.6
Oil vegetable, all types	3.9	Infant formula	5.9
Rice	3.5	Yogurt	5.3
Total	**50.3**	**Total**	**53.4**

Final, children, Energy contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Tortilla, and maize products	15.3	Tortilla, and maize products	17.7
Sugar, fortified	10.9	Sugar, fortified	10
Bread	9.1	Bread	9.4
Eggs	5.3	Eggs	5.6
Chicken	4.6	Oil vegetable, all types	4.4
Rice	4.2	Beans products	4.1
Beans products	4	Rice	3.8
Total	**53.4**	**Total**	**55**

Protein intake: In terms of protein intake at baseline, the three main sources included eggs, tortilla and maize products and bread, which contributed with 36% (SPJ) and 34% (STU). Of interest, fortified blend flours were present in SPJ (about 10%) and yogurt and infant formula (about 13%) in STU. Out of the five main protein sources, eggs was the most important.

At final, the three most important included eggs, chicken, tortilla and maize products, which contributed with about 38% for both, SPJ and STU. So, it is important to note that at the end of the study, two animal sources (eggs and chicken) were within the top 3 protein food sources, which combined they contributed with about 26% and 24%, for SPJ and STU, respectively. Plant food sources, such as tortilla and maize products, beans and bread contributed with about 26% and 27%, for SPJ and STU, respectively.

TABLE 35. PROTEIN SOURCES IN CHILDREN, AT BASELINE AND FINAL ASSESSMENT

Base Line, Children, Protein contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Eggs	19	Eggs	13.3
Tortilla, and maize products	10.7	Bread	10.7
Bread	6.5	Tortilla, and maize products	10.1
Potatoes	5.1	Potatoes	8.1
Vitacereal	4.8	Yogurt	8
Incaparina	4.6	Infant formula	5.7
Total	**50**	**Total**	**55.1**

Final, children, Protein contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Eggs	13.8	Eggs	14.5
Chicken	12.8	Tortilla, and maize products	13.9
Tortilla, and maize products	12	Chicken	10
Beans products	7.6	Beans products	7.9
Bread	6.2	Bread	6.1
Total	**52.4**	**Total**	**52.4**

Iron intake: Table 36 presents the six foods that contributed with about 54% of iron intake, at baseline. Interestingly, out of the top six, eggs --animal food source--, contributed with about 9% and 7%, for SPJ and STU, respectively. Green leafy vegetables contributed with 8% for SPJ. While, for STU, infant formula contributed with about 6.8%; for SPJ, fortified blend flour contributed with 7%.

For final assessment, out of the top 6 foods, tortilla and maize products and bread contributed with about 26% of iron intake in both communities. Green leafy vegetables contributed with a 10% in SPJ and was not present within the top 6 iron sources for STU. Eggs, contributed with about 7% in both communities, and was the only animal source within the top 6 food sources.

TABLE 36. IRON SOURCES IN CHILDREN, AT BASELINE AND FINAL ASSESSMENT

Base Line, Children, Iron contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Tortilla, and maize products	11.4	Potatoes	15.4
Potatoes	11.2	Bread	12.4
Eggs	9.3	Tortilla, and maize products	10.3
Bread	8.3	Eggs	7.1
Green leafy vegetables	8	Infant formula	6.8
Incaparina	7.2	Oats	6.1
TOTAL	**55.4**	**TOTAL**	**58.1**

Final, children, Iron contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Tortilla, and maize products	14.8	Tortilla, and maize products	17.1
Bread	11.6	Bread	12.5
Green leafy vegetables	10.3	Eggs	7.3
Beans products	6.9	Beans products	7.1
Eggs	6.7	Potatoes	5.7
Potatoes	4.1	Incaparina	5.5
Total	**54.4**	**Total**	**55.2**

Zinc intake (Table 37)**:** For baseline zinc intake sources, tortilla and maize products was the top source with about 17% and 14% contribution in SPJ and STU, respectively. Eggs was the second top source with about 14 and 10%, for SPJ and STU, respectively. Of interest, fortified blend flour contributed with about 16% in SPJ, and yogurt and infant formula with about 17% in STU.

For final assessment, tortilla and maize products contributed with about 21% and 25%, for SPJ and STU. Eggs was the second top zinc source for SPJ (12%) and STU (11%). Chicken and beef contributed with about 16% in SPJ, while only chicken contributed with about 7% in STU.

In summary, it is important to remark the increased contribution of animal sources in the study population at the end of the study in both groups

TABLE 37. ZINC SOURCES IN CHILDREN, AT BASELINE AND FINAL ASSESSMENT

Base Line, Children, Zinc contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Tortilla, and maize products	17.1	Tortilla, and maize products	13.8
Eggs	13.9	Eggs	10.4
Incaparina (fortified blend flour)	8.8	Chayote	9.8
Vitacereal (fortified blend flour)	7.8	Yogurt	8.9
Potatoes	5.6	Infant formula	8.2
Beef	5.5	Potatoes	6.4
Total	**58.7**	**Total**	**57.5**

Final, Children, Zinc contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Tortilla, and maize products	21.5	Tortilla, and maize products	24.9
Eggs	12.1	Eggs	11.3
Chicken	8.9	Beans products	8.4
Beans products	7.9	Incaparina (fortified blend flour)	7.9
Beef	5.7	Chicken	7
Total	**56.1**	**Total**	**59.5**

Vitamin A source intake (Table 38**):** At baseline, five top foods contributed with about 80% of the intake in both clusters, however, it is important to show that fortified sugar contributed with about half of the total intake of vitamin A in both clusters. Eggs was the only animal source within the top five, with a contribution of about 11% and 9%, for SPJ and STU, respectively. Plant sources, such as tomatoes and carrots combined contributed with about 10%. However, for SPJ, green leafy vegetables contributed with 4.6% and was not within the top 5 in STU. Infant formula was present within the top five only STU, with an important contribution of about 9.3%.

At final assessment, sugar continued being the main source of almost half the vitamin A intake. Eggs was next with 9 and 11%, for SPJ and STU, respectively. Vegetable sources such as carrots, green leafy vegetables and tomatoes contributed with about 12% in SPJ and 16 in STU.

TABLE 38. VITAMIN A SOURCES IN CHILDREN, AT BASELINE AND FINAL ASSESSMENT

Base Line, Children, vitamin A contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Sugar, fortified	52.7	Sugar, fortified	51.7
Eggs	11	Carrots	10.1
Tomatoes	4.9	Infant formula	9.3
Green leafy vegetables	4.6	Eggs	9
Carrots	4.5	Tomatoes	3.7
Total	**77.7**	**Total**	**83.8**

Final, children, vitamin A contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Sugar, fortified	48.6	Sugar, fortified	48.6
Eggs	9.4	Eggs	11
Carrots	8.6	Carrots	9.4
Incaparina	4.5	Green leafy vegetables	3.4
Green leafy vegetables	3.2	Tomatoes	3.3
Total	**74.3**	**Total**	**75.7**

Folate intake (Table 39): At baseline, five food contributed with about 50% of the intake in both clusters. In SPJ, eggs was the most important contributors with about 14%, while tortilla and maize products, pasta (fortified wheat flour), beans and potatoes summed 36%. For STU, pasta was the top sources (about 15%), while chayote was next with 12.8%. For ST, eggs was the only animal source within the top five food sources with almost 10%.

At final assessment, beans became the top source of folate with about 20% in both clusters. Eggs and pasta were present in both clusters with a contribution of about 18.2% and 23%, for SPJ and STU, respectively. Tortilla and maize products was also present in both clusters with 9.8% and 11.8%, for SPJ and STU, respectively.

TABLE 39. FOLATE SOURCES IN CHILDREN, AT BASELINE AND FINAL ASSESSMENT

Base Line, Children , Folate contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Eggs	13.8	Pasta	14.7
Tortilla, and maize products	12.6	Chayote	12.8
Pasta	9.6	Eggs	10.2
Beans products	9.5	Cookies	6.9
Potatoes	7.1	Tortilla, and maize products	6.8
Total	**49.8**	**Total**	**51.2**

Final, children, Folate contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Beans products	19.9	Beans products	20
Tortilla, and maize products	9.8	Pasta	11.7
Eggs	9.6	Tortilla, and maize products	11.8
Pasta	8.6	Eggs	11.3
Rice	7.6	Cookies	6.7
Total	**52.2**	**TOTAL**	**58.9**

Calcium sources intake (Table 40): At baseline, six top foods contributed with about 54% and 60%, for SPJ and STU, respectively. Out of the top six foods, tortilla and maize products was the main source with 18.4% and 16.2%, for SPJ and STU, respectively. Eggs and bread were present in both clusters and contributed with about 16% and 14%, for SPJ and STU, respectively. Green leafy vegetables contributed with 8% in SPJ. Again, infant formula was an important source in ST with almost 9%.

At final assessment, tortilla and maize products became the most important source of calcium with about 22% and 26%, for SPJ and STU, respectively. Eggs and milk were important sources in both clusters, which combined it summed up 13% in both clusters. Green leafy vegetables contributed with about 9.6% in SPJ and almost 5% in STU. Beans was also an important source with 5% in SPJ, and 6% in STU.

TABLE 40. CALCIUM SOURCES IN CHILDREN, AT BASELINE AND FINAL ASSESSMENT

Base Line, Children, Calcium contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Tortilla, and maize products	18.4	Tortilla, and maize products	16.2
Eggs	10.4	Yogurt	13
Green leafy vegetables	8.1	Infant formula	8.8
Potatoes	6.6	Potatoes	7.8
Vitacereal (fortified cereal blend)	5.5	Eggs	7.4
Bread	5.5	Bread	6.8
Total	**54.5**	**Total**	**60**

Final, children, Calcium contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Tortilla, and maize products	22	Tortilla, and maize products	26
Green leafy vegetables	9.6	Eggs	8.4
Eggs	6.8	Beans products	6.2
Milk	6.6	Milk	5.5
Beans products	5.3	Bread	5.2
Cheese	4.7	Green leafy vegetables	4.8
Total	**55**	**Total**	**56.1**

Vitamin B_{12} intake (Table 41): At baseline, five foods contributed with about 80% of the intake. In SPJ, eggs and beef were the most important contributors with about 52%, while for ST, eggs was the only animal source within the top five food sources with almost 30%. Interestingly, fortified bled flours and infant formula contributed with about 15% in SPJ and 13.6% in STU. It is also important the contribution of dehydrated soups, which contributed with about 14% in SPJ and 20% in STU. The latter shows the important role of processed foods.

At final assessment, again, eggs showed to be best source with about 42 and 44%, for SPJ and STU, respectively. However, it is important the contribution of other animal sources, such as chicken, beef and milk, which combined summed up about 31% and 27%, for SPJ and STU, respectively. So, in summary animal sources contributed with more than 70% of the intake of vitamin B_{12}.

TABLE 41. VITAMIN B12 SOURCES IN CHILDREN, AT BASELINE AND FINAL ASSESSMENT

Base Line, Children, vitamin B12 contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Eggs	41.6	Eggs	29.9
Soup, dehydrated	14.1	Soup, dehydrated	20.1
Beef	10.9	Yogurt	14.4
Incaparina (fortified blend flour)	8.5	Infant formula	8.9
Vitacereal (fortified blend flour)	6.3	Incaparina (fortified blend flour)	4.7
Total	**81.4**	**Total**	**78**

Final, children, vitamin B12 contribution			
SPJ		**STU**	
Food source	**%**	**Food source**	**%**
Eggs	42.1	Eggs	43.9
Chicken	12.9	Chicken	10.4
Beef	11.5	Beef	9.9
Soup, dehydrated	6.6	Milk	6.3
Milk	6.2	Soup, dehydrated	5.5
Total	**79.3**	**Total**	**76**

FOOD FREQUENCY INTAKE DURING FOLLOW UP AND FINAL ASSESSMENT

Table 42 shows the food frequency intake of main food groups for women and children; expressed as the number of times each food group was reported as consumed during the previous 7 days. This information complements the macro and micronutrient intake reported by 24hr recalls. However, this approach allows determining which foods are most commonly consumed within the time frame of previous 7 days and to document the frequency reported for those foods promoted by the project (meat consumption and green leaves vegetables).

Of interest, tortilla/maize products, cereals and sugar, and green leafy vegetables were the foods with the greater number of times consumed during the previous 7 days.

To avoid underestimation, green leaves vegetables were reported individually and then combined as one group. At second follow up and at final assessment, participating women consumed as an average 9.6 and 8.6 times a week of any type of the green leaves vegetables promoted by the project, respectively. It is important to remark that the green leaves vegetables promoted by the project were selected as good sources of protein and micronutrients, especially minerals such as iron. Results were comparable between assessments and among communities. The assessments periods corresponded to the peak stage of the implementation.

Furthermore, consumption of animal food sources, beans and dairy were about 6, 3 and 2 times during the previous 7 days, at both the second interim assessment and final assessment, being comparable between communities.

The results are in concordance with the dietary intake and adequacies reported in the previous section. Even when this was a relatively vulnerable population, it had a relatively acceptable access of adequate sources of nutrients and therefore, nutrient gaps corresponded mostly to key nutrients such as zinc and vitamin B12. Results were comparable among communities.

Results for children reflected a close correlation with women results.

TABLE 42. FOOD FREQUENCY CONSUMPTION OF FOOD GROUPS, AT 2ND. AND FINAL EVALUATION, IN WOMEN AND CHILDREN, ACCORDING TO COMMUNITY

	Women 2nd follow up evaluation May-2016				Women FINAL evaluation Dec-2016			
	SPJ N=96		STU N=101		SPJ N=84		STU N=88	
Food groups	**Mean**	**SD**	**Mean**	**SD.**	**Mean**	**SD**	**Mean**	**SD.**
Green leaves vegetables	9.64	5.762	9.43	6.427	8.62	5.650	8.44	5.683
Other vegetables	2.76	2.491	3.11	1.832	1.43	1.779	1.35	1.431
Animal food sources	6.23	3.686	6.17	3.265	6.88	3.548	7.74	4.674
Beans	3.16	3.232	2.37	2.335	3.83	3.439	3.91	3.993
Dairy products	2.03	2.469	1.56	2.170	2.04	3.102	1.85	2.659
Cereals and sugar	29.08	5.430	27.93	7.323	34.67	9.345	33.90	9.029
Fortified blend flour	2.26	3.294	2.11	2.379	1.77	2.901	2.55	4.438

Tortilla maize and maize products	20.99	2.681	22.12	2.673	21.50	5.117	21.33	4.680
Fruits	2.27	2.023	2.59	2.438	4.63	3.556	4.58	4.849

Food groups	CHILDREN, 2nd Follow up evaluation, May-2016 SPJ N=96		STU N=101		CHILDREN, FINAL evaluation, Dec-2016 SPJ N=85		STU N=89	
	Mean	SD	Mean	SD.	Mean	SD	Mean	SD.
Green leaves vegetables	9.27	5.438	9.32	6.456	8.67	5.500	8.44	5.358
Other vegetables	2.80	2.590	3.06	1.854	1.49	1.868	1.35	1.478
Animal food sources	6.13	3.677	6.24	3.296	7.34	3.750	7.74	4.397
Beans	3.14	3.243	2.29	2.075	3.75	3.453	3.99	3.967
Dairy products	2.20	3.204	1.59	2.281	3.19	5.107	2.08	3.297
Cereals and sugar	28.43	6.422	27.59	7.220	35.60	9.488	33.96	8.802
Fortified blend flour	3.89	7.010	3.22	5.170	2.87	5.275	3.52	5.981
Tortilla maize and maize products	19.11	5.729	19.65	5.903	19.78	6.402	19.61	6.798
Fruits	2.52	2.583	2.76	2.487	6.06	5.704	5.78	5.543

Diet diversity

For women, minimum diet diversity (MDD) was assessed by 24h diet recalls following FANTA/FAO (2016) criteria and for children, we used WHO criteria (WHO 2009).

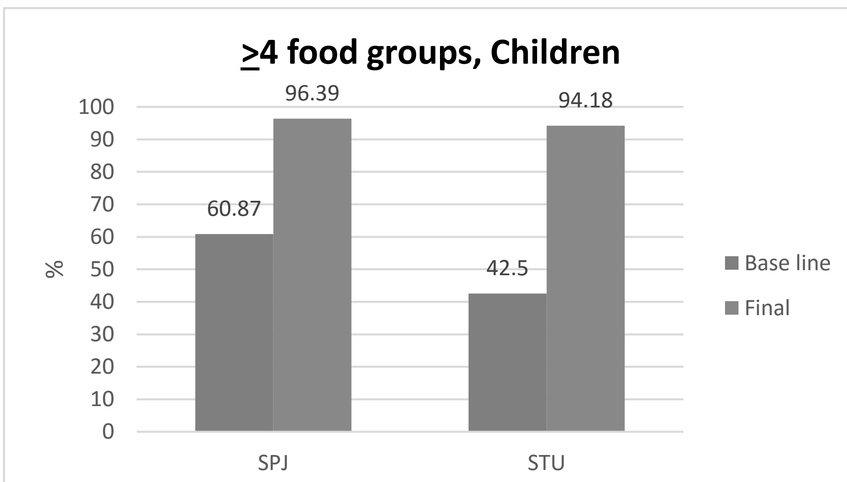
Women: At baseline, women were comparable in terms DD across communities, as 76% (SPJ) and 79% (STU), met the criteria of MDD (>=5 food groups). At the end of the study, DD improvement was greater for SPJ, reaching 84% (about 8.5 pp%) respect to STU (80%, with 1 pp% of change).

GRAPH 2. Percent achieving Minimum Dietary Diversity for Women of Reproductive Age (MDD-W) (≥5 food groups yesterday

Looking at specific food groups, at baseline SPJ showed greater reports than STU respect to dark leafy vegetables, pulses and eggs. On the other hand, STU showed greater reports than SPJ respect to nuts/seeds, dairy, other vitamin A-rich fruit and vegetables and MFP food groups. At final, SPJ showed to keep higher percentages of reporting in dark green vegetables and pulses; while STU, higher percentages for nuts, other vitamin A-rich fruits and vegetables and MFP.
The changes at the end of the study for each community showed that for SJP there were increases in dairy, other fruits and MFP food groups. The group of dark green vegetables showed a slight decrease of about 5%, respect to BL. On the other hand, for STU, the food group with greater increases were dark green leafy vegetables, other fruits and eggs. MPF kept relatively the same at about 73%.

Children: At baseline, 61% of children of SPJ and 42% in STU met MDD (4 + foods groups). At the end, there was a marked improvement for both communities, reaching about 95% of MDD, which is remarkable.

Looking at specific food groups, at baseline SPJ showed higher percentages for MFP, vitamin-A rich fruits and vegetables, eggs and legumes. It is important to remark that most food groups were reported as an average 55% for SPJ and 47% for STU. In the case of eggs and MFP, the percent reported was around 50% and 31%, respectively.



GRAPH 3. Percent achieving Minimum Dietary Diversity for Children (MDD) (≥4 food groups, according to WHO 2009)

In spite of differences found at baseline among communities, at final SPJ showed comparable reports than STU respect to all seven-food groups. It is important to remark that most food groups were reported as an average 73% for SPJ and STU. In the case of eggs and MFP, the percent reported was around 67%.
In terms of changes between BL and final, SPJ showed the greater changes in dairy, MFP, vitamin-A rich fruits and vegetables, eggs, with an average of increase of about 24% for these food groups. For STU, there was a similar pattern of increase in dairy, MFP, vitamin-A rich fruits and vegetables and eggs, with an average increase of 33% for these food groups.

In conclusion, in both communities, there were improvements in MDD from baseline to final in both women and children, especially in dairy, MFP, eggs and green leafy vegetables food groups.

HEMATOLOGICAL STATUS BY HB, BASELINE AND FINAL ASSESSMENT, IN WOMEN AND CHILDREN

Women: For women, the mean values for Hb at baseline and final assessment are presented in Tables 43, 44 and 44A. Mean values between clusters were comparable at baseline (13.30 vs 13.58 g/dL, p>0.05), but Hb mean values were statistically different between clusters at final assessment (13,47 for SPJ vs 14.12 g/dL for STU, p<0.001). The Hb paired mean difference (change) between baseline vs final assessment showed an increase of 0.27 g/dL (CI, -0.05 – 0.60, p>0.05) and 0.63 g/dL(CI, 0.34 – 0.92, p<0.001), for SPJ and STU, respectively. On the other hand, although both groups increased Hb mean values, the difference in magnitude of change between clusters was 0.36 g/dL (CI, -0.79 – 0.07, p>0.05 (in favor of STU), which did not reach a significance.

In women, the baseline prevalence of anemia was 17.3% and 14.3% for SPJ and STU, respectively; and at the end, it was 7.5 and 0%, for SPJ and STU respectively. These changes showed an improvement in terms of hematological indices (Table 44).

Children: Table 45 and Graph 4 show the hematological status of study children by stage and cluster. In general, there was an increase in Hb values from baseline to final assessment and this occurred for both clusters. However, it is importante to note that baseline HB means for SPJ children were lower than STU (10.90 vs 11.19 g/dL, respectively, p<0.05). At second interim assessment (assessment #3) when the children had a mean age of about 28 months, the mean of Hb were comparable between clusters at 12.1 g/dL. At final assessment, the Hb group mean comparison showed that STU continued with higher mean values respect SPJ (12.86 vs 12.54 g/dL, respectively (p<0.01)).

Tables 46 (Panels A and B). looking at paired wise comparisons, SPJ showed a Hb change from baseline to second interim and to final assessments of 1.4 g/dL (CI, 1.074 - 1.734) and 1.82 g/dL (CI, 1.457 - 2.183), respectively, which was significant for both comparisons (p<0.001). For STU, Hb changed from baseline to second interim and to final assessments of 0.82 g/dL (CI, 0.527 - 1.105), and 1.51 g/dL (CI, 1.172 - 1.842), both of which were significant (p< 0.001). In summary, during the implementation study, it was observed a significant increase in Hb values respect to baseline at the interim assessment #2 (assessment #3) and at final assessment (p<0.05) in children of both clusters.

Difference of differences between clusters: SPJ had a trend to a greater increase in Hb during the study, respect to STU. The baseline and second interim assessment difference of differences between clusters (SPJ with 1.45 vs STU with 0.82g/dL) was significant at about 0.60 g/dL (CI, 0.203-1.005, p<0.03) (in favor of SPJ). On the other hand, the baseline and final difference of the difference between clusters was 0.31 g/dL(CI, -0.13913 - 0.76018), which did not reach a significant difference (p>0.05). Of interest, the second interim assessment and final assessment difference of differences between clusters was significant between clusters (p<0.05) in favor of STU. This indicates that the main study difference of differences in terms of Hb between clusters was shown at around 20 months of study implementation (when the children were about 28 months of age) and it was in favor of the community with the full implementation. However, even when there was a tendency to continue improving the Hb mean values in both clusters, it was more marked in STU and this made both clusters comparable at the end of the study.

Graph 5 shows the rate of baseline anemia for all the participating children (both clusters combined), which was 43.9%, which according to the WHO reference, the two study population showed a severe rate of anemia. The comparison between study clusters showed that the baseline prevalence of anemia for SPJ and STU, was 46.7% and 41.1%, respectively. During the course of study implementation (at second interim assessment at about 12-20 months), the anemia prevalence had decreased to a level of 3.2% in both groups; and at the end of the study (at 20-30 months of implementation), it was 4.5% and 3.2%, for SPJ and STU, respectively The data above provides evidence of an improvement in terms of hematological status in both clusters, with only a trend to greater changes in favor of the SPJ (see next section on other biomarkers for iron status).

TABLE 43. HEMOGLOBIN LEVELS IN WOMEN AT BASELINE AND FINAL ASSESSMENTS AND MEAN DIFFERENCES BY TIME POINTS AND CLUSTERS

		Baseline	**Final**	**Final vs baseline Hb differences within each cluster,**		**Final vs baseline Hb Difference of difference between clusters**
COMMUNITY		**Hb (g/dL)**	**Hb (g/dL)**	**Hb g/dL (mean values) CI 95%**	**(p value)**	**Hb g/dL (mean values) CI 95% (p value)**
SPJ	N	133	80	80	**0.10**	**0.36 -0.79 – 0.07 (p>0.05)**
	Mean	13.30	13.58	0.27 -0.05 – 0.60		
	SD	1.33	1.16	1.48		
	Minimum	9.5	8.4	-5		
	Maximum	16.1	15.9	3		
STU	N	126	94	94	**0.001**	
	Hb Mean	13.47	14.12	0.63 0.34 – 0.92		
	SD	1.3489	0.75	1.40		
	Minimum	10.3	12.2	-3.4		
	Maximum	17.7	16.1	4.3		
Total	N	259	174	174		
	Media	13.382	13.867	0.47		
	SD	1.3416	0.9959	1.44		
	Minimum	9.5	8.4	-5		
	Maximum	17.7	16.1	4.3		

TABLE 44. HEMOGLOBIN LEVELS IN WOMEN AT BASELINE AND FINAL ASSESSMENTS AND ANEMIA RATES BETWEEN TIME POINTS AND CLUSTERS

									MEAN DIFFERENCES, Final vs baseline (change)				
Women	**N**	**Mean**	**SD**	**Anemia %**	**N**	**Mean**	**SD**	**Anemia %**	**N**	**Mean difference Hb g/dL**	**SD**	**Mean comparison p value**	**Difference of difference between clusters Hb g/dL, CI, (p value)**
	Baseline assessment				**Final assessment**				**Comparisons**				
SPJ	133	13.3	1.3	17.3	80	13.6	1.2	7.5	80	0.27	1.48	0.10	0.36 -0.79 - 0.07 (>0.05)
STU	126	13.5	1.3	14.3	94	14.1	.7	0	94	0.63	1.40	0.001	
All	259	13.4	1.3	15.8	174	13.9	1.0	3.4					

***TABLE 44A*. ANEMIA RATES IN WOMEN AT BASELINE AND FINAL ASSESSMENT, ACCORDING TO PHYSIOLOGICAL STATUS AND COMMUNITY**

Assessment	Physiological status	N (Both communities)	SPJ - Anemia			STU - Anemia		
			N anemia	% column	% raw	N anemia	% column	% raw
Baseline	Pregnant (PW)	52	1	7.7%	3.4%	3	27.3%	13.0%
	Lactating (LW)	100	7	53.8%	14.3%	6	54.5%	11.8%
	NON_PW/LW	107	5	38.5%	9.1%	2	18.2%	3.8%
	Total	259	13	100.0%	9.8%	11	100.0%	8.7%
Final	NON_PW/LW	158	4	80.0%	5.6%	0	0.0%	0.0%

TABLE 45. HEMATOLOGICAL STATUS BY HEMOGLOBIN LEVEL IN STUDY CHILDREN BY TIME POINT OF ASSESSMENT AND CLUSTER

		Baseline	Evaluation #2	Evaluation # 3	Final
SPJ	N	94	30	93	88
	Age (mo)	10.5	20.5	27.7	34.0
	Hb g/dL(mean)	10.9	10.6	12.1	12.54
	Hb g/dL (SD)	1.36	1.32	0.79	0.85
STU	N	97	32	93	95
	Age (mo)	10.5	20.5	28.1	34.5
	Hb g/dL(mean)	11.19	11.03	12.13	12.86
	Hb g/dL (SD)	1.27	1.18	0.66	0.89
Total	N	191	62	186	183
	Age (mo)	10.5	20.5	27.9	34.3
	Hb g/dL(mean)	11.05	10.82	12.14	12.70
	Hb g/dL (SD)	1.29	1.25	0.73	0.88

TABLE 46. PAIRWISE MEAN COMPARISONS OF HEMOGLOBIN IN STUDY CHILDREN AT BASELINE, FOLLOW UP AND FINAL ASSESSMENTS BY CLUSTERS

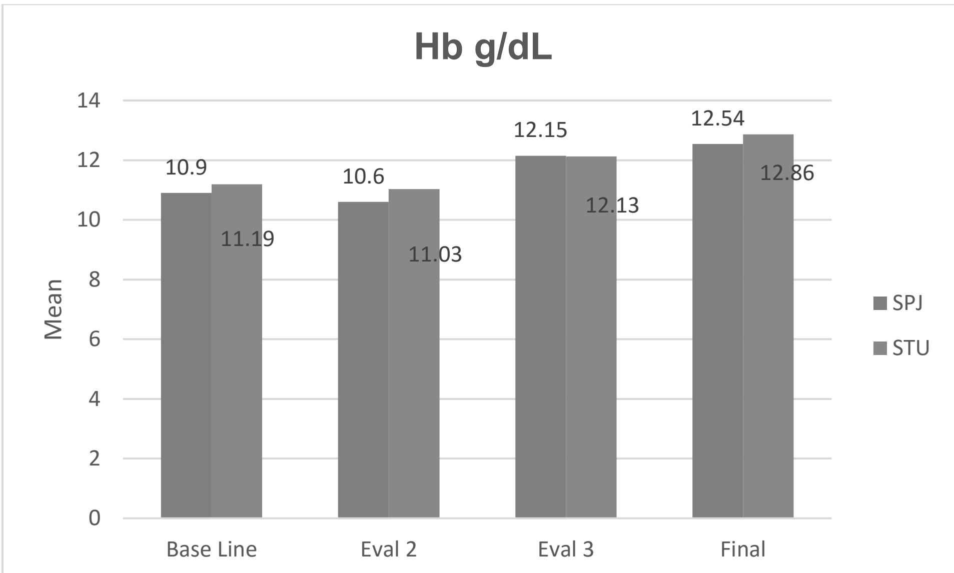
Panel A: Mean values by pairwise comparisons at specific time points

Community	Pair #	Time point assessment pairwise comparisons	N pairs	Mean Hb g/dL	SD Hb G/dL
SPJ	Pair 1	Interim #2	75	12.20	.821
		Baseline		10.80	1.393
	Pair 2	Final	70	12.58	.846
		Baseline		10.76	1.386
	Pair 3	Final	76	12.55	.874
		Interim #2		12.14	.831
STU	Pair 1	Interim #2	76	12.17	.644
		Base Line		11.36	1.273
	Pair 2	Final	75	12.88	.8944
		Base Line		11.38	1.288
	Pair 3	Final	78	12.82	.876
		Interim #2		12.10	.689

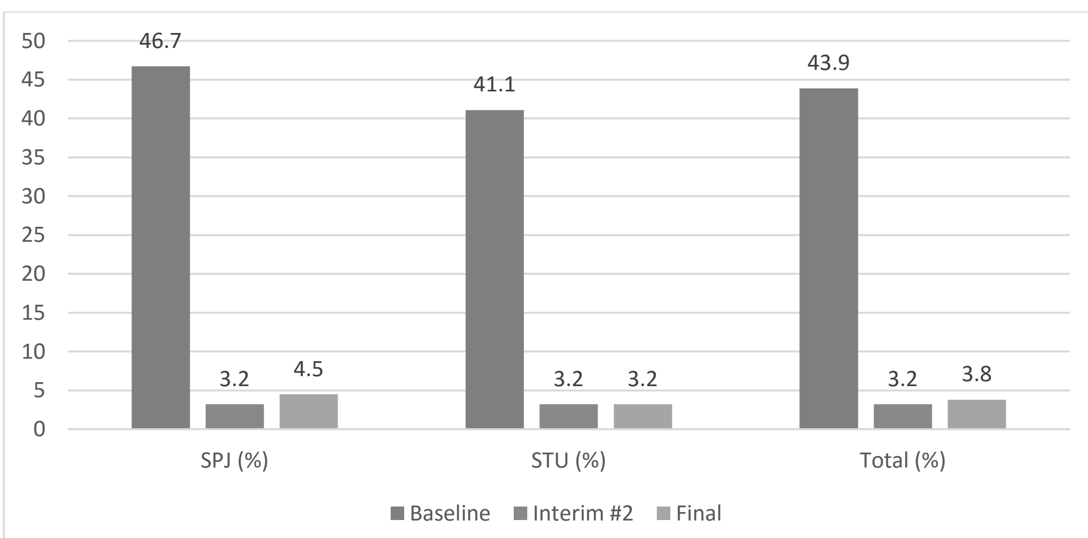
TABLE 47. PAIRWISE MEAN COMPARISONS OF HEMOGLOBIN IN STUDY CHILDREN AT BASELINE, FOLLOW UP AND FINAL ASSESSMENTS BY CLUSTERS

Panel B: Comparison of mean differences of differences at specific time points by clusters

Pairwise comparisons Differences between time points	COMMUNITY	N	Unadjusted Hb difference between time points at each cluster (changes across time points)			Mean differences of differences between clusters, at specific time point
			Mean Hb (g/dL)	SD Hb (g/dL) CI 95%	P value<	Mean (g/dL) CI 95% (p<)
Interim #2 vs baseline	SPJ	75	1.4	1.44 1.074 - 1.734	0.001	0.59 0.15 - 1.02 (p<0.008)
	STU	76	0.82	1.26 0.527 - 1.105	0.001	
Final vs baseline	SPJ	70	1.82	1.52 1.457 - 2.183	0.001	0.31 -0.17 - 0.80 (p>0.05)
	STU	75	1.51	1.46 1.172 - 1.842	0.001	
Final vs interim #2	SPJ	76	0.41	0.77 0.238 - 0.591	0.001	-0.3 -0.55 - -0.04 (p<0.02)
	STU	78	0.71	0.81 0.529 - 0.896	0.001	



GRAPH 4. Hemoglobin mean values (g/dL) in study children by time point and community, showing the trend toward higher values as the study progressed.



GRAPH 5. Anemia (%), in children, at baseline and final evaluation, according to community. There is a significant decrease in anemia rates from baseline to final assessment.

IRON STATUS BY BIOMARKERS: INTERIM AND FINAL ASSESSMENT

Iron status and rates of inflammation in children and women

Ferritin and soluble receptors of transferrin have been widely used to determine iron status at population level. Although these biomarkers are no readily available at every setting, they can provide a more reliable information regarding iron status compared to hemoglobin. It is known that the anemia, as determined by low hemoglobin levels, may have some limitations. However, because of the simplicity of its determination, it has become the standard method for anemia prevalence studies around the world. It is known that low levels of hemoglobin are a late state of iron deficiency. Therefore, when possible, the use of iron status biomarkers, such as ferritin and soluble receptors of transferrin, can be of a great utility in population studies related to determine iron status.

One important aspect to take into account is that iron biomarkers are known to be affected by the inflammation status of the individual. As a matter of fact, ferritin, the biomarker most commonly used to determine iron stores, is also an acute phase protein, and therefore, it can be falsely elevated in response to an infection (independently of the iron status), preventing the identification of actual iron deficiency (Rohner F, 2017). Fortunately, these limitations can be puzzle out by establishing the inflammation status of the subject through the determination of the levels of two acute phase response proteins, such as C-reactive protein (CRP) and alpha glycoprotein (AGP). Elevated values of CRP or AGP reflect that the subject is either incubating an infection or is acutely infected or is recovering of an infection. In doing so, iron status assessment using either ferritin or soluble receptors of transferrin is possible after adjusting for inflammation status.

For this study, iron biomarkers and inflammation proteins were obtained only at the two last evaluations of the study (second interim and final). Table 47 and 48 show the prevalence of inflammation –with elevated levels of CRP in study population of children and women, at the time when biomarkers were obtained. In general, children showed a prevalence of inflammation, as determined by elevated levels of CRP (>=5mg/L) at the second interim and at the final assessment of 13.5% y 10%, respectively. By using AGP level (>=1g/L) at the second interim and at the final assessment the prevalence was 16.4% y 16.8%, respectively. Prevalence was relatively comparable between clusters (data no shown in tables). The prevalence of alteration of these biomarkers is moderate in the study population respect to other reports in developing populations, where higher prevalence (11% thru 40% with ferritin >5mg/L; and 20% thru 64.5% with AGP>1g/L); and with elevation in the two biomarkers, from 14% thru 67.5%) have been reported (Rohner F, 2017).

By excluding of the analysis the group of children with inflammation status of children (by using cut-off limits for CRP and AGP), the prevalence of iron deficiency is determined. In other words, the population of children with elevated inflammation biomarkers were separated out to calculate the actual prevalence of iron deficiency.

Table 47 shows the prevalence of iron deficiency after adjusted by biomarkers of inflammation.

TABLE 48. PREVALENCE OF IRON DEFICIENCY IN CHILDREN AS ASSESSED BY FERRITIN AND TRANSFERRIN RECEPTORS, ADJUSTED BY INFLAMMATION STATUS, ACCORDING TO COMMUNITY

		Second interim assessment (10-20 month follow up)					Final assessment (20-30 month follow up)	
Cluster	Overall study group N	Cases with elevated levels of CRP >= 5mg/L N (%)	Ferritin deficiency <12 ug/L N (% of N without inflammation)	STFR elevated >=8.3 mg/L, N (% of N without inflammation)	Overall study group N	Cases with elevated levels of CRP >= 5mg/L N (%)	Ferritin <12 ug/L N (% of N without inflammation)	STFR >=8.3 mg/L, N (% of N without inflammation)
SPJ	91	14 (15.4%)	9 (11.7%)	0 (0%)	80	9 (11.2%)	7 (9.9%)	7 (9.9%)
STU	94	11 (11.7%)	14 (16.9%)	0 (0%)	93	9 (9.7%)	6 (7.1%)	4 (4.8%
Combined	185	25 (13.5%)	23 (14.4%)	0 (0%)	173	18 (10.4%)	13 (8.4%)	11 (7.1%)

Children: Table 47 show the overall prevalence of iron deficiency in the children study population as assessed by ferritin at both, the second interim and final assessment with a trend to lower percentages at the final assessments, 14.4% vs 8.4%, respectively. Cluster analysis showed STU with the greatest reduction of iron deficiency, from 16.9 % to 7.1%, in this relatively short period. It is important to note that both percentages of iron deficiency were already in a low range.

Table 47 also shows the overall prevalence of iron deficiency in the children study population as assessed by soluble receptors of transferrin, at both the second interim and final assessments. For both clusters combined, the prevalence was 0 and 7.1%, for the second interim and final assessments, respectively. At final assessment, for SPJ and STU, the prevalence of iron deficiency was 9.9 and 4.8%, respectively, being both values in a relatively low range of iron deficiency.

Correspondence between anemia prevalence changes during the study and biomarker status for iron deficiency in study children.

It is important to note the close relationship between the hemoglobin results (anemia status) and biomarkers for iron deficiency, such as ferritin and STFR. As mentioned above, the study children showed a marked improvement in the levels of hemoglobin and anemia rates in both clusters, which was obvious since the second interim assessment, after 10-20 months of follow up. At the end of the study, there was a very low rate of anemia in children (4.5%% and 3.2% for SPJ and STU, respectively). The availability of iron status biomarkers, which reflect more reliably iron reserves, allowed us to observe relatively low rates of iron deficiency in this population, thence, confirming the improved iron status of the study population determined by hemoglobin measurements.

Unfortunately, we did not have iron biomarkers at baseline assessment as to be able to track changes along the study, but we were able to have them available only until the last part of the study. However, it is important to remark the concordance between the two biomarkers for iron status and anemia, not just in the direction but in magnitude. The biomarkers and hemoglobin confirmed that study children had low rates of anemia and of iron deficiency at the end of the study, which can be linked to the comprehensive study intervention.

Biomarkers for inflammation and iron deficiency in women:

Table 48 shows the overall prevalence of elevated values of CRP (inflammation) in women study population at the end of the study was 14.8% (being comparable across clusters), indicating a moderate rate of inflammation and therefore, it is not expected a significant impact on iron status biomarkers.

The overall prevalence of iron deficiency in women study population as assessed by ferritin and STFR at final assessment showed a low prevalence, 4.3% vs 1.4%, respectively. Even at the low range of prevalence, cluster analysis showed higher prevalence for low ferritin (6.8% vs 2.5%) and for STFR (3.4% vs 0%), for SPJ and STU, respectively.

Correspondence between anemia prevalence changes during the study and biomarker status for iron deficiency in study women.

As mentioned above, at the end of the study there was an improvement in the levels of hemoglobin and anemia rates in women of both clusters. There was a very low rate of anemia in women at the end of the study (from 7.5 to 0% for SPJ and STU, respectively). The availability of iron status biomarkers, which showed a low prevalence of iron deficiency at the end of the study (Table 48) allowed us to confirm the marked low rates of iron deficiency, thence, confirming the improved iron status of the study women population as determined by hemoglobin. It is important to remark the concordance between the three biomarkers for anemia and iron status, which agreed not just in the direction but also in the magnitude of the change toward improvement.

TABLE 49. Prevalence of iron deficiency in women as assessed by ferritin and transferrin receptors, adjusted by inflammation status, according to community

	Women, final assessment (20-32 months of follow up)			
Cluster	**Overall study group N**	**Cases with elevated levels of CRP >= 5mg/L N (%)**	**Ferritin deficiency <15 ug/L N (% of N without inflammation)**	**STFR elevated >=8.3 mg/L, N (% of N without inflammation)**
SPJ	71	12 (16.9%)	4 (6.8%)	2 (3.4%)
STU	91	12 (13.2%)	2 (2.5%)	0 (0%)
Combined	162	24 (14.8%)	6 (4.3%)	2 (1.4%)

Evaluation of intervention components impact on the hematological outcome.

Given the positive and significant outcome of the intervention, it is important to assess with more detail what component of the intervention was more closely related to hemoglobin outcome. This is the description of such analysis.

Study design: According to study design, both communities were assigned to receive individual counseling, group sessions and home garden extension services. The intervened community, additionally received support to raise animals (supplies and extension services).

Statistical analysis: For statistical analysis, the hemoglobin level was considered the variable response from baseline, interim assessment and final assessments. The exposure intervention was the total number of education encounters each family had during study duration and the number of total encounters per each individual component. The encounters included home visits for individual counseling on child and maternal health and nutrition, home visits for extension services for home gardens and for animal raising (rabbits).

To create a gradient in the exposure variable (education encounters), the distribution of variable was assessed and cut-off points were defined for low and high exposure. A low exposure was considered when the number of cumulative encounters was lower than the 25th percentile of the distribution of total number of encounters. Few cases had missing values (usually due to early withdrawal) or because the component was absent in that community. In these cases, the total number of encounters was placed to zero. A combined variable was created to sum up the high exposure of number of visits for each component. In this model, a family was considered exposed to full package if the three components were high (education sessions + home gardens + animal raising), otherwise, it was considered as a low exposure.

The covariates taking into consideration for the child were age, gender and diet diversity at each evaluation time (according to WHO); for the mother, age and schooling. As first step, baseline mean hemoglobin values were compared between treatment communities and no significant differences were found. Additionally, the distribution of the covariates at each assessment time were tested for normality, both visually and statistically. Statistical analysis were performed by using Stata (15.0) (Rabe-Hesketh & Skrondal A, 206). A p-value <0.05 was considered significant.

Reference: Rabe-Hesketh, S. & Skrondal, A., 2006. Multilevel and longitudinal modeling using Stata. American Statistician, 60(3), pp.293–294.

Table 1. Distribution of cumulative number of education encounters per participating family from baseline to second interim assessment

Education activities (type of encounter) N of events (cut off)	Number of encounters	Percentagee
Home visits for individual counseling on maternal and child health and nutrition		
< 23	49	25.7
23 +	142	74.3
Group education sessions on maternal and child health and nutrition		
< 12	53	27.8
12 +	138	72.2
Home garden visits (extension services)		
< 25	54	28.3
25 +	137	71.7
Animal raising home visits (Rabbits) (extension services)		
0 visits	104	54.5
1+	87	45.5
Package of interventions		
Individual counseling + home gardens + animal raising (rabbits)	61	31.9
At least one component or none	130	68.1

Table 2. Distribution of cumulative number of education encounters per participating family from baseline to final assessment

Education activities (type of encounter) **N of events (cut off)**	**Number Total = 191**	**Percentage Total = 100.0**
Home visits for individual counseling on maternal and child health and nutrition		
< 20	18	9.4
20 +	173	90.6
Home garden visits (extension services)		
< 28	55	28.8
28 +	136	71.2
Animal raising home visits (Rabbits) (extension services)		
0	97	50.8
1 +	94	49.2
Package		
Individual counseling + home garden + animal raising (rabbits)	63	33.0
At least one component or none	128	67.0

Table 3. Individual effect of study intervention components on child hemoglobin, at both, baseline vs interim assessment and baseline vs final assessment.

Intervention (Component)	**Baseline vs Interim assessment**	**Baseline vs Final assessment**
	Coefficient (Hb) (CI95%)	**Coefficient (Hb) (CI95%)**
Home visits for individual counseling on maternal and child health and nutrition	-0.20 (-0.70, 0.30) p-valor = 0.436	-0.19 (-0.77, 0.38) p-valor = 0.52
Group education sessions on maternal and child health and nutrition	-0.17 (-0.65, 0.30) p-valor = 0.480	0.043 (-0.55, 0.63) p-valor = 0.881
Individual counseling + group education sessions	-0.069 (-0.50, 0.36) p-valor = 0.752	0.039 (-0.47, 0.55) p-valor = 0.520
Home garden visits	-0.16 (-0.65, 0.32) p-valor = 0.514	-0.02 (-0.59, 0.53) p-valor = 0.919
Animal raising home visits (Rabbits) (extension services)	0.52 (0.09, 0.95) p-valor = 0.018	0.31 (-0.15, 0.78) p-valor = 0.191
Package (individual counseling + home gardens + animal raising (rabbits)	0.53 (0.068, 1.00) p-valor = 0.025	0.44 (-0.05, 0.93) p-valor = 0.080
Adjusted by time of assessment, child covariates (age at baseline, gender, number of food groups (FAO, WHO) (reported at baseline and final assessment), mother covariates (age, schooling) and intervention independent components (for individual models of the intervention components).		

Summary of main findings and conclusions:

Individual effect of study intervention components on child hemoglobin, at both, baseline vs interim assessment and baseline vs final assessment were analyzed. By using adjusted generalized estimating equations models (GEE), we estimated the effect of each intervention component using the difference – in-differences adjusted for timing, child and mother characteristics and the number of food groups in children (WHO).

Table 3 provides difference-in-difference estimates for child hemoglobin values for each time period relative to the pre-intervention levels. The estimates are interpreted as the change in hemoglobin level in the intervention group relative to the change in the comparison group. Between the baseline and interim assessment and after adjusting for time assessment, child covariates (age at baseline, gender, number of food groups reported (WHO) at baseline and final assessment), mother covariates (age and schooling), and for independent intervention components (for individual models of the intervention components), we found a positive and significant change on hemoglobin values with a DID of 0.52 (0.09, 0.95) p-valor = 0.018 for the animal raising component (rabbits, extension services); which remained significant even after adding the other two components in the model (individual counseling + home gardens), with an effect of 0.53 g/dL, CI 95% (0.068, 1.00; p = 0.025). The same analysis carried out for the hemoglobin values between baseline and final assessment for both groups showed a marginal significant effect of the rabbit component (as well as the combined package) with a DID: 0.44, 95%CI: -0.05, 0.93; p-valor = 0.080.

In conclusion, there was an overall improvement in hematological status in children in both communities from baseline to second interim and final assessment. However, by using multilinear regression analysis and after adjusting by several child and mother covariates, the differential positive impact observed in hemoglobin levels (about 0.53 g/dL) in favor of the community with full package, could not be explained by the variation in the education and home garden component in both communities. On the other hand, the presence of the animal raising component was associated with the significantly differential increase in hemoglobin observed in the community with full package at the second interim assessment and was marginally significant at final assessment. This differential response was not affected when adding to the model, both the education and home garden component.

DISCUSSION OF RESULTS

Objectives and Study design

The study had the objective to evaluate the impact of a comprehensive intervention of health, nutrition and agriculture in two rural communities located in SW low lands of Guatemala. Specifically, we tested the differential impact of two agriculture intervention approaches: One intervention focused on household gardens and another, adding livestock raising to home gardens. Both clusters received training on health and nutrition and household food production. All participating families were exposed to regular group education sessions and individual counseling sessions. The cluster with the livestock intervention was additionally exposed to training in household food production practices related to rabbits or chicken raising, though extension services.

The training plan on health and nutrition was intensive with a good coverage of participating families as documented in the monitoring section, a key component for the implementation of the study. Local field staff was trained in both the methodological aspects of delivering training to the participating families, but also in regard the contents of the curriculum of training. The field staff was supervised along the duration of the intervention to assure fidelity of the intervention. Both, field staff and participating families were comfortable with the good interaction, level of trust and experience gained along the duration of the study. This facilitated the proper implementation of the study and prompted a positive response on behalf the participants.

The topics of health and nutrition covered during the group and individual training sessions delivered by field staff were well implemented and according to the plan. This training provided a strong support to the families toward promoting behavioral change. According to data tables presented above, and based on the quantity and quality of training sessions –group sessions and individual counseling--, we consider that this component achieved good coverage in terms of number of families, provided a good exposure (high rate of contacts or visits and the number of topics) and with sufficient time exposure (duration between 20-30 months), as to influence the study health and nutrition outcomes.

The home garden intervention reached a good coverage and intensity along the duration of the study. Food production activities were well supported by group demonstrations and participatory cooking sessions (field days). These were opportunities for exchange of experiences with and among participating families about taking care of the home garden, the use of the produce, the importance to include it in the regular meal recipes of the family, and most importantly, sharing positive experiences and also the challenges. These were important moments to generate group discussions to find and accord collective solutions.

However, it is important to note that there was a differential level of coverage and effectiveness of the implementation of the livestock intervention in the corresponding cluster (SPJ). The livestock intervention based mostly on rabbit raising (and a lesser extent in chicken), because there was a previous experience raising rabbits in this community. Rabbit raising have the potentiality of meat production in a relatively short time and because it required low external inputs and did not compete with household food resources. However, many factors affected the proper implementation of the rabbit intervention. For instance, some families decreased the initial interest for rabbit raising as the study progressed, due to animal care high demands. In other cases, the provided animals died due to lack of care or for rabbit diseases. In some cases, the family consumed or sold the initial lot of animals provided by the study before the reproductive cycle took place and the number of animals increased. There was also a limitation in the number of cages available at each household as to host the growing number of animals, in spite of being made of local materials of relatively low cost.

In several cases, families asked to switch toward chicken raising practices. So, at the end of the study (20-30 months of implementation), in the livestock cluster only about 22% of the families were able to continue with the rabbit raising practice. Interestingly, these reduced number of families were not even that successful in reaching effective or optimum animal reproduction levels as to increase the availability of rabbit meat for regular consumption or for income generation. This outcome is very important to note, given this component received a great attention trough frequent home visits, supply provision and frequent field days (group meetings) carried out to reinforce the knowledge of the importance of animal protein consumption and the feeding practices promoted. During these field days, families gathered to share experiences through demonstrations of food preparation (recipes) using the home garden and livestock produce. It is likely that as a consequence of the intensive exposure of key messages, that some transference of knowledge and experiences may have occurred and have impacted positively the consumption of other animal sources.

In addition of the intensive support provided by local field staff, we were able to obtain specialized support from international experts in rabbit raising. With the support of the USAID Farmer to Farmer Initiative, Robert Spencer (a rabbit consultant from Alabama, USA), visited twice the research study area and worked closely with the participating families during a week each time to share first hand practical experience of the process, from hygiene, sanitation, nutrition and reproduction through slaughtering and consumption. This was a very interesting experience for the participating families, who were able to see that a foreign expert was teaching them the great benefits of raising rabbits. The project was lucky enough to also involve Mrs. Spencer (RIP, 2016), who accompanied Mr. Spencer in his visit to Chocolá. She devotedly worked with groups of women in the meat processing and cooking, as to reinforce the intervention.

On the other hand, food animal sources were reported in significant rates in women and children in both clusters. The mean of number of times reported animal food sources during the last seven days ranged from 6.2 and 6.9. These rates were comparable between clusters.

At follow up and final assessments, it was observed that as a result of the support provided at household level in terms of home gardens and education activities, there was a significant consumption of the food promoted by the study. These foods were promoted because they were rich sources of nutrients, especially protein and minerals, such as iron. A reported average consumption between 8-9 times week in mothers and children in both clusters is very significant and may explain in part the improvements in hemoglobin and iron status in mothers and children at the end of the study in both clusters ($p<0.001$).

Although there was a greater changes in hemoglobin levels in children of SPJ cluster respect to STU at the second interim assessment ($p<0.05$), it not reach significance ($p>0.05$) at the final assessment. On this regard, during the period from second interim and final assessment (about 6 months lapse), STU continued improving the Hb values (a greater increase) than SPJ, and therefore, at the end the Hb mean values were comparable between both clusters ($p>0.05$). We do not have a clear explanation for this interesting pattern. However, it is interesting to note the consistency between the two evaluations carried out during the last year of the intervention and the clear pattern of increase respect to baseline. These findings of a good hematological status at the end of the study are well supported by the results of other iron status biomarkers, such as ferritin and transferrin receptors, which were analyzed in a reference laboratory in Germany. The results show a relatively low rate of iron deficiency in the study population during the last part of the study, which in another way, confirms the results of improvement in mean values of Hb and the low rates of anemia at the end of the study.

On the other hand, the results can be compared with national rates of a recent nutrition survey. At baseline, the rates of anemia in study children were lower than national rates of children of 6-12 months of age at about 70% (ENSMI 2014-15); however, at the end, the study children showed much lower rates (<5% in both clusters) than the rates of anemia reported for children between 24 -36 months of age at 27% (with an overall rate of anemia in children <5 yr at national level of 32.4%, and for Suchitepéquez, 37.7%), which corresponds to the mean age of study children at the end of the study. This provides an external validity of the positive impact of the study in terms of hematological status.

The baseline rates of anemia in study women were 17.3% and 14.3% for SPJ and STU, respectively; which were comparable with national rates at 13.6% and for Suchitepequez, at 17% (ENSMI, 2014-15). However, at the end of the study, these rates decreased to 7.5% and 0%, for SPJ and STU, respectively. Again, this shows there was an improved status of hemoglobin in study women along the duration of the study. Furthermore, the clear pattern of an improved hemoglobin status is consistent with the iron status biomarker results, which in another way it confirms the study findings.

Plausibility of results: The study was designed to evaluate the impact on iron status of a comprehensive intervention. The findings of improvement in hemoglobin and iron status biomarkers in women and children in both clusters are consistent with the implementation of a comprehensive intervention with education of improved nutrition practices for women and children, household food production and consumption of the foods promoted. In addition, the significant increase in the mean values of hemoglobin and the decrease of anemia rates at the second follow up are very consistent respect to the observed estimates at the end of the study, confirming the pattern of improvement. Furthermore, the high correspondence between low anemia rates and low prevalence of iron deficiency (by iron biomarkers), provides evidence of consistency of findings.

In spite of the importance highlighted of integrated interventions of nutrition, health and agriculture and their impact on nutrition outcomes, there have been few studies with strong evidence regarding the linkage between nutrition and agriculture. Since the conception of this study, it has been interesting to see the publication of a couple of studies addressing this issue. For instance, Olney and co-workers (Olney, 2015), reported a 2-year integrated agriculture and nutrition and health behavior change communication program targeted to women and their children, in 55 villages of Burkina Faso. This cluster randomized controlled trial reported impacts on Hb in the intervention group, with changes in Hb of about 0.51g/dL (marginal significance, $p=0.07$), but significant impact on anemia in the younger group of children (3-5.9 months, $p<0.03$), respect to control groups. The authors claimed this was the first study that documented significant positive effects of an integrated nutrition/agriculture intervention on child nutrition outcomes.

More recently, Osei & co-workers (Osei, 2016) in Nepal reported the positive impact of the combination of home garden, poultry and nutrition education program targeted to families with young children and women. This was a randomized controlled study which involved over 2600 mother-child pairs with a follow up over 2.5 years. The authors reported improvement in anemia rates in children 12-48 yrs of age and in women respect to control group; however, there was no impact on child anthropometry.

Summary of findings in similar studies in the literature

Author/year/place	**Description of study**	**Population**	**Findings, Hematological (Hb) indicators**
Olney, 2015 Burkina Faso	2-year integrated agriculture and nutrition & behavior change Cluster randomized trial	55 villages Women and children	**Children 3-12 mo:** Increase **in Hb**, with Difference in difference (DID) of 0.51g/dL respect to control, marginally significant (P=0.06) **Anemia** at the end of study 77.5% with reduction (DID) of -3.4pp, respect to control (p=0.43). **Children 3-6 mo:** Increase in Hb, with Difference in difference of 0.76g/dL, respect to control (p=0.02) Anemia rates: Significant reduction in young children (3-5.9 months), DID -14.5pp, respect to control p<0.02 (anemia rate at baseline and final,
Osei, 2006 Nepal	Non blinded, randomized controlled trial; Combination of home garden, poultry and nutrition education 2.5 yrs	Families with young children and women (N=2600 pairs).	HB concentration significant **lower** at post-intervention compared to baseline, in both groups. Improvements in anemia rates in children. **Anemia rates at Postintervention:** **Children:** Treatment

			vs control group: 42.5% vs 30.8% . **Women,** treatment group vs control group: 35.8% vs 24.6%.
Guatemala (present study)	Randomized controlled trial; 27 months; Intervention: integrated agriculture (household food production, home gardens and animal raising), health and nutrition with a behavior change component	Low lands, South coast of Guatemala (Suchitepéquez) 259 pairs of women/children	**Hemoglobin (HB):** Both study groups improved significantly at the interim (1.4 vs 0.82 g/dL, cluster with full package) and final assessment (1.82 vs 1.51, clusted with basic package) respect to baseline (p<0.001). However, adjusted difference in difference (DID) of HB between clusters was significant (0.53 g/dL, p<0.05) in favor of the cluster with full intervention at about 20 months of follow up. At final DID of 0.31 g/dL in favor of cluster with full intervention, but it did not reach significance. **Anemia rates, baseline vs final:** significantly reduced in children (46.7% vs 4.5% for cluster with full intervention; 41.1% vs 3.2% in cluster with basic package, for baseline vs final. **Women:** Both groups improved HB, but there was not significant difference. Overall anemia rate decreased from

			9.8% to 5.6% in cluster with full package and from 8.7% to 0% in cluster with basic package.

The findings of improvement in anemia rates and iron status reported in our study are much greater compared to recent reports mentioned above, in which both studies included an integrated approach including homestead interventions plus an important education and behavior change component. First, it is important to highlight again that our study had nutrition aims clearly stated since the beginning, had a long term follow up, included baseline, follow up and final assessments. Although the sample size of our study is much smaller compared to the reports cited above, our study was more complex and more intense in terms of implementation. The sample size of our study was sufficient to demonstrate the change in biomarkers. On the other hand, one major difference in this study, respect the more recent reports, was the addition of highly reliable biomarkers for iron status, such as ferritin and transferrin receptors, which supported the hemoglobin results. The inclusion of these biomarkers has not been done before and enhances the strength of evidence of the findings.

In summary, this study provides evidence that an integrated approach involving health, nutrition and agriculture with a duration of at least 24 months of follow up may have a positive impact in nutrition outcomes, especially in iron status biomarkers in mothers and children under five yrs of age of rural populations. Furthermore, the presence of an animal raising component was associated with a significantly greater differential response in favor of the community with full package.

Implications of the findings:

We have two key messages out of this study. First, a comprehensive intervention like the one implemented (package of several components) here had a positive significant impact in hematological status of children. However, the community with the raising animal component showed a greater differential response in hemoglobin levels. For policy makers and program implementers interested in linking agriculture, health and nutrition, it is important to take into account these findings and the relevance of integrated approaches and also the importance of the animal raising component. Although no positive changes were observed in terms of stuntin –as it has been reported in similar studies--, this study demonstrated that hematological biomarkers are sensitive to integrated approaches to improved nutrition at community level in underprivileged populations. Positive outcomes in hematological status are likely to be demonstrated with comprehensive approaches with at least 20 months of time exposure. In other words, the implementation of one or two components in a nonintegrated fashion during short periods of time are likely to demonstrate no impact. Further studies at greater scale level are needed and

Limitation of the study

One important limitation of study implementation was the relatively high rate of early withdrawals during the first year of the study. This imposed a great challenge respect to study design, sustainability and in terms of budget. However, the addition of a second cohort of participants allowed to complete the study.

Another important limitation in terms of study design was that the intervention cluster (SPJ) had a lesser degree of implementation of animal raising than planned, which was more obvious at the final stage of the study. There were many challenges associated with animal raising of rabbits given that at the end of the study only around a quarter of the participants were still involved in rabbit raising. However, there were still an important number of families raising other type of animals of small species, specially chicken. Important was the finding that at the end of the study there was acceptable consumption of animal food sources, even in the community without animal raising intervention, which may show the impact of the education component. In addition, the STU showed an important involvement in animal raising as well, which did not depend on the direct support of the study field staff. On this regard, at the end of the study the two study groups were not that different in terms of animal raising. This may have affected the ability to discriminate a significant differential response between clusters at the second interim assessment, but not significant at the end of the study. The fact that there was an outcome difference in terms of biomarkers at the second interim assessment in favor of SPJ, but about six months later, both groups were comparable, makes us speculate that an important reduction in the exposure of the integrated intervention may have occurred in the intervention cluster in the final stage of the study.

Conclusions

In conclusion, this study provides evidence that an integrated approach involving health, nutrition and agriculture with a duration of at least 24 months of follow up may have a significant positive impact in nutrition outcomes, especially in hemoglobin and iron status biomarkers, of mothers and children under five yrs of age of rural populations. Although both groups showed important changes in iron biomarkers at the end of the study, we were able to discriminate a differential response at the second interim assessment in favor of the cluster with full package, but only marginally significant at the end. Regarding the plausibility of results, we can attribute the significant changes along the study to the intense and integrated intervention of education on health, nutrition and agriculture.

Recommendations.

Given the enormous importance in the developing world of understanding the potential impact of integrated interventions including agriculture on improving nutrition outcomes (biomarkers), we believe that the experience gained and the evidence generated herein, provides enough insights as to continue with more efforts in this research field as to reach more generalizable conclusions. In the last few years a series of new studies have been published regarding integrated homestead interventions, however, there are still huge research gaps.

Given every setting offers its unique challenges, great attention should be placed to adopt or adapt the specific methodological aspects used in this study at every setting of interest. For instance, one important challenge was related to the need of greater support to families in rabbit raising activities (extension services, supplies, more cages, etc). These type of interventions require a great effort in terms of manpower providing extension services, but also a strong component of behavior change.

Discuss potential negative deviances from the previewed research plan:

See below in section of unexpected difficulties.

Mention and discuss major unexpected difficulties / problems in pursuing your activities (e.g. change in personnel)

As presented in a previous section, the study implementation faced challenges of diverse type, including, a significant early withdrawal rate, which demanded the recruitment of a second cohort to compensate for withdrawals in 2015, and thence, the extension of the study for at least 6 months longer, with logistical and budget implications.

We also faced the difficulties during the last part of the study when dwindling the study, such as field staff reduction, change in the training model to allow sustainability. Extreme weather conditions

An unexpected high rate of early withdrawal at the beginning of 2015 and the decision made to recruit new participants. At the end of the study, we conclude that this was a sound decision to assure the completion of the study.

Climate/weather conditions in tropical Chocola:

<u>*Weather conditions in the Chocola area:*</u> As it commented before, Central America region was affected during 2015 and 2016 by the most severe form of the "El Niño" phenomenon, with droughts and short periods of torrential rain. In Guatemala, our research site is located less than 50 miles from the warm waters of the Pacific Ocean.
The negative impact of weather conditions caused severe damage in home gardens during the first year of the study, and therefore, loss of crops. Field staff and families found a way to implement mitigation and adaptation actions to protect the home gardens by irrigation and protection with "toldos" (plastic sheet ceiling).
,
<u>*Working on resilience to severe climate*</u>. We spent a great amount of effort working in developing models for ceiling or covering the home gardens by building "toldos" made of plastic sheets and local materials (wood and bamboo) and plastic sheets. We are aware it is very important to keep study gardens productive around the year, as this would support availability, access and consumption of nutritious vegetables. Even we built coverings to some gardens, because of this was unexpected, we could not afford to provide protection to all study gardens.

Challenges in animal raising:
In general and in spite the challenges, a group of families continued working with rabbits until the end of the project. Several limitations were identified that prevented the expansion of the activity, including a high mortality in newborn rabbits and the need of several additional rabbit cages at each home. It was evident the need for a stronger nutrition and sanitary program In addition, in spite of the great support received from Mr. and Mrs Spencer during his two visits to Chocola, it was obvious that it required more efforts to support families in the full adoption of rabbit raising, as a strategy to increase the household supply of animal protein and micronutrients. On the other hand, home gardens were in general more easily adopted by the families.

As commented before, there are some successful stories of some participating families who were able to raise so many rabbits, that they were able to sell with profits. It is expected that as these experiences continued to be shared, it may provide confidence to the rest of participants.

General additional conclusion of the study implementation:

In summary, this project funded by Nestle Foundation completed successfully the implementation plan in all its stages.

A positive nutrition outcome, especially of hemoglobin and iron status of women and children under five years of age, was observed associated with study implementation.
During the dwindling phase, a sustainability plan was implementing through the identification and training of the local leaders among the participating families.

I. Publications

Are there publications which have been published or submitted based on this grant? Please send a PDF-file of the article to the Nestlé Foundation upon publication.

At least two manuscripts have been outlined for publication in peer reviewed nutrition journals: a) experiences in the implementation of an integrated approach of health, nutrition and agriculture to improve nutrition outcomes; and b) Impact on nutrition outcomes, especially on iron status indicators in women and children of an integrated health, nutrition and agriculture intervention.

During the summer of 2015, we received a group of pre-graduate students from the Minority Health International Research Training Program (from the University of Alabama at Birmingham, AL, USA MHIRT), for which I have been the International Mentor in Guatemala for many years. They spent 10 weeks in Chocolá to gain experience in the implementation of the project. The draft of early version of manuscript was previously shared to NF, but after completing a new set of statistical analysis, this is now under deep revision/editing.

As a way to communicate the results with the scientific community, an abstract on the nutrition impact of the study is going to be presented at the American Society of Nutrition (ASN) meeting, Boston, on June 2018. The notice of approval has just received.
An abstract with main study findings will also be submitted to the Latin American Congress of Nutrition to be held in Mexico 2018.

II. Summary of the expenses during the report period

(In the preferred currency <u>and</u> US $ for the total)

4.1. Summary of the financial statement from the Administrative Offices of the University / Institution
This report can be enclosed to this report and/or mailed separately to us by surface mail.

- A copy of project expenses with NF format is attached to this progress report.
  This copy is signed by INCAP Financial Officer.

Financial management of the project between INCAP and Seed for the Future organizations for the current funding period

SfF and INCAP continued working together in the implementation plan during the last funded period. Accordingly, under a Contractual Agreement (August 2016) a specific amount of funds were transferred to SfF to meet the specific commitments (deliverables) during the last part of 2016. A great commitment from SFF was to support the closing activities of the intervention and the final assessment. After three years of working together as a team, we are happy we were able to complete the implementation of this study. In general, the budget has been executed accordingly to the plan.

In this report, INCAP is presenting the financial report for the expenses made to cover all activities for which INCAP was directly responsible to finance and also the amount of funds INCAP transferred to SfF to cover field activities during the time period. There is also a summary and balance table which shows the current budgetary situation of the project.

Briefly, the balance from the last financial report was USD 11,588.69, which summed up to the FN's installment received in 2016 (USD35995), it made up USD47583.69. The total amount of funds spent during the current funding period, since March 1st 2016 thru November 30th 2017, is USD65,544.88 with a new balance at November 30th 2017 of USD-17,961.19. This negative balance has been covered with an Institutional loan from INCAP and will be reimbursed with funds from the last NF installment corresponding to the 10% of total budget committed upon receiving the final technical report. The last NF installment pending to receive is of USD28451.

INCAP is still pending to cover obligated expenses with Seeds for the Future of about USD6000 (including additional support to cover closing activities not previously budget), which will be paid with the remaining 10% of funds pending to be reimbursed from our donor after receiving the final report.

We have also obligated some funds to cover expenses related to sharing the results through conference attendance abroad and for publications expenses. Because of the nature of publication activities related to a research project, after completing this final report to donor, we are committed to complete the main manuscript. As commented before in January 2018 an research abstract was submitted to the American Society of Nutrition (ASN), which will take place in Boston MA, USA in June 2018. Funds are budgeted for registration fee, a two way trip, hotel and daily allowances. Some funds are also allocated for final preparation of manuscript and journal submission expenses. An abstract will be also prepared for the 2018 Latin American Congress on Nutrition, a prestigious regional forum to share the results of the present study. This component is vital to be able to share and communicate the study findings.

Budget execution during the last period period.

The INCAP Official financial report is attached as Annex.

The following section applies only to the FINAL REPORT:

5
III. Equipment Information

Equipment Description	Functionality	Location	Future Use
NA			

Is the functionality of all equipment assured for the next few years? If not, why? Can the Foundation or another institution be of help?

No major equipment was bought with NF funds.

6
IV. Capacity building

Please describe whether the PI personally as well as certain of his collaborators achieved the targets which were formulated regarding capacity building. If yes, please describe what aspects you profited the most. If not, please discuss why the targets have not been reached. Be critical towards yourself as well as the funding source or other institutions. How will you assure to maintain the gained capacity?

Institutional strengthening: with the implementation of the project, SFF upgraded its capabilities in terms of implementation research in health, nutrition and agriculture. At the beginning, it was challenging for SFF not just in terms of a greater number of participating families to work with but also the number of staff involved to cover the study activities and the high level of demands of the study. The high level of training and organization provided by INCAP enriched and strengthened SFF in several ways. The new experience gained for StF will continue strengthening their daily activities and roles in the community.

Local field staff: A great component of this project was to support the development of local capacities to address health and nutrition problems. A good roster of local field extensionists were trained in all aspects of health, maternal and child nutrition and household food production models But overall, the project promoted in the field staff self-confidence and leadership to approach families and local leaders and to engage them in their own development.

It is important to mention that when INCAP conducted the first phase of training, it was a great challenge for the field staff to understand/adopt/apply the principles of maternal/child health and nutrition or to be able to follow the methodological aspects of adult education toward behavior change (for example, group education sessions and individual counseling sessions at home). However, it was satisfying to see the accomplishments achieved by the local staff after the intensive training and the initial phase of supervised activities. All these new abilities gained by the field staff will remain after the study concluded.

After the finalization of the study, some people has been retained by SFF to continue with their ongoing activities, while other have been recognized as valuable staff and found opportunities in other local NGOs or have been hired by government institutions working the same area.

Professional staff: The technical staff of SFF in charge of local implementation of the project was also benefitted of the training and experience gained in the implementation of this NF's project. Mr. Armando Astorga (Agronomist), the SFF´s local manager of the project, is a great example of how the implementation of the project fostered his development. Mr. Astorga is currently leading SFF´s projects in the same region, promoting the implementation of the "household farm model", an integrated approach to promote nutritious food availability, good nutrition practices and income generation activities, all of which is based on the experience gained in this project. In addition, Mr. Astorga is being recognized as an expert in the topics of food production models at local level. He has been invited to give conferences in national congresses and also he has been invited to visit Nicaragua to share his experience working on this project.

It is also important to mention the great role of a other local professionals at SFF, such a Social Worker, primary school teachers, and computer staff, who upgraded their capabilities to be able to respond the project needs. This capabilities remains at SFF after the project ended.

Participating families: At level of participating families, an important group of them remains active with ongoing activities carried out by SFF through the "household farm model". In the interim and final assessment, we learned that above 90% of families were willing to continue working with the kitchen garden given the great benefits they perceive. In addition, a group of families have continued being engaged with the "Household farm model", which allowed to upgrade the capabilities of the families to continue working in an organized, independent and empowered fashion toward achieving their goals of a better future. This is very encouraging.

MHIRT program: In the summer of 2016 a group of students from the MHIRT program in UAB (University of Alabama at Birmingham, Alabama, USA), visited Chocola as to gain experience in program implementation in nutrition and health. The team was composed by four pregraduate and one master students spent 8 weeks in Chocola. A manuscript is now in progress as a result of this experience.

V. Sustainability issues of the project

What is the immediate consequence from the study? How will you implement the results of your study at the public health level in your geographical area and country? How do you *assure that the results of your study will be sustainable and trickle down to the population in the short term and in the longer term. What is your aim for the first year after completion of the study? What are your next steps?*

The immediate consequence of the study outcomes relates to the awakening of families, community leaders and local authorities about the public health and nutrition problem addressed and the feasibility of implementing evidence based approaches to resolve the issues of food insecurity in vulnerable populations. In addition, the positive results of the study in terms of improving hematological status of mother and children is of great benefit for the participant families. The findings are of great interest to local and national MoH authorities. This is the first time that an integrated health, nutrition and agriculture project demonstrated a positive outcome in biochemical biomarkers in women and children and therefore, there is a great potential for escalating the model to other regions.

The outcome results will be shared with MoH, Ministry of Agriculture and Development, at local and National level as to facilitate the adoption and implementation of some of the components into their own programs. “Family Farms Program” or “Household Agriculture Program” (Translated from Spanish: Programa de Agricultura Familiar), is a government program that is in process of implementation, which is undertaking many challenges. The integrated approach (health, nutrition and agriculture) and the training model used on this project is of the interest of the Ministry of Agriculture for the potential adoption/adaptation of some of the components. Therefore, it is important to share them the results as to be considered in their implementation plans.

Finally, as mentioned above, a smaller group of participants are still actively engaged in food production models, as a way to cope with poverty and food insecurity. The successful experience of this group of participants enables them to continue involved and practicing what they learned. A follow up to these participants at the beginning of next year 2018 is going to be planned as to gain experience about the sustainability of the intervention promoted by this project after one year of finalization.

References

Bhutta ZA, Das JK, Rizvi A, Gaffey MF, Walker N, Horton S, et al. Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? Lancet. 2013;382:452-77.

Bhutta ZA, Ahmed T, Black RE, Cousens S, Dewey K, Giugliani E, et al. What works? Interventions for maternal and child undernutrition and survival. Lancet. 2008;371:417-40.
Dewey KG, Adu-Afarwuah S. Systematic review of the efficacy and effectiveness of complementary feeding interventions in developing countries. Matern Child Nutr. 2008;4 Suppl 1:24-85.

FAO and FHI 360 (2016). Minimum Dietary Diversity for Women: A Guide for Measurement. Rome: FAO.

Instituto de Nutrición de Centro América y Panamá –INCAP--. Tablas de composición de alimentos. 2010. Guatemala City, Guatemala.

Instituto de Nutrición de Centro América y Panamá –INCAP--. Recomendaciones dietéticas diarias. 2012. Guatemala City, Guatemala.

Lassi ZS, Das JK, Zahid G, Imdad A, Bhutta ZA. Impact of education and provision of complementary feeding on growth and morbidity in children less than 2 years of age in developing countries: a systematic review. BMC Public Health. 2013;13 Suppl 3:S13.

INCAP (2013). Estudio complementario al análisis de los datos de la encuesta nacional de condiciones de vida de Guatemala (ENCOVI 2006): Referencia para diseñar intervenciones específicas de micronutrientes (fortificación de alimentos y suplementación). Eds: Menchú, MT., Méndez H., Dary O. Guatemala: INCAP.

Ministerio de Salud Pública y Asistencia Social (MSPAS) (1995). Encuesta nacional de micronutrientes (Tans: National Survey of Micronutrients). Guatemala.

Ministerio de Salud Pública y Asistencia Social (MSPAS) (2014-15). Encuesta nacional de salud materno infantil 2014-2015 (ENSMI) (Trans: National Survey of Maternal & Child Health). Guatemala.

Olney DK, Pdehombga A, Ruel MT, Dillon A. J. A 2-Year Integrated Agriculture and Nutrition and Health Behavior Change Communication Program Targeted to Women in Burkina Faso Reduces Anemia, Wasting, and Diarrhea in Children 3–12.9 Months of Age at Baseline: A Cluster-Randomized Controlled Trial. J Nutr. 2015; 145 (6): 1317-1324.

Organización Mundial de la Salud. La alimentación del lactante y del niño pequeño. Washington, D.C. 2010.

Osei A, Pandey P, Nielsen J, Pries A, Spiro D, Davis D, Quinn V, Haselow N. Combining Home Garden, Poultry, and Nutrition Education Program Targeted to Families With Young Children Improved Anemia Among Children and Anemia and Underweight Among Nonpregnant Women in Nepal. Food and Nutrition Bulletin 2017; 38 (1): 49-64.

Rohner F, Namaste SML, Larson LM, Addo OY, Mei Z, Suchdev PS, Williams AN, Sakr Ashour FA, Rawat R, Raiten DJ, and Northrop-Clewes CA. Adjusting soluble transferrin receptor concentrations for inflammation: Biomarkers Reflecting Inflammation and Nutritional Determinants of Anemia (BRINDA) project. Am J Clin Nutr 2017;106(Suppl):372S–82S.

Shrimpton R, Victora CG, de Onis M, Lima RC, Blössner M, Clugston G. Worldwide timing of growth faltering: implications for nutritional interventions. Pediatrics. 2001 May;107(5):E75.

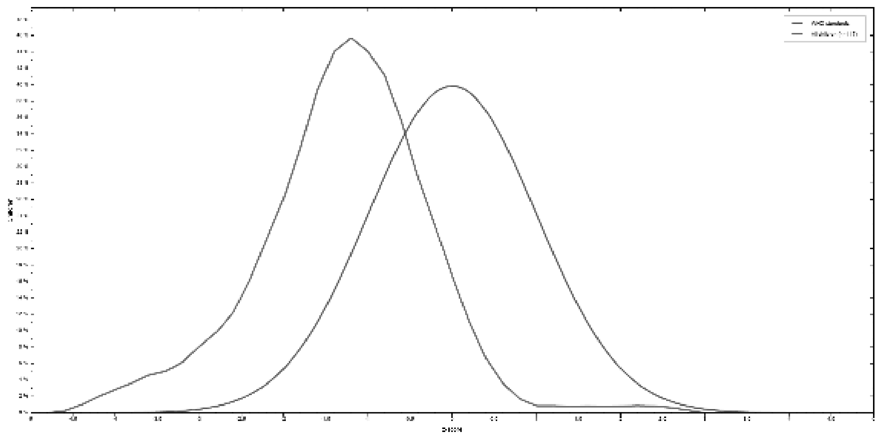
Victora CG, de Onis M, Hallal PC, Blössner M, Shrimpton R. Worldwide timing of growth faltering: revisiting implications for interventions. Pediatrics. 2010 Mar;125(3):e473-80. doi: 10.1542/peds.2009-1519.

WHO. Haemoglobin concentrations for the diagnosis of anemia and assessment of severity. Vitamin and Mineral Nutrition Information System. Geneva. World Health Organization, 2011 (WHO/NMH/NHD/MNM/11.1). Available at: http:/who.int/vmnis/indicators/haemoglobin.pdf.

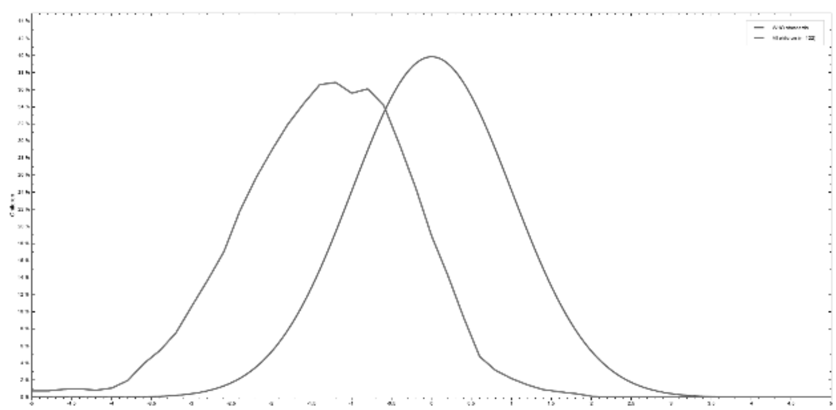
WHO (2008). Indicators for assessing infant and young child feeding practices : conclusions of a consensus meeting held 6–8 November 2007 in Washington D.C., USA. WHO: Geneva.

Anexos

Baseline
SPJ
HAZ scores

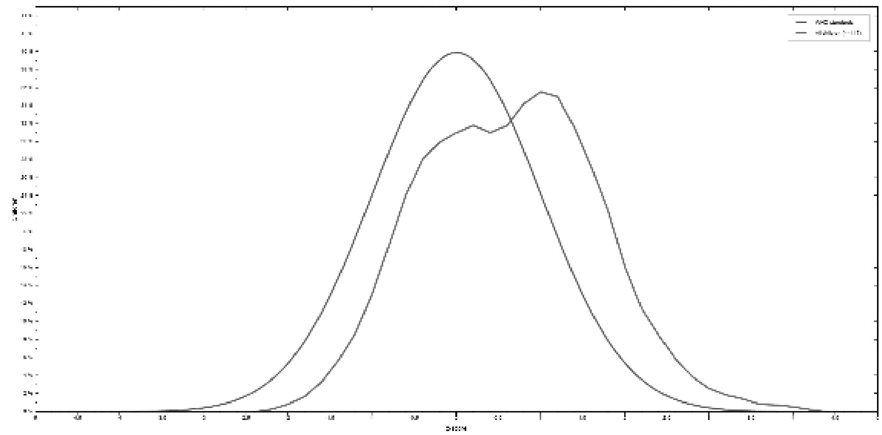


Baseline
STU
HAZ scores

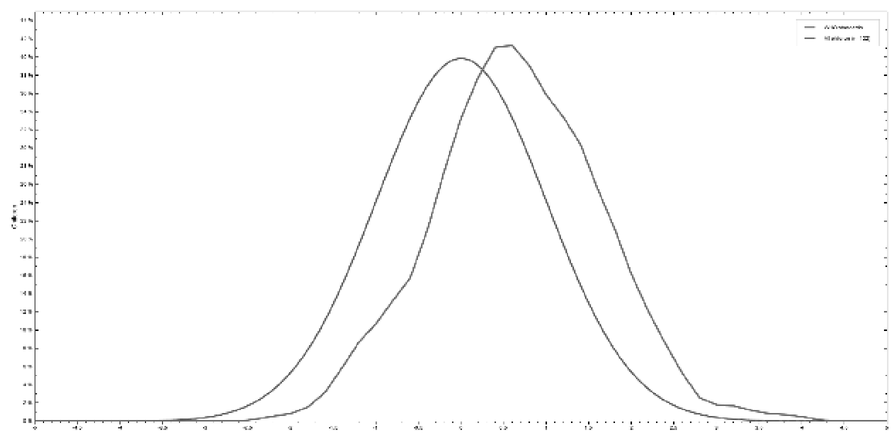


GRAPH 6. CHILDREN GROWTH AT BASELINE. COMPARISON OF HAZ SCORES OF STUDY POPULATION RESPECT TO WHO STANDARDS. THE GREEN CURVE REPRESENTS THE WHO REFERENCE CURVE.

Baseline
WHZ
Community: SPJ

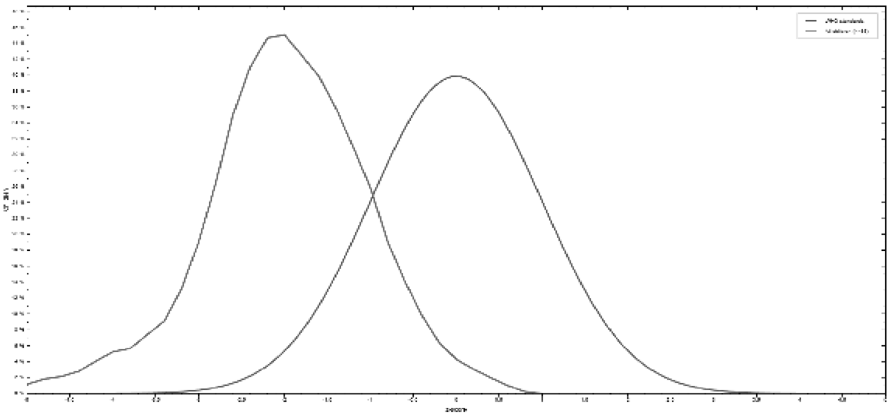


Baseline
WHZ
Community: STU

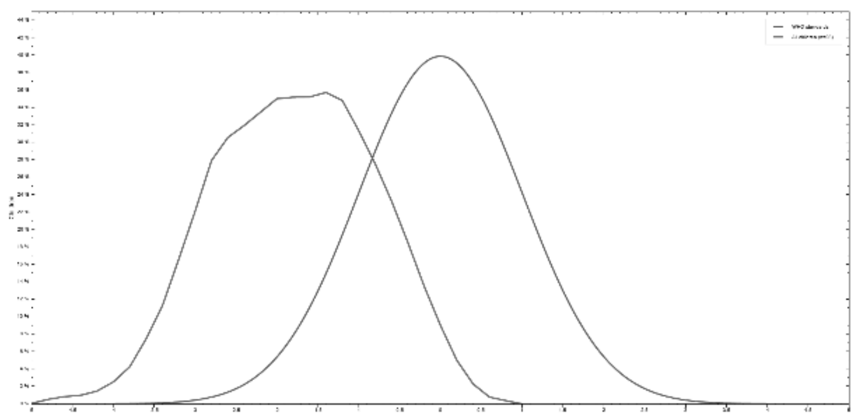


GRAPH 7. CHILDREN GROWTH AT BASELINE. COMPARISON OF WHZ SCORES OF STUDY POPULATION RESPECT TO WHO STANDARDS, FOR SPJ AND STU COMMUNITIES. THE GREEN CURVE REPRESENTS THE WHO REFERENCE CURVE.

Final, Height for age Z (HAZ) Scores SPJ

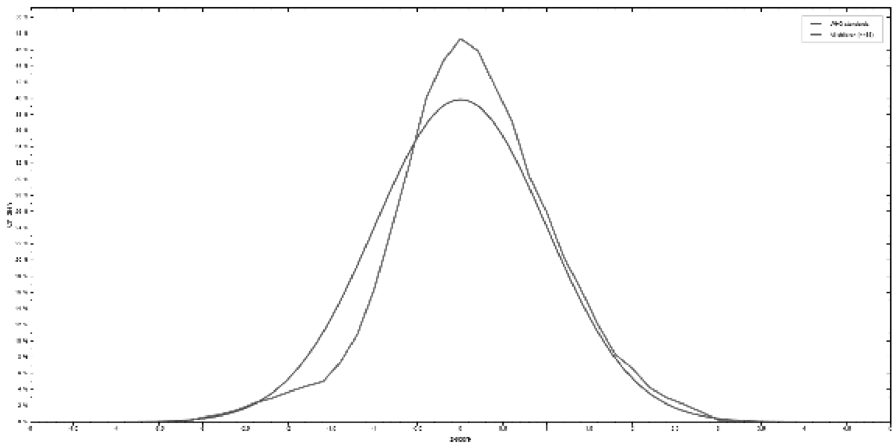


Final, Height for age Z (HAZ) Scores STU

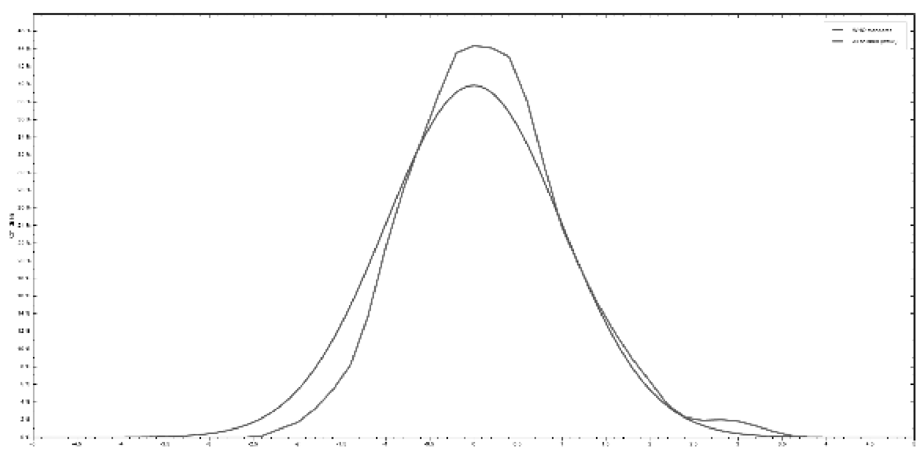


GRAPH 8. CHILDREN GROWTH AT FINAL. COMPARISON OF HAZ SCORES OF STUDY POPULATION RESPECT TO WHO STANDARDS. THE GREEN CURVE REPRESENTS THE WHO REFERENCE CURVE

Final
WHZ
Community: SPJ



Final
WHZ
Community: STU



GRAPH 9. CHILDREN GROWTH AT BASELINE. COMPARISON OF WHZ SCORES OF STUDY POPULATION RESPECT TO WHO STANDARDS, FOR SPJ AND STU COMMUNITIES. THE GREEN CURVE REPRESENTS THE WHO REFERENCE CURVE.