Food-Based Approaches to Reducing Micronutrient Malnutrition

An Impact Evaluation of the UNICEF ICBD Program in the Savelugu-Nanton District of Northern Ghana

Kenneth R. Simler
Krista L. Jacobs
Joseph Mensah-Homiah
Josée Randriamamonjy
Doris Wiesmann
Abizari Abdul-Razak

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International Food Policy Research Institute
2033 K Street, NW
Washington, DC 2006
USA

In collaboration with
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and
University for Development Studies, Tamale

Executive Summary

Assuring food security is one of the most important challenges facing the world today, especially in low income countries. Food security is often conceptualized in the context of food energy, or calorie intake. However, it is increasingly recognized that a large proportion of the world's population has diets that are deficient in other nutrients, especially micronutrients such as vitamin A and iron. In Ghana, it is estimated that over three-quarters of children 6–59 months suffer from some level of anemia, and that over 60 percent of children less than 6 years old have sub-clinical vitamin A deficiency. It has been estimated that vitamin A deficiency contributes to 1 out of 3 deaths of Ghanaian children between 6 and 59 months, or a total of 86,000 deaths between 2001 and 2005.

Until recently, most efforts in Ghana to combat micronutrient malnutrition have focused on vitamin supplementation (e.g., the distribution of vitamin A capsules) and food fortification (e.g., salt iodization). More recently there have been efforts to include a third approach based on dietary change, also known as food-based approaches. Food-based micronutrient strategies use a combination of production-oriented and consumption-oriented approaches to increase the consumption and absorption of foods rich in micronutrients, especially among children and pregnant and lactating women. In addition to improving micronutrient status, such interventions are hypothesized to have other beneficial nutrition effects and to have positive impacts on household income. The Ghana Poverty Reduction Strategy explicitly calls for the promotion of food-based approaches to reduce malnutrition.

Objectives

In 2000, UNICEF–Ghana and the International Food Policy Research Institute (IFPRI) agreed upon a program of action research to evaluate the scope for food-based strategies to reduce micronutrient undernutrition in Ghana. The food-based strategies were planned as one component of UNICEF's broader Integrated Community Based Development (ICBD) program, to be implemented first in Savelugu-Nanton District. The research is intended not only to fill the immediate need of assessing the interventions in Savelugu-Nanton District, but also to contribute more generally to the consideration of food-based micronutrient strategies. The evaluation of the impact of the interventions includes a range of outcome measures, such as nutritional status of children less than five years old, the rate of exclusive breastfeeding in the first six months of life, the percentage of children 6–9 months old receiving solid/mushy food, the percentage of women with body mass index (BMI) less than 18.5, and the percentage of women with access to credit. The evaluation also considers the additional effects on these indicators of other interventions that are implemented both individually and in combination with the food-based micronutrient intervention.

The ICBD program implemented in Savelugu-Nanton District was composed of several intervention components. These were introduced in Savelugu-Nanton between the last quarter of 2001 and the last quarter of 2002, and are described in section 2 of the report. The three main intervention components were the Linkages program of behavior change communication, a group microcredit-with-education program implemented by the

Ghanaian Danish Community Programme (GDCP), and the food-based micronutrient intervention. The food-based intervention was developed by UNICEF, with assistance from the University for Development Studies (UDS), the Noguchi Memorial Institute for Medical Research (NMIMR), and IFPRI. Officials from UNICEF and Savelugu-Nanton District plus other stakeholders selected 50 communities for participation in the first round of the ICBD program in Savelugu-Nanton. The three different interventions were mixed and matched to create four different intervention "packages", with the different packages randomly allocated among the 50 communities. The evaluation team randomly selected an additional 15 communities that were not part of the first round of the ICBD program; this group was designed to serve as the main basis for comparison, or "control".

Methods

Two extensive household and community surveys were carried out in Savelugu-Nanton District in 2001 and 2004. These surveys provide the empirical foundation for the quantitative part of the evaluation. Each sample household had at least one child less than three years old, and the survey asked particularly detailed questions about that child and his or her primary caregiver. Each of the two surveys covered approximately 1,600 households, roughly equally distributed among the five groups of communities (the four intervention packages plus the control communities). The surveys were conducted during approximately the same months in each year to help control for intra-annual seasonal variation. The quantitative data from the surveys is complemented by qualitative information collected in the program area, including operations research undertaken by NMIMR.

The primary method for evaluating impact quantitatively in this study is the "difference-in-differences" approach, also known as the double-difference method. Details of the methodology are described in section 3 of the report, but the main idea is that the double-difference method compares changes in outcome indicators between 2001 and 2004 across each of the five groups of communities. This provides an estimate of the average program impact, which can be interpreted as the expected effect of implementing the same program in a similar setting elsewhere. The averages are based on all surveyed households, whether or not they participated in the intervention.

Results

The dominant impression that arises from the double-difference analysis is the apparent lack of detectable impact of the interventions. The majority of the comparisons showed no significant difference between any of the groups. Furthermore, it bears noting that some of the significant differences that are observed are less systematic than one would expect. It is also important to note that the absolute levels of change are often negligible. For example, for most groups the questions about caregivers' knowledge of micronutrient-rich foods and treatment of diarrhea showed steps backwards; this is certainly more disconcerting than finding that an intervention group did not improve more than a control group that had also improved.

Detailed findings concerning the impact of the interventions on various outcome indicators are presented in section 4 of the report. To summarize some of the key findings of the evaluation:

- Participation in the interventions is strikingly low. For most of the interventions, less than one-half of the surveyed households reported participating; in some instances it was less than one-quarter. Large proportions of households said they were not aware of the interventions. The low level of participation is most likely an important reason behind the low levels of average impact observed.

- There is little or no improvement in children's nutritional status. However, the lack of improvement in anthropometry is perhaps understandable, given the short time between the surveys (3 years), the short time since the implementation of the interventions (approximately 2 years, sometimes less), and the numerous other constraints that exist.

- More difficult to explain is the apparent lack of impact on many of the child care and feeding practices that could ultimately lead to improvements in nutritional status. The interventions had virtually no impact on improving rates of exclusive breastfeeding, timely introduction of complementary foods, or improving dietary diversity. Except for a greater percentage of primary caregivers in the LMCFB group being able to identify a food that improves eyesight, caregivers' knowledge of micronutrient-rich foods did not improve in any of the communities.

- There was some evidence of improvement in children's consumption of micronutrient-rich foods, but with the somewhat perverse result that the strongest impact was seen in the Linkages-plus-microcredit (LMC) communities, which did not have a food-based micronutrient component. A similarly peculiar result was observed in the treatment of diarrhea, in which the control group performed better than any of the ICBD intervention groups.

- There are some positive results that emerge. The GDCP microcredit program did appear to increase the use of credit in the communities where it was introduced in 2002 (the LMC and LMCFB groups). Also, the production of orange-fleshed sweet potato increased in the food-based micronutrient intervention communities (LFB and LMCFB), although because of the timing of the survey, it was not possible to determine if the sweet potatoes were being given to young children.

Timing, participation, and sustainability

In attempting to uncover some of the reasons behind the apparently small impact of the interventions, the evaluation looks behind the survey results to some of the more structural issues that may have limited the impact of the interventions. Section 5 of the report pays particular attention to (a) the relatively short time period between the implementation of the intervention and the evaluation, (b) the low level of participation in the interventions, and (c) questions of sustainability of the interventions, especially in cases where the implementing agency has ceased or scaled back its involvement in the communities. These issues are especially relevant because most of the intervention components involve some degree of behavior change in food habits, which can take considerable time to be accepted, adopted, and practiced.

As for participation, less than one-half of the households or primary caregivers surveyed in the four groups of ICBD intervention communities reported any participation in the interventions. Participation was much lower for some interventions. The low participation rates impose a ceiling, or upper bound, on the amount of average impact that can be expected from the interventions. Although we do not have a great deal of information to explain the low participation rates, two important reasons appear to be lack of awareness of the interventions and lack of time.

It is probably too early to assess whether the interventions have acquired the momentum to be self-sustaining. Of the three interventions examined, the GDCP microcredit is probably the least cause for concern, as to the best of our knowledge GDCP is continuing operations in Savelugu-Nanton for the foreseeable future. Both Linkages and the food-based micronutrient intervention have marked important organizational transitions in the past year or two that may have implications for their continued effectiveness. The Academy for Educational Development (AED) ended its support to the Linkages program in Ghana in September 2004, as was originally scheduled. Similarly, NMIMR's and UDS's contributions to the food-based intervention were planned for finite periods, with NMIMR staff departing Savelugu-Nanton in 2003, and UDS operating on a smaller scale than it was at the launch of the intervention in 2002. In each case the strategy was not for the implementing organization to simply drop operations and see if they would fly in the communities. Rather, conscious efforts were made to transfer skills to appropriate persons in Savelgu-Nanton District departments, nongovernmental organizations, community organizations, and community leaders. It would be wise to monitor the activity levels with regard to the interventions evaluated here in the coming years to assess the degree to which they have become integrated into the communities and become self-sustaining.

Conclusions

Since it was first introduced, the ICBD approach has emphasized not only getting results, but the participatory and empowering process by which programs are developed. The ICBD program in Savelugu-Nanton largely followed the approach that was used in other districts in the Northern Region. Although UNICEF and its partners are well-respected and welcomed in the communities in Savelugu-Nanton, an important finding from the surveys is the apparent low participation rate in the ICBD interventions. It is possible that low participation rates are attributable to the interventions being in the early stages of implementation, and still not tightly integrated in the communities. On the other hand, new interventions often draw many participants precisely because they are new, with participation tapering off as time passes and some community members lose interest.

Rather than wait to see which of these alternatives will play out in Savelugu-Nanton it may be advisable to seek ways of increasing participation. That many respondents were reportedly not aware of various ICBD activities suggests that improved methods of notifying communities and ensuring that the information spreads throughout communities would be worthwhile. Attracting those respondents who did not participate because of competing time commitments is likely to be more difficult.

As noted earlier, the short time that the interventions were in place prior to the evaluation increases the difficulty of detecting significant improvements in outcome indicators. Even if all of the intervention components had been launched promptly in September 2001 it is very demanding to expect measurable impact by the time of the follow-up survey less than three years later. It is especially important to note the pilot nature of the food-based micronutrient intervention, which was a new initiative. It can be expected that future efforts to implement food-based micronutrient programs in other areas will take less time and money to get off the ground. The approaches used in Savelugu-Nanton to identify appropriate entry points for the food-based strategy can be applied elsewhere with modest modification, although it should not be expected that the specific components (solar drying, the particular foods added to enrich porridge, etc.) will be the same in every setting.

There are several steps that could be taken in the short term to help illuminate future directions. A first step could be to learn if program impact is different for participants and nonparticipants when participation is defined at the individual and household level, rather than at the community level as was done here. Further analysis can help determine if program impact still differs after controlling for characteristics of participants, who are a self-selected subsample. But further quantitative analysis of the survey data can only go so far. It will be equally important—or quite likely more important—to review the current state of the interventions from a more qualitative perspective, working with communities to gain a better sense of where the interventions have and have not resonated with community needs and interests. In the same context, it will be useful to see which elements of the interventions have taken hold and become self-sustaining, and to understand why.

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Successful completion of a project as large as the evaluation of UNICEF's ICBD program in Savelugu-Nanton requires the concerted effort, talents, and goodwill of a large number of people and organizations. At the risk of inadvertently omitting one or more of the people, we would like to express our gratitude to those who contributed to the planning and implementation of the survey.

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for the main survey in 2004[1] were Raphael Adu-Gyamfi, Conrad Weobong, Moomin Abu, James Fearon, and William Asante. In addition, Rose Dufe supervised the anthropometry team, and Kareem Daari supervised the collection of local market price information.

The interviewers for the main survey in 2004 were:

Abdul Rahaman Aziz	Alhassan Muazu	Salifu Aminu
Abdallah Abdul-Karim	Fuseini Abdul Majeed	Salifu Habib
Abukari Adam	Fuseini Zakaria	Seidu Meri
Abukari Ayishetu	Mahama Wumbei	Shaibu Ibrahim
Abukari Jemilatu	Mohamed S. Ibrahim	Tawfiq Abukari
Abukari Karima	Mohamed Samata	Yahaya Iddrisu
Adam Abdulai	Mohammed Hashim	Yakubu Haruna
Adam Abdul-Jawad	Muhammed Ibn Tuahir	Seidu Abass
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Alhassan Arimiyawu	Osman Yussif	

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Clerical

Victor Dittoh	Abukari Musah	Abdulai Salifu
Baba Alhassan	Sumani Issifu	
Bawa Huzaifa	Alhassan Alhassan Yoona	

Editing

Abdulai Akibu	Alfred Kpieta
John Bidzakin	Victor Dittoh

[1] Only the personnel involved in the 2004 survey are listed here. Those who were only involved in the 2001 survey appear in the 2001 baseline survey report (Simler et al. 2003).

Data Entry

Wumpini Abukari	Eric Naminse Yaw	Sidua Hor Batini
Vivian Fiatusey	Martin Nyaaba Adokiya	
Patrick Aalangdon	Martin Adarkwah	

Data Cleaning

Abdallah Abdul-Karim	Alhassan Arimiyawu	Salifu Habib
Abukari Ayishetu	Alhassan Muazu	Mohamed Samata
Abukari Jemilatu	John Bidzakin	Yahaya Iddrisu

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1. Introduction

1.1 Problem statement

Assuring food security is one of the most important challenges facing the world today, especially in low income countries. Food security is the physical and economic access by all people, at all times, to sufficient safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO 2002). Presently, sub-Saharan Africa is the only region of the world where food security is declining, not only in absolute numbers of people, but also as a percentage of the population.

Food security is often conceptualized in the context of food energy, or calorie intake. However, it is increasingly recognized that a large proportion of the world's population has diets that are deficient in other nutrients, especially micronutrients such as vitamin A and iron. Iron deficiency is the leading cause of anemia, which impairs the physical and cognitive development of children, and may negatively affect the functioning of the immune system. In adults, anemia causes fatigue and reduced work capacity, and adverse pregnancy outcomes (fetal growth retardation, low birth weight, and elevated risk of maternal death). Vitamin A deficiency impairs child growth and development, vision, and immune function, and is also associated with increased morbidity and mortality in infants, children, and pregnant women. Severe vitamin A deficiency can result in blindness and death.

In Ghana, it is estimated that more than 75 percent of children between the ages of 6 months and 59 months suffer from some level of anemia (GSS/NMIMR/ORC Macro 2004). Over 60 percent of children younger than 6 years old are estimated to suffer from sub-clinical vitamin A deficiency (Micronutrient Initiative 2004). It has been estimated that vitamin A deficiency contributes to 1 out of 3 deaths of Ghanaian children between 6 and 59 months, or a total of 86,000 deaths between 2001 and 2005 (Ghana PROFILES 2000).

Until recently, most efforts in Ghana to combat micronutrient malnutrition have focused on vitamin supplementation (e.g., the distribution of vitamin A capsules) and food fortification (e.g., salt iodization). More recently there have been efforts to include a third approach based on dietary change, also known as food-based approaches. Food-based micronutrient strategies use a combination of production-oriented and consumption-oriented approaches to increase the consumption and absorption of foods rich in micronutrients, especially among children and pregnant and lactating women. In addition to improving micronutrient status, such interventions are hypothesized to have other beneficial nutrition effects, and have positive impacts on household income. The Ghana Poverty Reduction Strategy explicitly calls for the promotion of food-based approaches to reduce malnutrition (Government of Ghana 2003).

1.2 Objective of the study

In Ghana, the United Nations Children's Fund (UNICEF) works with local communities, government, and nongovernmental organizations for the promotion of

children's welfare. In 2000, UNICEF–Ghana and the International Food Policy Research Institute (IFPRI) agreed upon a program of action research to evaluate the scope for food-based strategies to reduce micronutrient undernutrition in Ghana. The food-based strategies were planned as one component of UNICEF's broader Integrated Community Based Development (ICBD) program.

UNICEF operates ICBD programs in several districts, and for programmatic reasons, it was decided to base the action research in Savelugu-Nanton District. The primary reason for choosing Savelugu-Nanton District for the evaluation was timing: as the ICBD interventions had not yet begun in Savelugu-Nanton, UNICEF could include the food-based strategies as part of the intervention program from the beginning. In addition, beginning the evaluation before implementation of the interventions helps to provide a clearer measure of the impact of the interventions.

The research is intended not only to fill the immediate need of assessing the interventions in Savelugu-Nanton District, but also to contribute more generally to the consideration of food-based micronutrient strategies. To date there have been few rigorous studies of food-based approaches, and those that have been conducted have sometimes neglected the non-nutritional benefits that food-based approaches can yield (Ruel and Levin 2000). As described in the original project proposal (Ruel, Levin, and Brouwer 2000), the evaluation of the impact of the interventions will include a range of outcome measures, including:

- nutritional status of children less than five years old,
- the rate of exclusive breastfeeding in the first six months of life,
- the percentage of children 6–9 months old receiving solid/mushy food,
- the percentage of women with body mass index (BMI) less than 18.5, and
- the percentage of women with access to credit.

The evaluation also evaluates the additional effect on these indicators of other interventions that are implemented both individually and in combination with the food-based micronutrient intervention. One of these complementary interventions is the Linkages program, which focuses on behavior change communication to improve breastfeeding and complementary feeding practices. Another complementary program is a microcredit-with-education program that targets women.

1.3 Outline of report

This report is organized as follows. Section 2 describes the three interventions in the ICBD program in Savelugu-Nanton that are considered in this evaluation. It also explains the allocation of different combinations of interventions, or intervention packages, to different communities in the district. The evaluation methodology is presented in section 3. This includes the overall philosophy for assessing the impact of the interventions, a brief description of the survey protocols, the quantitative methodology used to evaluate

impact, and a discussion of the strengths and limitations of the methodology. Section 4 contains a lengthy analysis of the impact of the different intervention packages on a wide range of outcome indicators. The impact of the interventions is assessed from several angles, and the implications of the findings are discussed. Section 5 follows with a discussion that seeks to interpret the findings from a broader perspective, from which lessons may be drawn. A summary, and concluding remarks, are provided in section 6.

2. Description of interventions

The ICBD program implemented in Savelugu-Nanton District was composed of several intervention components. These were introduced in Savelugu-Nanton between the last quarter of 2001 and the last quarter of 2002. The three main intervention components on the nutrition side of the ICBD program were the Linkages program of behavior change communication, a group microcredit-with-education program implemented by the Ghanaian Danish Community Programme (GDCP), and a food-based micronutrient intervention developed by UNICEF, with assistance from the University for Development Studies (UDS), the Noguchi Memorial Institute for Medical Research (NMIMR), and the International Food Policy Research Institute (IFPRI). This section briefly describes the main features of each intervention component. Four different combinations, or "packages," of intervention components were introduced in communities in Savelugu-Nanton, and this section also briefly describes the process by which the different intervention packages were allocated among the communities.

2.1 Linkages

Linkages is a program providing technical information, assistance, and training to organizations on breastfeeding, related complementary feeding and maternal dietary practices, and the lactational amenorrhea method, a modern postpartum method of contraception for women who breastfeed. It is managed by the Academy for Educational Development (AED) and operates in many low-income countries throughout the world, in partnership with national health ministries and other host country organizations. In Ghana, Linkages operated primarily in Northern Region, Upper East Region, and Upper West Region, working with Ghana Health Services, UNICEF, the Ministry of Local Government, the Association for Church Development Projects (ACDEP), Ghana Red Cross, Catholic Relief Services, Freedom from Hunger/Ghana, and other civil society organizations (AED 2004).

Linkages employed a strategy of behavior change communication (BCC) to deliver messages on timely initiation of breastfeeding for newborns, exclusive breastfeeding of children less than 6 months old, and timely complementary feeding of children 6 months and older. The Linkages program in Ghana used a variety of communication channels to convey messages about appropriate child feeding practices, including radio, mother-to-mother support groups, home visits by community workers, and contacts at health facilities, among others. An element of the strategy was to build capacity in local partner organizations to extend the BCC messages, largely through a training-of-trainers approach.

In addition to radio messages and other mass media, the implementation of the Linkages program in Savelugu-Nanton District consisted principally of providing training to a small core group of health personnel. This group was then responsible for extending—or "multiplying"—the training to smaller groups throughout the district. In Savelugu-Nanton Linkages worked more or less exclusively through the existing government health system (District Health Management Team and Ghana Health Services). This is in contrast to the approach in some other districts, where civil society

organizations such as Catholic Relief Services played a major role in the implementation of the Linkages BCC program.

2.2 GDCP microcredit

GDCP is a rural development program sponsored by the Ghanaian Danish Community Association (GDCA), a local nongovernmental organization. It has been operating group microcredit programs in northern Ghana for several years, in collaboration with UNICEF and with other organizations. The GDCP microcredit program is modeled loosely on the group credit approach of the Grameen Bank in Bangladesh. Prospective credit recipients form "solidarity groups," and it is the groups, rather than individual members, that apply for and receive credit from GDCP. The groups are jointly responsible for repaying the credit.

There are a range of activities that may qualify for GDCP credit, but agricultural processing and trading businesses are the most common. A majority of the GDCP loans are for amounts of 500,000 cedis (approximately US$50) or less. The usual term of the loan is one year, with loan payments typically starting about three months after the initial disbursement.

In addition to providing loan funds, the GDCP microcredit program also has an educational element. GDCP provides members of credit groups with educational information about running an enterprise, such as savings, banking and bookkeeping. GDCP also disseminated extension messages about subjects such as hygiene, nutrition, and sanitation.

2.3 Food-based micronutrient intervention

The food-based micronutrient intervention is the most recently developed intervention. In fact, the food-based intervention was developed specifically for the Savelugu-Nanton ICBD program, reflecting mutual interest on the part of UNICEF, IFPRI, and other stakeholders for having a rigorous evaluation of food-based approaches to reducing micronutrient malnutrition. As a result, the food-based intervention had the advantage of being especially tailored to conditions in Savelugu-Nanton. It also had many of the disadvantages that are common to new initiatives or pilot programs, including getting a relatively late start as the design was finalized, and having to work through more trial-and-error than interventions that are more established and have already been implemented elsewhere.

The food-based micronutrient intervention had several elements. As noted in the introduction, food-based approaches typically address micronutrient issues at several points, including production, processing, and consumption of micronutrient-rich foods. As each of these involves at least some degree of behavior change, each element also had an associated educational component. Additional details for each category of food-based sub-component are described below.

2.3.1 Consumption: porridge enrichment

Infants that are exclusively breastfed for the first six months of life, as is recommended, can obtain all the nutrients they need through breastmilk. When semi-

solid complementary foods are introduced to the child's diet, it is important that they also contain the iron, vitamin A, and other nutrients required for physical and mental development and proper functioning of the immune system to ward off illnesses. The soft porridges that are the main complementary foods for children 6–12 months are typically based on starchy staples, which are filling, but not sufficiently nutrient-dense to meet dietary requirements. A common strategy is to add nutrient-dense foods to the child's porridge.

Following a review of previous studies and a series of field trials by a team from NMIMR in selected communities in Savelugu-Nanton, several appropriate micronutrient-rich foods were identified as foods to promote for enriching young children's porridges, including eggs, groundnut paste, red palm oil, and fish powder. Meetings were held in each of the communities to teach mothers of young children (especially targeted to mothers of children 6–12 months old) about the role of iron and vitamin A in the diet, and what foods contain these nutrients. Mothers were also engaged in a demonstration of enriching porridges with different foods, including cooking and tasting the enriched porridges, and feeding it to their children. Mothers were encouraged to tell other mothers who had not attended the meeting about the enriched porridge recipes, and to bring friends to the next meeting. These activities were carried out by the NMIMR team, in coordination with Ghana Health Services and the Savelugu-Nanton District Health Management Team (DHMT). Armar-Klemesu and Zakariah (2003) present a detailed description of the design and implementation of the porridge enrichment element of the food-based micronutrient intervention.

The consumption element of the food-based intervention also promoted the consumption of orange-fleshed sweet potatoes, and dark green leafy vegetables.

2.3.2 Processing: solar drying

Many of the plant foods that are rich in micronutrients have pronounced seasons of production and consumption. One of the most dramatic examples is mangoes, which are in season only one or two months per year. During the season mangoes are widely available, but they are never seen the rest of the year. The same is true to a lesser degree with dark green leafy vegetables.

Drying foods is a well-known means of extending their shelf-life, thus extending the time period over which those foods may be consumed after a given harvest. But not all drying methods are equal. For example, drying vegetables such as okra, pepper, and green leafy vegetables is quite common in Savelugu-Nanton, typically by spreading the foods on compound floors and drying them by direct sunlight. Many of the food's nutrients are lost when they are dried in direct sunlight. More nutrients are retained when foods are dried in the shade, but the challenge then becomes how to generate enough heat to dry the foods quickly enough.

Several organizations engaged in intermediate and appropriate technology have developed simple dryers that can be used in the shade, generating heat from indirect sunlight to dry the foods, leading to greater nutrient retention in the dried foods. The team

from NMIMR studied solar dryers[2] already in use in Ghana's Northern Region and in other parts of Africa. Their review and consultations with UDS engineering faculty indicated that the Kavungu style dryer would be appropriate in Savelugu-Nanton. An expert on solar drying at UDS made modifications to improve the Kavungu design.

With funding from UNICEF, 100 of the solar dryers were produced locally and distributed to the communities involved in the food-based micronutrient intervention. Each community received between two and six solar dryers. As dryers could not be provided for all households, the decision was made to allocate the dryers to large households in the community. To be considered "large" a household had to have at least six mothers with children less than five years old. When there were more than six of these in a community, large households drew lots to determine where the dryer would be placed.[3] These large households would serve as custodians of the dryers, and any member of the community would be entitled to use the solar dryers. Although the original design of the intervention envisioned using the solar dryers to dry micronutrient-rich fruits, such as mangoes, in practice the dryers were used mostly for drying green leafy vegetables.

This component of the intervention is also described in greater detail in the NMIMR report by Armar-Klemesu and Zakariah (2003).

2.3.3 Production: orange sweet potatoes, green leafy vegetables, guinea fowl

As much of Savelugu-Nanton's agriculture is based on subsistence and a large share of the food consumed is produced either by the household or by neighboring farmers, increasing local production of micronutrient-rich foods is an important pre-condition for increasing the consumption of those foods. The production element of the food-based intervention began with a three-day Participatory Technology Development (PTD) workshop led by experts from UDS and agriculture extension officers, with representatives from each of the communities involved in the food-based intervention. Follow-up meetings were held in each of the food-based intervention communities to promote the production of orange-fleshed sweet potatoes, dark green leafy vegetables, guinea fowl, and eggs.

The design of the food-based intervention examined the existing food production systems in Savelugu-Nanton and took an incremental approach to increasing the production of micronutrient-rich foods. For example, although sweet potatoes are grown in Savelugu-Nanton, they are not one of the major crops. In addition, the varieties that were grown prior to the intervention were white-fleshed varieties with virtually no beta carotene content. UDS agronomists and agricultural extension officers collected suitable planting material (vines) from outside the region and distributed them to farmers. They also worked with farmers in the intervention communities to teach them how to grow the orange-fleshed varieties, as well as provide advice on maintaining the vines during the dry season.

[2] Even though the drying takes place in the shade, the technology is referred to as solar drying because the heat is generated from the sun, rather than from another fuel source. Thus, direct sun drying could also be called solar drying, but the results are quite different.
[3] This method of allocation was proposed by the communities.

Green leafy vegetables such as *ayoyo*, *bra*, and *alefu* are already grown widely in Savelugu-Nanton, but the production season for each is short. Ensuring adequate intake of micronutrients requires access to micronutrient-rich foods throughout the year. Production of dark green leafy vegetables was promoted with two objectives: 1) to increase the number of months during the year that the fresh leaves are available, and 2) to increase the total volume of production, to help maximize the impact of the solar dryer element of the intervention. Activities in this area of the food-based intervention included extension meetings on production of these crops, and free distribution of seeds.

Most of the foods rich in vitamin A and iron are not plant foods, but animal source foods. At present, the intake of animal source foods (e.g., meat, fish, eggs, and dairy) in Savelugu-Nanton is very low, especially among young children. The production component of the food-based intervention sought to increase the production of guinea fowl, both for egg production and for meat. At an early stage it was determined that intensification of guinea fowl production could only be achieved with relatively large changes in current practices and significant additional resources (e.g., building housing for guinea fowl). Because of this, the guinea fowl component of the production strategy was eliminated from the intervention program.

2.4 Intervention packages

It is anticipated that in addition to their individual contributions to improving nutrition in Savelugu-Nanton, the three interventions might also work synergistically. For example, it is one thing to learn what complementary foods a child needs, but it is something else to have both that knowledge and the resources to put that knowledge into action. As described in the original evaluation project proposal, the three interventions were grouped into four different intervention "packages." A roughly equal number of communities were randomly selected for each intervention package.

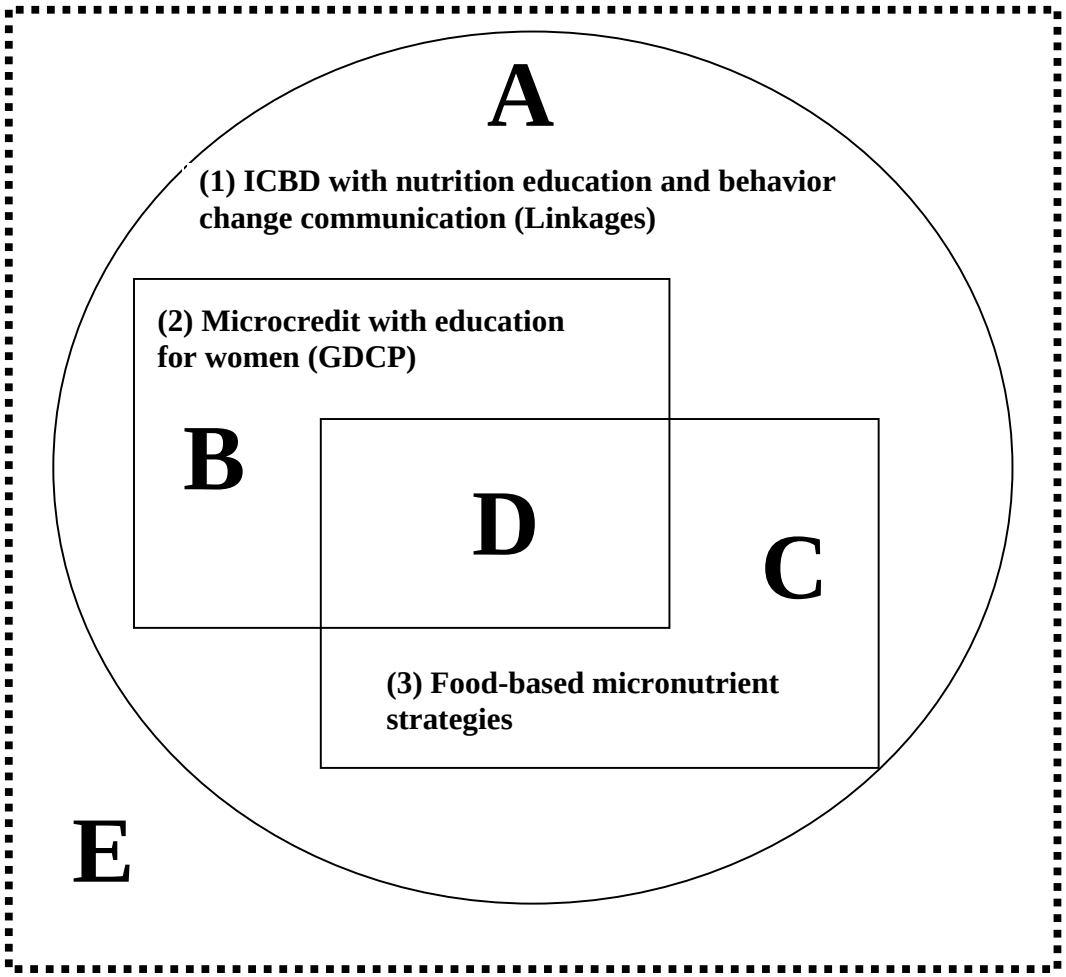
The three different interventions described above are shown in the Venn diagram in Figure 2.1. The large square that surrounds the circle and two rectangles represents all of Savelugu-Nanton District. The Linkages program is numbered (1) and is represented by the large circle inside the square. The GDCP microcredit program is numbered (2) and is represented by the rectangle on the left, inside the circle. The food-based micronutrient intervention is numbered (3) and represented by the rectangle on the right, also inside the circle.

Five groups of communities are also shown in the figure, labeled A through E. The communities in group A only receive the Linkages intervention, whereas the communities in group B receive both the Linkages intervention and the GDCP microcredit program. Similarly, the communities in group C receive the Linkages program and the food-based micronutrient intervention. Group D receives all three of the interventions: Linkages, microcredit, and food-based. Finally, group E receives none of the three interventions.

That some communities receive the benefits of a program and others do not raises important ethical issues. It should be emphasized that non-ICBD communities are not being kept out of the program so that they can serve as a "control" group. Like any such

organizations, UNICEF and its partner institutions (e.g., UDS, the Savelugu-Nanton District Assembly, GDCP, and Linkages) have very real financial, administrative, and personnel constraints. They simply do not have the resources to launch the ICBD program simultaneously in every community in Savelugu-Nanton, just as they cannot launch the program everywhere in the Northern Region, or everywhere in Ghana. The allocation depicted in Figure 2.1 shows the situation at the beginning of the implementation of the ICBD program in Savelugu-Nanton. Over time all communities in the district become involved in one or more of the interventions.

Figure 2.1—Schematic diagram of ICBD intervention packages



A key element of the ICBD process is for communities to identify their own needs, and help shape the interventions to address these needs. The community action plans that were developed in each community showed that there was excess demand for microcredit. That is, more communities identified microcredit as a pressing need than could be served by the ICBD program in the first year in Savelugu-Nanton. In contrast,

there was very little demand for food-based micronutrient interventions. In the interest of fairness to the communities, it was decided to allocate the different interventions randomly among the 50 communities selected for the first round of ICBD programs in Savelugu-Nanton. The random allocation has the side benefit of improving the rigor of the evaluation design.

The allocation of the microcredit and food-based interventions was done in two stages, starting with microcredit. In February 2002, leaders from each of the 50 communities met for three days at the Savelugu-Nanton District Assembly Hall to learn more about the ICBD program. At the end of the meeting, a leader from each community went to the front of the room to draw a folded slip of paper from a box. On each slip of paper was written "yes" or "no," with "yes" indicating that the community would be part of the microcredit program, and "no" indicating that the community would not be in the first round of the microcredit program.

A few months later, a similar random draw was made for the food-based micronutrient intervention, but with two slight differences. First, the draw was made not by leaders of individual communities, but by Savelugu-Nanton District officials; UNICEF officials also attended the drawing. Second, the drawing was stratified based on the allocation of microcredit. In practice, there were two different boxes, one for communities that had already been selected for microcredit and the other for those communities that did not get microcredit. Each box had equal numbers of slips of paper indicating "yes" or "no." The random draw for the food-based micronutrient intervention was stratified this way to ensure that roughly equal numbers of communities would be in each of groups A through D.

The fifth group, group E, was selected in May 2001 during the preparations for the baseline interview. For this selection process, each of the communities that was not among the initial 50 selected for the ICBD program was assigned a number. Using a customized computer program, the survey team made a random draw of all of the non-ICBD communities, listing them in the order they were drawn. These communities were visited, in the order they were randomly drawn, until the number of households covered was approximately equal to the number of households in each of groups A through D. A table of the survey communities and their intervention packages is shown in Table 2.1.

Table 2.1—Allocation of communities to intervention groups

Group A: Linkages Only	Group B: Microcredit (LMC)	Group C: Food-based (LFB)	Group D: Microcredit & Food-based (LMCFB)	Group E: Control
Kpalyogu	Yemo	Tampion-Gushie	Botingli	Kanshegu
Sahani	Tumahi	Zoonayili	Kpalung (Sav)	Janjori-Kukuo
Zoggu	Yong	Looni	Laligu	Sahanayili
Nyoligu	Tootenyili	Kpukpalgu	Nyerigiyili	Janakpiang
Kpalung	Kpunduli	Nabogu	Fazihini	Dingoni
Yiwogu	Guno	Kukuobilla	Nyamandu	Kpachelu
Kpung	Naprisi	Sana	Dohi	Chahiliyi
Sugu-Tampia	Nanton-Kurugu	Nambagla	Sankpiem	Ying
Wawani	Tinkurugu	Pigu	Kuldanaali	Langa
Tigla	Jegun	Yogu	Koduhzegu	Zisungnaayili
	Dipali-Adiyili	Diare	Saakpuli	Kpannya
	Gbanga	Yizegu	Gushie	Chahi-Yapalsi
	Tarikpaa	Moglaa	Zoosali	Kadua
				Dikpungi
				Kadia

3. Evaluation methodology

A clear understanding of the methodological approach is essential for comprehending the findings, implications, and limitations of the evaluation. This section describes the overall philosophy and perspective that guides the evaluation of the program. It also provides guidelines for interpreting the results, and caveats that must be considered. It summarizes the content and implementation of the household and community surveys that form the empirical core of the impact evaluation. This section also briefly describes the operations research—or process analysis—that was conducted to understand more completely the implementation of the food-based intervention. The quantitative methods used for the impact analysis are presented and discussed briefly; a more complete description of the technical details is presented in the appendix.

3.1 Overview

As discussed in the original project proposal (Ruel, Levin, and Brouwer, 2000), a key product of this study is an evaluation of the impact of the interventions on a range of outcome variables. These include the nutritional status of underfives and women (as measured by anthropometric indicators), indicators of exclusive breastfeeding and appropriate complementary feeding for the relevant age groups, the quality of children's diets, and the proportion of women with access to microcredit. A related objective is to assess the differential impact of intervention components and combinations thereof. To accomplish this requires two types of comparisons: (1) a measure of how these indicators change over time, namely, before and after the implementation of the interventions, and (2) a measure of how those changes over time differ between the various intervention packages described in section 2.

The first of these comparisons does not require much explanation. Baseline information was collected from individuals and households in program communities in 2001. This was after selection of the communities that would be included in the first round of the ICBD program, but prior to any program-related activities in those communities. Program activities commenced shortly after completion of the baseline survey in 2001. A follow-up survey was conducted in 2004 in the same communities, at the same time of the year, covering most of the same topics. The change in outcome measures within a given community can be estimated by examining the change in those measures between the two surveys. This is sometimes called a "naïve" estimate (also known as a reflexive comparison) of the program impact, because it does not consider other important factors, as it is incorrect to attribute all observed changes to the interventions.

To go beyond the naïve estimate of program impact requires the second comparison, measuring how much an outcome variable changed in the communities receiving one intervention package compared to the changes observed in another set of communities that received a different intervention package. The underlying logic is perhaps clearest when one compares one of the intervention groups (e.g., the Linkages + microcredit group) with the communities in the control group. Consider a hypothetical scenario in which the 2001 baseline survey followed a generally good harvest year in the district, but

the 2004 follow-up survey took place after a bad year, when harvests, food availability, and incomes were generally lower throughout the region. Consider further the possibility that because of the interventions in the program communities, households were better able to insulate themselves from the adverse effects of the poor harvest, so that even though conditions were worse in 2004 than in 2001, the decline was less pronounced in the program communities than in the control communities. In such a situation, a "naïve" estimate of program impact that only measures changes over time and not between intervention packages would incorrectly conclude that the program had had a negative impact on the outcome variables.

It bears emphasizing that even though the term "control group" might conjure images of a laboratory experiment, in fact the control group of communities does not exist in a vacuum. For instance, they may be involved in, and benefit from, other programs implemented by the Savelugu-Nanton District Assembly, central government, or some of the many nongovernmental organizations operating in the area, such as World Vision or Catholic Relief Services. Indeed, over time the control communities became involved in the UNICEF ICBD program. Thus our estimate of the impacts of the UNICEF ICBD programs does not compare the ICBD programs versus a complete absence of any programs, but rather compares the ICBD programs versus what would likely occur in the absence of the ICBD programs. This is discussed in more detail below.

Evaluation of changes in outcome variables across intervention groups is complemented by other quantitative information that helps to assess the operations of the interventions. For example, did the interventions reach the intended beneficiaries, and if not, why not? Did the interventions lead to a beneficial change in behavior, even if that change did not register an impact in one of the outcome indicators (e.g., did more mothers follow complementary feeding guidelines, even if improvements were not seen in anthropometric outcomes?).

The quantitative evaluation of program impact is in turn complemented by a mixed-method (qualitative and quantitative) evaluation of the implementation of some of the intervention components. It is recognized that the implementation of programs sometimes necessarily deviates from the original plans, whether due to unforeseen constraints, taking advantage of unanticipated opportunities, or other reasons. Fully understanding the outcome of an intervention requires more than examining the before and after pictures, but also an appreciation of the operations of the intervention.

3.2 Household and community surveys

As noted above, most of this evaluation is based on household and community surveys conducted in Savelugu-Nanton District in 2001 and 2004. The surveys were conducted in the same 64 communities in both 2001 and 2004. Of these 64 communities, 49 were among the 50 communities that were selected by UNICEF and the Savelugu-Nanton District Assembly for the first round of the ICBD program, which began in 2001.[4] The remaining 15 communities were randomly selected from the other

[4] Through miscommunication, one of the original 50 communities (Nakpanzoo) was inadvertently used as a site for pre-testing the survey questionnaire in 2001. For reasons of survey reliability, it is generally not

communities in Savelugu-Nanton District. Each of the surveys took place over the course of approximately three months, and each covered approximately 1,600 households. Table 3.1 provides additional general information about the household and community surveys.

Table 3.1—Characteristics of household and community surveys in Savelugu-Nanton

	Year	
	2001	2004
Survey dates	22 May – 20 August	7 June – 21 August
Number of communities	64	64
Number of households[1]	1,578	1,689
Number of individuals	23,580	26,078
Number of households per intervention group		
Control	352	387
Linkages only	283	314
Linkages + Microcredit	336	332
Linkages + Food-based	324	347
Linkages + Microcredit + Food-based	283	309

[1] This is the final number of households with sufficiently complete and usable data.

Because a primary objective of the interventions is to improve the nutrition and health of young children, only households that had a child less than three years of age were considered for the survey sample. These households were identified by a quick census that was carried out in May of 2001 and 2004, immediately prior to the survey in the 64 survey communities. As large, extended households are the norm in Savelugu-Nanton, a majority of households have at least one child less than three years old. Even so, achieving an adequate sample size remained a concern, so that in almost all communities, every household with a child less than three years old was included in the 2001 survey sample. The only exceptions to this were the two largest communities, Diare and Zoggu, where subsets of households were randomly selected. Before beginning the survey in a community, community meetings were held to explain the objectives of the survey and answer questions.

The household questionnaire covered a wide range of topics pertaining to household food consumption, agricultural production, use of credit, socioeconomic status, housing characteristics, water sources, sanitation, and household demographic composition and structure, among others. Particularly detailed information was collected on one child less than three years old (the “index child”) in each sample household, as well as on that child’s primary caregiver, who was usually the child’s biological mother. This in-depth

recommended to include pre-test respondents in the final survey sample. In addition, community members indicated that being surveyed again would inconvenience them considerably, so it was mutually agreed to exclude Nakpanzoo from the surveys, even though it would continue in the ICBD program.

information included child feeding practices (both breastfeeding and complementary feeding), health of the child and primary caregiver, hygiene, and sanitation. Primary caregivers were also surveyed on their nutritional knowledge and practices, autonomy in decision-making, and availability of social support and alternate caregivers. In a separate session, height and weight measurements were taken on all children in the household less than five years old and their primary caregivers. Households were also asked about their participation in any of the ICBD interventions, or similar interventions sponsored by other organizations.

It should be noted that the samples in 2001 and 2004 were drawn independently. That is, it was not designed as a longitudinal study that tracked the same households and individuals over time. Nevertheless, approximately one-half of the households that were in the 2001 sample are also in the 2004 sample. Because three years elapsed between the surveys, none of the index children in 2001 were also index children in 2004, because it is impossible to be less than three years old in each period. However, approximately one-sixth of those identified as primary caregivers in 2001 were also interviewed as primary caregivers in 2004.

The household survey was complemented by a community survey, which was based on interviews with a group of key informants in each community. The community survey focused on the public services available in the community, and for services not available, the distance to the nearest place that offered those services. It also collected information about the types of groups active in the community.

In both 2001 and 2004, development of the survey questionnaires began several months before the survey began. IFPRI researchers, UDS lecturers (who also worked as survey field supervisors), and graduate students from Cornell University and the University of California at Davis carefully reviewed all questions, pretested the survey questionnaires, and revised the questionnaires. The questionnaires were translated into Dagbani using a process of translation-and-back-translation, to ensure that the Dagbani version conveyed the intended meaning.

A large group of survey interviewers (36 in 2001, 25 in 2004) were employed to implement the survey. Interviewers were selected from a large pool of applicants, with several of them participating in both years of the survey. Interviewers participated in a one month training program that emphasized interviewing skills, interview and questionnaire management, and proper handling of confidential information. During the interviewer training sessions the questionnaire was pretested again and refined further.

3.3 Methodology for evaluating impact

It is expected that the ICBD interventions will lead to an improvement in the outcome variables. However, the world is not static, so it can also be expected that change in these variables would occur even in the absence of the interventions. The challenge for the evaluation is to isolate the changes that could be attributable to the intervention from the changes that would have occurred without the intervention. The same logic extends to comparisons between the intervention groups.

The primary method for evaluating impact quantitatively in this study is the "difference-in-differences" approach, also known as the double-difference method. This provides an estimate of the "average program impact," which can be interpreted as the expected effect of implementing the same program in a similar setting elsewhere. The example shown in Table 3.2 will help illustrate the approach. Each column of the table represents one of the five different intervention groups; as noted earlier, each of them comprises 10 to 15 communities. The first row of results shows the average stunting prevalence from the 2001 survey, calculated as the percentage of children less than five years old with height-for-age z-scores below –2. The second row of results shows the corresponding percentages from the 2004 survey, and the third row shows the difference between the two years, with negative numbers indicating a reduction in the prevalence of stunting and positive numbers indicating an increase in the stunting prevalence.

Table 3.2—Example of double difference methodology using underfive stunting prevalence

	Control	Linkages only	Linkages + microcredit	Linkages + food-based	Linkages + microcredit + food-based
Average in 2001	39.1	42.8	41.5	41.5	43.3
Average in 2004	38.4	45.4	44.1	38.2	41.3
2004 average minus 2001 average	-0.8	2.6	2.7	-3.3	-2.0
Linkages only	3.4				
Linkages + microcredit (LMC)	3.5	0.1			
Linkages + food-based (LFB)	-2.5	-5.9	-6.0		
Linkages + microcredit + food-based (LMCFB)	-1.2	-4.6	-4.7	1.3	

From the third row of results, which reports the change between the two surveys, it may be observed that the stunting prevalence decreased in the Control, LFB, and LMCFB communities, and increased in the L and LMC communities. This represents the naïve, or reflexive, comparison referred to earlier. A more robust comparison is to compare not only the changes over time within each group, but also the magnitude of the changes between groups, or the "difference in differences." The lower panel of Table 3.2 shows the double-difference results for all possible pairs of intervention groups. The "Control" column reports the double differences for each of the interventions relative to the Control group, e.g., the Linkages only communities had a *change* in stunting prevalence of 3.4 percentage points (2.6 – –0.8) greater than that observed in the control communities. This is larger than the single difference increase in stunting in the Linkages only communities between the surveys (2.6 percentage points), reflecting the outcome that stunting worsened in those communities even as it improved in the Control communities.

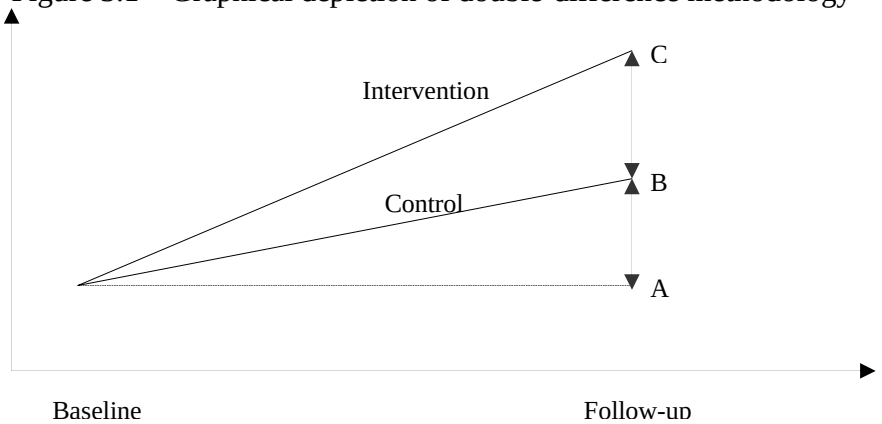
Similar pairwise comparisons are shown in the other columns in the bottom panel of Table 3.2. For example, the change in stunting in the LFB communities relative to the L communities was –5.9 percentage points (–3.3 – 2.6), which hints at (but does not prove) greater impact on stunting when the FB interventions are added to Linkages.

It may be useful to consider the general structure of the double-difference estimate of program impact. To simplify the exposition, consider only two groups, which we can call Control (denoted by *C*) and Intervention (denoted by *I*). As in the present case, there are two time periods when data are collected, one before and one after the intervention; these are denoted by the subscripts 0 and 1, respectively. Thus, in general terms, the double-difference estimate of the impact of the intervention is calculated as:

$$impact = (I_1 - I_0) - (C_1 - C_0)$$

The same calculation may be illustrated graphically, as shown in Figure 3.1 (Maluccio and Flores 2004). For simplicity, we assume in this illustration that the intervention and control groups start with the same average value for the outcome indicator in the baseline period (assuming otherwise does not change the logic, but does complicate the discussion slightly). The average value of the outcome indicator increases by the distance AB in the control group and by the distance AC in the intervention group. The naïve estimate mentioned earlier would mistakenly report the impact of the intervention as AC, which overstates the true impact of the intervention. In contrast, the double-difference estimate would more correctly report the impact of the intervention as the difference in the changes in the two groups, which is the distance BC.

Figure 3.1—Graphical depiction of double-difference methodology



Returning to the tabular presentation shown in the example in Table 3.2, it is possible to use the general notation to describe the contents for each of the cells in the table. Table 3.3 shows the calculations for the five different groups (control plus four intervention packages) considered in the present study with the general notation, with the survey years denoted as 1 (for 2001) and 4 (for 2004).

Table 3.3—General layout of double-difference results tables

	Control	Linkages	LMC	LFB	LMCFB
Avg. in 2001	C_1	L_1	LMC_1	LFB_1	$LMCFB_1$
Avg. in 2004	C_4	L_4	LMC_4	LFB_4	$LMCFB_4$
2004 avg. – 2001 avg.	$C_4–C_1$	$L_4–L_1$	$LMC_4–LMC_1$	$LFB_4–LFB_1$	$LMCFB_4–LMCFB_1$
L	$(L_4–L_1) – (C_4–C_1)$				
LMC	$(LMC_4–LMC_1) – (C_4–C_1)$	$(LMC_4–LMC_1) – (L_4–L_1)$			
LFB	$(LFB_4–LFB_1) – (C_4–C_1)$	$(LFB_4–LFB_1) – (L_4–L_1)$	$(LFB_4–LFB_1) – (LMC_4–LMC_1)$		
LMCFB	$(LMCFB_4–LMCFB_1) – (C_4–C_1)$	$(LMCFB_4–LMCFB_1) – (L_4–L_1)$	$(LMCFB_4–LMCFB_1) – (LMC_4–LMC_1)$	$(LMCFB_4–LMCFB_1) – (LFB_4–LFB_1)$	

Additional technical details of the evaluation methodology and the double-difference estimator appear in the appendix.

3.4 Advantages and limitations of the evaluation methodology

As described above, the principal advantage of the double-difference approach it compares the outcomes in the intervention groups with a credible real life counterfactual, the control group. If exogenous factors such as rainfall led to improved outcomes throughout Savelugu-Nanton between 2001 and 2004, we would not want to ascribe those gains to the intervention. Similarly, if outcome indicators worsened between the two surveys because of adverse climatic conditions, we would not want to say that the interventions led to deterioration of the outcome indicators. The control group of communities, which was randomly selected from all the communities in Savelugu-Nanton that were not chosen in the first round of the ICBD program, is the best approximation available of how outcomes would have changed in the absence of the ICBD program. This includes not only natural factors such as weather, but also human-driven factors such as government programs at the central, regional, or district levels, as well as the effects of interventions undertaken by nongovernmental organizations.

A second advantage of the double-difference approach is that it provides some protection against reporting changes in outcome indicators that are not reflective of genuine change in those indicators, but that may be attributable to differences in the implementation of the two surveys. For example, examination of the data from the 2001 survey indicated that dietary diversity may have been underestimated because of questionnaire design and insufficient probing by the interviewers. In 2004 the survey questionnaire and the interviewer training were modified to correct this problem, with the result that dietary diversity increased in all groups. At least a portion of this increase is almost certainly attributable to the change in data collection procedures, but the double-

difference estimate allows us to "net out" that component because the change in interview protocol was applied uniformly to all households interviewed.[5]

One of the elements of the study design that was not altered between 2001 and 2004 was the timing of the interviews. As shown in Table 3.1, the surveys were conducted at approximately the same time of the year, with almost all of the interviews taking place during the months of June, July, and August. This helps to control for intra-annual seasonal effects, which appear to be pronounced in the Northern Region, with food availability much greater in the post-harvest period towards the end of the calendar year. This contrasts with a definite "hungry season" during the growing season, when many households have exhausted their stocks from the previous harvest but have yet to reap from the new season. Thus, although the present evaluation design avoids confounding the results with seasonal effects, it does capture the information at what is arguably the most food insecure part of the year. This is an advantage in the sense that by definition, food security implies access to sufficient food at all times. If results were limited to the post-harvest period they would likely paint a much more optimistic, but unrealistic, picture.

For this evaluation, most of the results are presented as averages for the surveyed households in the various intervention groups. The surveyed households were selected from all households in the communities, regardless of whether the household or its members participated in the intervention programs. In the program evaluation literature this approach is known as measuring the "intent to treat" effect. Assuming that the program is beneficial for those who participate in it, the effect of including the outcomes of households that did not participate in the interventions is to dilute the measured impact of the interventions. As such it is a conservative estimate of program impact. The survey data show that participation rates for many of the interventions was low: often no more than one-quarter or one-half of the surveyed households reported participating in the intervention programs. As a result, the measured impact of the program at the community level tends to be much smaller than it is for the minority of households that participated in the program. If the objective is to have an impact only on those who participate, then the intent-to-treat approach tends to understate the impact. On the other hand, if the objective is to have an impact on <u>all</u> children under three years-old in the ICBD communities, then the intent-to-treat approach is appropriate for evaluating the impact on the community.

The intent-to-treat approach, measuring average impact at the community level, has another important advantage. Although it may be tempting to restrict the analysis to those who participated in the programs, doing so would introduce a bias in the evaluation results. Determination of intervention packages in each community was made randomly, with the exception of the selection of the initial 50 communities for the ICBD program. However, after a community was selected for an intervention package, participation in the intervention was made through a nonrandom process of self-selection. That is, anyone who wanted to participate in the program could do so, and those who chose not to

[5] It should be noted that this safeguard only exists when the modifications are small, so that the same concept is being measured in the two surveys, albeit with presumably less bias and more precision.

participate were not obliged to do so.[6] It is usually the case that those who choose to participate in interventions are different from the rest of the population. Participants tend to be more motivated, more receptive to messages, and often better educated. As a consequence, it is difficult to disentangle the relative contributions of the participants' characteristics from the contributions of the interventions. In principle, it would be possible to separate the effects by developing two-stage selection models that first estimate the probability of participation based on household and individual characteristics, and then estimate the impact of the intervention conditional upon participation. However, selection models are beyond the scope of the present evaluation.

Because the conditions for the evaluation are not completely controlled, there are some factors that reduce the rigor of the evaluation and the robustness of the findings. The first of these is the nonrandom selection of the first 50 ICBD communities in Savelugu-Nanton District. It is these communities that make up the four different intervention packages, with their outcome indicators compared against each other and against the control group of communities. The process for selecting the 50 communities to be in the first round of the ICBD program in Savelugu-Nanton does not appear to be well documented. From discussions with various interested parties, it appears that the selection was made through a consultative process that included Savelugu-Nanton District officials, representatives from UNICEF, and representatives of nongovernmental organizations working in the district. Informal interviews with participants from the district and UNICEF indicate that the selection criteria were not rigid, and that there was a desire to include a mix of relatively disadvantaged communities, some "high potential" communities, and to have a broad geographic spread.

Because this initial group of ICBD communities was not randomly selected, it is possible that their initial conditions may differ. In other words, there could be systematic differences between the ICBD communities and the control communities that would affect the impact of the interventions. For example, if the ICBD communities were initially much worse off than the control communities, they might show a more rapid improvement in outcome indicators because they are starting from such a low base. Conversely, their outcomes could be much worse because they do not have adequate supporting infrastructure and institutions to facilitate successful implementation of the interventions.

Fortunately, the nonrandom selection of the first group of ICBD communities does not appear to be a serious problem. The data from the 2001 baseline survey were used to compare the 50 ICBD communities with the 15 control communities, and the two groups of communities were found to be remarkably similar across a wide range of characteristics (IFPRI and UDS, 2003). The most prominent differences between the two groups of households is that, on average, the 50 communities in the first round of the ICBD program tended (a) to have poorer access to safe sources of drinking water, (b) to be less likely to produce rice, and (c) to be more likely to be engaged in fishing as a

[6] It bears mentioning that for the microcredit intervention, self-selection determined who applied for credit, but that granting of credit was also influenced by the criteria of the credit organization. As these criteria were very inclusive, it appears that the self-selection of credit applicants was the most important factor that determined microcredit participation in the communities that had that intervention component.

livelihood. Overall, our comparison of the two groups of communities at the baseline indicates that the nonrandom selection of the first group of communities is not likely to introduce a significant bias in the impact evaluation

A second aspect of the implementation of the ICBD that complicates the evaluation is the fact that the control communities were included in the second and third rounds of the ICBD program. Thus, they were involved in at least some of the interventions prior to the follow-up survey in 2004. The direction of the bias from this "contamination" of the control group is easy to predict: it is likely to diminish the measured impact of the interventions. This is because instead of comparing intervention versus "no intervention" we are comparing "more intervention" versus "less intervention."[7] One way to mitigate this problem would be to include information about each community's exposure time to the intervention in the analysis, on the assumption that the intervention's impact increases over time, at least in the short term. This approach could be extended to take account of the introduction of new interventions in the original 50 ICBD communities as well, such as communities that were originally in the Linkages only group but were later included in the GDCP microcredit program. Unfortunately, it has not been possible to pursue this refinement in the analysis, because efforts to acquire information about the expansion of the ICBD program have not been successful.

A related issue is the "contamination" of the control communities, and also the 50 original ICBD communities, by other interventions. Many governmental and nongovernmental development organizations are active in Savelugu-Nanton District, with a range of programs, many of them overlapping with the objectives of the ICBD program. One of the clearest examples of this was the discovery that 8 of the 26 communities randomly selected for the GDCP microcredit program already had GDCP credit programs in place (sponsored by organizations other than UNICEF) prior to the initiation of the ICBD program in those communities. The extent to which development programs other than the ICBD program affect the evaluation results depends upon how decisions are made to place programs in various communities. The influence on the evaluation will be minimal if other organizations make their program placement decisions independent of the selection of ICBD communities. However, if other organizations' program placement consciously favors non-ICBD communities (e.g., in the interests of more even distribution of programs) then the effect will be to reduce the measured impact of the ICBD program. Conversely, if other organizations' place their programs in the ICBD program communities, the evaluation would tend to overstate the impact of the ICBD program, because it would be measuring the effect of both the ICBD and the non-ICBD interventions. Naturally, the presence of additional, non-ICBD programs would tend to overstate the impact of the ICBD programs. The survey attempts to control for this type of confounding by asking respondents about the presence of, and participation in, interventions operated by other organizations.

[7] Ethical considerations are the primary justification for this compromising of the evaluation design. UNICEF and its partners did not have the resources or the capacity to introduce the ICBD program simultaneously in all communities in 2001, so phased introduction was inevitable. However, resources were available to extend the program to all communities by the end of 2003, and it would be unethical to deny a program with presumed benefits to some communities solely for the purposes of measuring the program's impact.

Finally, it should be noted that the 2001 and 2004 surveys are not longitudinal surveys. That is, they are not designed to track the same individuals and households over the three year interval. Samples for each survey were drawn independently, based on the universe of households in the sample communities with at least one child less than three years old. This is intuitively appealing because many of the ICBD interventions are aimed at children less than two years of age, and by the time the interventions were introduced many of the children in the 2001 sample were already older than two. The sample design yields samples that are representative of households with children less than three years old in each of the two years, but it bears noting that the results should be viewed as the results of two cross-sectional surveys, rather than following the same individuals over time.[8]

3.5 Additional sources of information

In addition to the survey-based quantitative analysis, this evaluation of the program and its constituent components is also informed by several qualitative sources of information. During the design phase of the food-based intervention and implementation phase of all interventions there was regular communication between key personnel at UNICEF, UDS, NMIMR, and IFPRI. The evaluation team was also able to obtain reports on the implementation of several of the interventions, but not all. One of the most useful sources of information for understanding the actual operations of the food-based intervention is the report by Armar-Klemesu and Zakariah (2003), commissioned by IFPRI and UNICEF, which includes a process evaluation (or "operations research") of the implementation of that part of the interventions.

[8] Because households often have several women of childbearing age, and women typically have multiple children, it happened that some households and primary caregivers appeared in both the 2001 and 2004 surveys. Longitudinal data are available for approximately 800 households and 250 primary caregivers, but it was not possible to complete the requisite matching exercise in time for the present report.

4. Impact of the ICBD interventions in Savelugu-Nanton

This section presents quantitative estimates of the impact of the ICBD intervention programs in Savelugu-Nanton. These results are based on data collected in the household and community surveys conducted in 2001 and 2004, which were described earlier in section 3.2. The analysis examines a wide range of outcome indicators, comparing the changes in the indicators over the three years across the five groups of communities. In most cases the approach used is the difference-in-differences methodology that was described in the preceding section.

The outcome indicators include anthropometry for all children less than five years old and their mothers, breastfeeding and complementary feeding practices for index children, consumption of micronutrient-rich foods and dietary diversity more generally. Results are also presented for outcomes such as production of micronutrient-rich foods, nutrition knowledge, health practices, and more general socioeconomic information such as asset ownership (both at the household level and for women specifically) and education. As participation rates in the various intervention packages are likely to have a major influence on all of the impact measures, we examine participation rates before discussing the estimated impact on outcome measures.

Before we present the results, there are a few useful remarks on how the findings are displayed. The majority of the results on outcome indicators are difference-in-difference analyses presented in tabular form, using the same structure shown earlier in Table 3.2. At the top of each table are the average values for the outcome indicator in each of the five intervention groups, calculated separately for 2001 and 2004. The single difference, or change in the average over time within each intervention group, is also presented. The bottom portion of the table is a triangular array of numbers, showing each of the ten possible pairwise comparisons between the five groups of communities. This bottom portion of the table is not shown when none of the double-differences are statistically significant. Significant differences between groups of communities are denoted by one asterisk (*) for significance at the five percent level and two asterisks (**) for significance at the one percent level.[9] Also, in the interests of convenience, the following abbreviations are used in the results tables, and often in the text, when referring to the different intervention groups:

L	Linkages only
LMC	Linkages + GDCP microcredit
LFB	Linkages + food-based micronutrient intervention
LMCFB	Linkages + GDCP microcredit + food-based micronutrient intervention

[9] The significance tests take into account the stratified cluster sampling procedure that was used for the two surveys. This is necessary because clustered observations tend to be more homogeneous than occurs with simple random sampling. However, the statistical tests reported here do not adjust significance levels (p-values) for testing multiple comparisons for a given outcome variable. Thus the results reported here overstate the statistical significance of the double-differences. See the appendix for a more complete discussion of these topics.

4.1 Participation in the intervention programs

As noted in section 3.3, the comparisons are made between groups of communities that received different combinations of interventions under the ICBD program. Although program placement at the community level was determined by random selection, program participation at the individual and household level was determined by a nonrandom process of self-selection. That is, once it was decided to implement an intervention in a community, it was left to individuals in that community to decide whether or not to participate in the program.

Preliminary analysis of the impact of the interventions revealed smaller impact than had been expected. Closer examination of the survey data indicated that much of the lack of program impact could be attributable to low participation rates in the interventions. To put it in very general terms, assume that there is a positive impact among those who participate in the intervention, and zero impact among those who do not participate. In this case, the average impact in the community will be directly proportional to the participation rate, so that even if the intervention has a large impact among participants, the average impact will be low if the proportion of nonparticipants is large.

Among the intervention components that were implemented in Savelugu-Nanton, the Linkages program was the most widely implemented, as it was introduced in all of the ICBD communities. It was also the first of the interventions to be introduced, so that the exposure time in each community is longer than is the case with the GDCP microcredit program or the food-based micronutrient intervention.[10] A principal mechanism of behavior change communication in the Linkages program is Mother-to-Mother support groups. In the 2004 survey, primary caregivers were asked several questions about awareness of, and participation in, Mother-to-Mother support groups.

Table 4.1 shows that awareness of Mother-to-Mother support groups is surprisingly low, especially when considering that the respondents are primary caregivers of children less than three years old, who are the main target audience of the Linkages program. With the exception of the LMCFB communities, less than one-half of the primary caregivers surveyed even knew about the mother-to-mother support groups. As might be expected, awareness is lowest in the control group, and is highest in the communities that had not only the Linkages program, but also the complementary interventions of microcredit and the food-based micronutrient intervention.

[10] It is our understanding that the Linkages program was extended to the control group of communities in subsequent years.

Table 4.1—Awareness of, and participation in, Linkages Mother-to-Mother support groups

	Percentage of primary caregivers who:			
Intervention package	Know about mother-to-mother support groups.	Participated in mother-to-mother support group in the past three years	Participated in mother-to-mother support group in the past three months	Recognize a Linkages counseling card
Control	17.1	7.9	0.7	34.5
Linkages only	32.1	22.6	2.6	48.6
Linkages + MC	45.8	35.3	5.4	63.7
Linkages + FB	42.0	29.1	3.5	53.2
Linkages + MC + FB	52.4	40.7	8.1	62.6
Total	37.2	26.4	3.8	51.8

With awareness of the Mother-to-Mother support groups so low, it is not surprising that participation was also low. In the four ICBD intervention groups, only about one-third of the primary caregivers participated in the Mother-to-Mother groups in some way over the preceding three years, ranging from 23 percent in the Linkages-only communities to 41 percent in the LMCFB communities (see second column of Table 4.1). When the reference period for participation in Mother-to-Mother support groups is shortened to the three months before the interview, participation drops off drastically to less than 10 percent of all surveyed primary caregivers, and less than 5 percent in the L and LFB communities.

The final column of Table 4.1 shows an interesting finding: primary caregivers' recognition of Linkages counseling cards is greater than their awareness of Mother-to-Mother support groups. It could be that the primary caregivers have seen the counseling cards in other settings, such as health clinics, but do not associate them with the Mother-to-Mother support groups. Indeed, research by AED has shown that more women receive Linkages' BCC information from radio and health workers than they do from Mother-to-Mother support groups. It is also possible that the passive nature of the survey question ("Do you recognize this card?") sets a low standard for getting a positive response.

Among those who were aware of Mother-to-Mother support groups but did not participate in the groups over the past three years (a total of 183 primary caregivers), the main reasons given for not participating were that they were not aware of group events (30 percent), that they had traveled outside the community at the time of the meetings (21 percent), or that they were too busy (17 percent). Of those who participated, a large majority (slightly over 80 percent) said that the information given at the Mother-to-Mother support group meetings was useful and that they were satisfied with the group.

Turning to the GDCP microcredit program, we see that participation rates were generally lower than those observed for the Mother-to-Mother support groups. As shown in Table 4.2, less than one-third of all the households interviewed in 2004 had at least one household member who was involved in GDCP credit activities (either receiving or repaying a loan) in the 12 months prior to the 2004 survey. As expected, the rate was

highest in the LMC and the LMCFB communities, where GDCP ran microcredit programs under the auspices of the ICBD program. More surprising is the relatively high rate of GDCP credit received in the communities that did not have GDCP as part of the ICBD program package: 23 percent of households in the Linkages only communities, 19 percent in the LFB communities, and 17 percent in the control communities. This may have occurred through expansion of UNICEF-supported GDCP microcredit in 2003 and 2004, or it could be through GDCP credit programs not affiliated with UNICEF.

Table 4.2—Participation in GDCP credit program (preceding 12 months)

Intervention package	At least one member of the household (percent)	Primary caregivers (percent)
Control	16.7	6.8
Linkages only	22.7	8.6
Linkages + MC	46.7	23.9
Linkages + FB	18.8	8.9
Linkages + MC + FB	46.5	24.6
Total	28.9	13.7

A similar pattern is observed when one examines participation in GDCP credit by primary caregivers, with the difference that the rate is approximately one-half that observed when the criterion is any household member (see second column of Table 4.2). Again, rates of GDCP credit among primary caregivers are higher in the LMCFB (25 percent) and the LMC (24 percent) communities, with approximately 9 percent of primary caregivers in L and LFB communities reporting receipt of GDCP credit. It is also useful to look at these from two other perspectives. First, even in the LMC and LMCFB communities, more than three-quarters of primary caregivers (and more than one-half of households) were not involved in the GDCP credit program. Second, the rate of GDCP credit participation is not that much higher than that observed in "non-GDCP" communities. The first of these indicates an overall dilution of the impact of the GDCP microcredit scheme on the entire population, and the second indicates a dilution of the impact when measured as a comparison of the GDCP and non-GDCP communities.

Table 4.3 presents several indicators of awareness of, and participation in, the various elements of the food-based micronutrient intervention. As appropriate complementary feeding was also addressed in the Linkages intervention, these results may be capturing participation in, or familiarity with, that component of the interventions as well. The first column shows primary caregivers' responses to the question "Do you know about porridge enrichment?" The results show that across all 64 surveyed communities, only about one-half of the primary caregivers responded affirmatively. Awareness is somewhat lower in the control communities and somewhat higher in the LMC, LFB, and LMCFB communities. Participation in meetings about porridge enrichment was lower, ranging from 26 to 46 percent in the four groups of intervention communities, and only 10 percent in the control group.

Table 4.3—Participation in various components of the food-based intervention

Intervention package	Primary caregiver says she knows about porridge enrichment	Primary caregiver attended at least one porridge enrichment meeting in the past 3 years	Primary caregiver aware of a solar dryer in the community	Anyone in household used a solar dryer in the past 12 months
Control	31.8	10.0	0.0	0.0
Linkages only	45.7	25.6	1.1	0.6
Linkages + MC	55.4	38.0	1.2	0.3
Linkages + FB	55.0	30.9	51.1	26.6
Linkages + MC + FB	63.2	45.9	79.8	47.5
Total	49.7	29.3	26.2	14.6

The third and fourth columns of Table 4.3 present results about another element of the food-based intervention, the solar dryers that were introduced in the communities. As mentioned earlier, it was not generally possible to provide each household in these communities with their own solar dryer, so they were placed either in a public site within the community or in the compounds of selected households (usually large households), with the understanding that anyone in the community could use them. The survey results show that only about 80 percent of primary caregivers in the LMCFB communities were even aware that there was a solar dryer in their community, with that awareness dropping off sharply to only 51 percent in the LFB communities. Use of the solar dryers is considerably lower, with only about one-half of the primary caregivers in LMCFB households reporting that at least one household member had used a solar dryer in the past year, and the rate dropping to about 27 percent in the LFB communities. Awareness and use of solar dryers in the control, Linkages only, and LMC communities is understandably low, as the solar dryers were not introduced in those communities under the ICBD program.

Another element of the food-based micronutrient intervention was the promotion of orange-fleshed sweet potatoes, which are high in beta carotene. The intervention included extension meetings to teach farmers about orange sweet potatoes, and free distribution of orange sweet potato vines for planting. Table 4.4 presents some results on participation in this element of the intervention. It shows that awareness of orange sweet potato was high in all communities, averaging 75 percent of all households surveyed, and slightly higher in the food-based micronutrient intervention communities (LFB and LMCFB). The percentage of households that planted orange sweet potatoes during the 2003 season was much lower, however. Even in the food-based micronutrient intervention communities (LFB and LMCFB), fewer than one in three households planted any orange sweet potatoes in 2003.[11]

[11] The reference year was 2003 for this question, and all agricultural production questions in the 2004 survey, because the survey started before planting was completed. In addition, the survey asked about

Table 4.4—Awareness of and participation in orange sweet potato production

Intervention package	Respondent knows about orange sweet potatoes	Household planted orange sweet potatoes in 2003
Control	71.3	11.2
Linkages only	70.9	11.6
Linkages + MC	74.5	17.4
Linkages + FB	77.4	23.4
Linkages + MC + FB	81.3	31.0
Total	75.0	18.7

These results on participation in the interventions suggest that the average impact from the interventions will be severely constrained by low participation rates. For all these measures, participating households and primary caregivers are outnumbered by nonparticipants. Even if an intervention had a significant impact on participants, that impact would be reduced to less than one-half when averaged across the wider community. This context needs to be kept in mind when assessing the impact on outcome indicators presented later in this section. We will return to the issue of low participation rates in section 5.

4.2 Anthropometry

4.2.1 Growth of children less than five years old

Anthropometry is a widely used means of assessing nutritional status. For children less than five years old ("underfives"), anthropometric assessment consists of weighing and measuring children, and comparing their measurements to internationally accepted standards, which are age- and sex-specific (CDC/WHO 1978). The most commonly used measures for underfives are height-for-age (stunting), weight-for-age (underweight), and weight-for-height (wasting). In this section we examine the anthropometry results for underfives in Savelugu-Nanton, drawing on the surveys conducted in 2001 and 2004, and compare changes between the control group of communities and the intervention groups of communities.

We begin with stunting, or linear growth faltering, which is often viewed as a measure of chronic deprivation. Stunting is usually a result of a combination of insufficient nutrient intake and repeated illness. It is a cumulative process that in most cases cannot be reversed, especially in developing country settings where the resources for "catch up" growth are lacking. Table 4.5 shows the mean height-for-age (HA) z-score for underfives in Savelugu-Nanton, disaggregated by intervention group.[12] We see that in 2001 the average HA z-score was roughly equal in all five groups, at about –1.7, which is very low. The mean values in 2004 are almost unchanged, although the mean HA z-score in the Linkages Only group worsens slightly (by about 0.1 standard deviations), and the

disposition of harvested crops, so the reference year had to be 2003, as the survey was completed before the 2004 harvest.

[12] In this and other tables presenting anthropometric results, the double-differences analysis includes the child's age and sex as covariates. This provides a measure of protection against the results being confounded by differing age or sex distributions across the intervention groups, although examination of the data did not reveal any significant differences in age or sex distribution.

Control group improves by a similar amount. Thus, the double-difference comparison shows that average HA z-score in the Linkages Only group significantly worsened relative to the Control group. That deterioration in the Linkages Only group is also statistically significant when compared to the LFB communities, which experienced a slight improvement between 2001 and 2004. When the height-for-age analysis is disaggregated by age (in one-year groupings) most of the double-differences are not statistically significant, because of the small changes observed over time and the smaller size of the subsamples.

Table 4.5—Mean height-for-age z-scores of children less than five years old

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	-1.72	-1.79	-1.80	-1.74	-1.73	-1.76
N (2001)	845	670	813	743	734	3805
Average in 2004	-1.63	-1.88	-1.81	-1.68	-1.70	-1.73
N (2004)	1010	766	901	960	910	4547
Avg. change (2004-2001)	0.09	-0.09	-0.01	0.06	0.04	0.02
Linkages only	-0.19 *					
Linkages+MC	-0.09	0.09				
Linkages+FB	-0.03	0.15 *	0.06			
Linkages+MC+FB	-0.05	0.14	0.04	-0.02		

Another way to measure stunting is by reporting the percentage of children whose HA z-scores are below a critical level, such as –2 z-scores or –3 z-scores, with the latter sometimes classified as severe stunting. Using the –2 z-score criterion, Table 4.6 shows that in 2001 the underfive stunting prevalence was similar across the five groups of communities, ranging from 39 percent in the Control communities to 43 percent in the LMCFB communities. Changes in 2004 are small, with slight improvements in the Control, LFB, and LMCFB communities, and slight deterioration in the Linkages Only and LMC communities. The double-difference estimate of the improvement in the LFB communities is statistically significant only when compared to the Linkages Only and the LMC communities.

Table 4.6—Stunting prevalence (z-score < –2) among children less than five years old

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	39.14	42.81	41.46	41.51	43.31	41.60
N (2001)	845	670	813	743	734	3805
Average in 2004	38.35	45.43	44.13	38.20	41.33	41.18
N (2004)	1010	766	901	960	910	4547
Avg. change (2004-2001)	-0.79	2.61	2.67	-3.31	-1.99	-0.42
Linkages only	3.68					
Linkages+MC	3.35	-0.33				
Linkages+FB	-2.43	-6.12 *	-5.79 *			
Linkages+MC+FB	-1.24	-4.92	-4.59	1.19		

Weight-for-age (WA) is a composite indicator of nutritional status. A child whose current health and nutrition are adequate may be underweight because he or she is stunted. That is, past events caused stunting, and the child is now shorter and lighter than

the standards for his or her age. Alternatively, a child who is not stunted could be underweight because of current acute nutritional stress, so that the child is much lighter than the standards even though his or her height corresponds to the standards. Table 4.7 presents the mean WA z-scores for underfives in the sample. As we observed with the mean HA z-scores, in 2001 there is little difference across the five intervention groups: the mean WA z-score is approximately –1.6 in each group. In 2004 there is a slight improvement in the LFB and LMCFB communities, and a worsening in the Linkages Only and LMC communities. The only double-differences that are statistically significant are the improvement in LFB communities relative to the declines in the Linkages Only and LMC communities.

Table 4.7— Mean weight-for-age z-scores of children less than five years old

	Control	Linkages		LMC		LFB	LMCFB	Total
Average in 2001	-1.59	-1.67		-1.61		-1.62	-1.61	-1.62
N (2001)	861	674		820		755	740	3850
Average in 2004	-1.59	-1.72		-1.70		-1.53	-1.59	-1.62
N (2004)	1035	773		912		977	924	4621
Avg. change (2004-2001)	0.00	-0.06		-0.10		0.09	0.02	0.00
Linkages only	-0.06							
Linkages+MC	-0.10	-0.04						
Linkages+FB	0.09	0.15	**	0.19	*			
Linkages+MC+FB	0.02	0.08		0.12		-0.07		

When we examine the underweight (WA z-score less than –2) prevalence among underfives, we see that all five groups of communities had similar rates of underweight in 2001, ranging from 36 to 40 percent of underfives (Table 4.8). As was observed with mean WA z-scores, the only statistically significant double-differences are seen in the LFB communities' improvement relative to the Linkages Only and LMC communities.

Table 4.8—Underweight prevalence (z-score < –2) among children less than five years old

	Control	Linkages		LMC		LFB	LMCFB	Total
Average in 2001	36.44	39.70		34.71		37.28	35.74	36.78
N (2001)	861	674		820		755	740	3850
Average in 2004	37.02	42.71		40.86		36.38	38.62	38.86
N (2004)	1035	773		912		977	924	4621
Avg. change (2004-2001)	0.57	3.01		6.15		-0.90	2.88	2.08
Linkages only	2.43							
Linkages+MC	5.63	3.20						
Linkages+FB	-1.50	-3.93	*	-7.13	*			
Linkages+MC+FB	2.29	-0.14		-3.34		3.79		

4.2.2 Adult women with children less than five years old

For adult anthropometry, the most commonly used measure is the Body Mass Index (BMI). The BMI is defined as a person's weight in kilograms divided by the square of the person's height in meters. Using the BMI, a person may be classified as normal (BMI $\geq$ 18.5 and BMI < 25), underweight (BMI < 18.5), overweight (BMI $\geq$ 25 and BMI < 30),

or obese (BMI > 30). Table 4.9 shows the percentage of mothers of underfives who are underweight according to this classification. Like the children's anthropometry, we observe that in 2001 the maternal underweight prevalence was roughly equal across the five groups of communities, at approximately 14 percent. In 2004 the maternal underweight prevalence declined by 1 to 5 percentage points. The sharpest drop was in the LFB communities; however, none of the double-differences are statistically significant.

Table 4.9—Percentage of mothers of underfives with low Body Mass Index (BMI < 18.5)

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	13.96	13.15	13.71	14.56	13.31	13.79
N (2001)	621	474	611	528	509	2743
Average in 2004	12.41	10.48	10.45	9.33	12.41	10.87
N (2004)	751	605	690	738	648	3432
Avg. change (2004-2001)	-1.55	-2.67	-3.27	-5.23	-0.90	-2.91

In poor areas such as Savelugu-Nanton, overweight and obesity are typically not identified as a major concern. However, overweight and obesity is a growing public health crisis throughout the world—including in low income countries such as Ghana—because overweight and obesity are risk factors for chronic diseases such as diabetes, hypertension, and cardiovascular disease. Table 4.10 shows that the rate of overweight and obesity (combined) is low among mothers of underfives in Savelugu-Nanton, averaging approximately 8 percent across the five groups. However, it bears noting that this is almost double the rate that was observed in 2001, and is something that any programs promoting dietary behavior change should keep in mind.

Table 4.10—Percentage of mothers of underfives who are overweight or obese (BMI > 25)

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	3.31	6.63	4.01	6.25	4.11	4.89
N (2001)	620	473	610	525	509	2737
Average in 2004	7.99	7.54	7.30	8.90	6.47	7.76
N (2004)	750	605	689	736	645	3425
Avg. change (2004-2001)	4.68	0.91	3.29	2.66	2.36	2.87
Linkages only	-3.77 *					
Linkages+MC	-1.38	2.39				
Linkages+FB	-2.02	1.75	-0.63			
Linkages+MC+FB	-2.32	1.45	-0.93	-0.30		

Although much of the discussion of children's and mother's anthropometry has tried to highlight statistically significant differences, one should not lose sight of the fact that the large majority of the comparisons showed no significant differences between the intervention groups. In this vein, perhaps the strongest finding is this: in all of the anthropometry comparisons that were examined, there was not even a single instance in which one of the four ICBD intervention groups outperformed the Control group.[13]

[13] This finding is even more striking when it is remembered that a relatively low threshold was set for statistical significance because p-values for the tests were not adjusted for multiple comparisons.

4.3 Child feeding practices

A core goal of the Linkages, Food Based, and Microcredit interventions is to improve children's health through improving their diets and ensuring that their nutritional needs are met. Undernutrition, anemia, and vitamin A deficiency are common among children younger than 3 years-old in Savelugu-Nanton. These children's diets tend to be lacking in foods rich in iron, vitamin A, and other micronutrients. We will assess the interventions' effectiveness in improving children's diets by investigating their impacts on different measures of the quality of children's diets. In this section we examine rates of breastfeeding and complementary feeding.

All of the differences-in-differences analysis on children's diets that follows controls for children's ages. Controlling for children's ages allows us to account for differences in how children are fed that are due to their age rather than due to any intervention. For example, older children are more likely to be fed more different kinds of foods, including eggs. If the children in Group A are older on average than children in the other groups, without accounting for children's age it will appear as though the interventions in Group A are responsible for increased egg consumption.

4.3.1 Breastfeeding

An assessment of the interventions' impacts on children's diets would not be complete without addressing how the interventions may or may not have influenced breastfeeding patterns. Although our study did not investigate breastfeeding patterns in detail, our results suggest that rates of full breastfeeding and complementary feeding have changed little the past 3 years.

The World Health Organization (WHO) recommends that children be exclusively breastfed for the first 6 months of life (WHO 2001). Nearly every child younger than 6 months in Savelugu-Nanton breastfeeds (see Table 4.11). In the 2001 survey every index child less than 6 months old took breastmilk, with the percentage dropping slightly in 2004.

Table 4.11—Breastfeeding rates among children less than 6 months old (percent)

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	100.0	100.0	100.0	100.0	100.0	100.0
N (2001)	41	31	45	26	37	180
Average in 2004	98.1	97.3	96.3	100.0	98.2	98.0
N (2004)	49	37	50	49	59	244
Avg. change (2004-2001)	–1.9	–2.7	–3.7	0.0	–1.8	2.0

However, rates of exclusive breastfeeding (only breast milk is consumed, no other food or liquid except medicine) and full breastfeeding (only breast milk and/or water and medicine are consumed) are considerably lower.[14] As Table 4.12 shows, only about one-

[14] The rates of exclusive breastfeeding, full breastfeeding, and breastfeeding, were constructed from the 7 day dietary recall provided by the child's primary caregiver. The different measures of breastfeeding are not mutually exclusive, but rather are different levels of restrictiveness. Breastfeeding includes children who consume breast milk and other foods, children who consume only breast milk and water, and children who consume breast milk only. Full breastfeeding includes children who consume breast milk and water and children who consume breast milk only.

half of the index children less than 6 months old were exclusively breastfed. Exclusive breastfeeding rates increased in all of the intervention groups except for the LMCFB communities, where there was a slight decline. None of the double-differences are statistically significant, in large part because the sub-sample of index children less than 6 months-old is small. Nevertheless, it may be noted that the largest increases in exclusive breastfeeding rates between 2001 and 2004 occurred in the intervention groups that initially had the lowest rates (Control and Linkages Only), with smaller changes in the groups that had higher rates in 2001. Thus the exclusive breastfeeding rates in the Control and Linkages Only group are catching up with the other three groups.

Table 4.12—Exclusive breastfeeding rates among children less than 6 months old (percent)

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	27.1	31.6	53.6	41.5	55.2	42.3
N (2001)	41	31	45	26	37	180
Average in 2004	40.8	51.9	63.1	51.1	54.0	52.3
N (2004)	49	37	50	49	59	244
Avg. change (2004-2001)	13.7	20.3	9.5	9.6	-1.2	10.0

Table 4.13 shows that approximately 80 percent of children less than 6 months old are "fully breastfed." In 2004 the rates of full breastfeeding ranged from 69 percent in the Control group of communities to 92 percent in the LFB communities. The full breastfeeding results show the only statistically significant double-difference for any of the breastfeeding results, namely, the 23 percentage point increase in full breastfeeding in the LFB communities relative to the Control communities. This relative gain is composed of roughly equal parts increase in full breastfeeding in LFB communities and decrease in the Control communities.

Table 4.13—"Full breastfeeding" rates among children less than 6 months old (percent)

	Control		Linkages	LMC	LFB	LMCFB	Total
Average in 2001	77.7		85.4	80.4	82.0	83.4	81.6
N (2001)	41		31	45	26	37	180
Average in 2004	68.9		80.8	84.7	91.6	84.8	83
N (2004)	49		37	50	49	59	244
Avg. change (2004-2001)	-8.8		-4.6	4.3	9.6	1.3	1.3
Linkages only	4.8						
Linkages+MC	14.7		9.9				
Linkages+FB	22.7	*	17.9	8.0			
Linkages+MC+FB	9.1		4.3	-5.6	-13.6		

4.3.2 Complementary feeding

At approximately 6 months of age, breast milk no longer meets all of a child's nutritional needs. The WHO recommends that complementary foods be introduced to children's diets at the age of 6 months. We used the 7 day dietary recall for the child to calculate the percentage of children aged 6-9 months who were consuming foods in addition to breast milk and water. Rates of complementary feeding in this age group declined in most of the intervention groups, and declined quite sharply in the Control group (see Table 4.14), although none of the double-differences between the five groups

are statistically significant. As was the case with the breastfeeding results, this is attributable in part to the small sub-sample of index children in this age group.

Table 4.14—Percentage of children 6–9 months old receiving complementary foods

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	74.9	83.6	72.3	85.4	77.4	78.9
N (2001)	24	26	37	25	30	142
Average in 2004	55.1	77.9	73.8	79.1	72.3	72.4
N (2004)	38	44	32	35	36	185
Avg. change (2004-2001)	-19.8	-5.7	1.5	-6.3	-5.2	-6.8

Late introduction of complementary foods is a serious problem that has been noted in previous studies in Savelugu-Nanton (UNICEF 2000; Simler et al. 2003) and northern Ghana more generally (Adjei and Schubert 2003). Both the Linkages program and the food-based micronutrient intervention place great emphasis on appropriate complementary feeding. This may help explain why the decline in complementary feeding rates was not as pronounced as it was in the Control group, but it does not explain why one out of four children 6 to 9 months old are not receiving any complementary foods at all. In both surveys the average age at which complementary foods are introduced is approximately 7.7 months. Late introduction of nutrient-dense complementary foods is no doubt an important contributor to the poor rates of child growth observed in the anthropometry results.

4.4 Children's consumption of micronutrient-rich foods

This section analyzes both general changes in the quality of diets for children 6–36 months of age in Savelugu-Nanton. First, we examine the proportion of children in this age group who consumed various micronutrient-rich foods that were promoted by the food-based micronutrient intervention, comparing changes across the intervention and control groups. As some of the interventions were specifically targeted to primary caregivers of 6–12 month-old children, we will also examine results for this age group separately, although the sub-sample size is small. We then examine responses of primary caregivers about their reasons for not adding micronutrient-rich foods to their children's porridge.

4.4.1 Specific micronutrient-rich foods

In this section we focus on specific micronutrient-rich foods that were part of the food-based micronutrient intervention. The porridge enrichment component of the food-based intervention taught caregivers of children 6–12 months old how to enrich the child's porridge with egg, red palm oil, fish powder or groundnut paste. This component also included discussions of what iron and vitamin A are, why they are good for the body, and what foods are good sources of them. The production components of the food-based micronutrient intervention attempted to increase the production of local foods that are good sources of iron or vitamin A through several avenues. One avenue involved agricultural extension meetings and providing households with planting materials for local dark green leafy vegetables and orange-fleshed sweet potato. Another avenue gave communities solar dryers so that leaves and fruits rich in provitamin A carotenoids could be preserved and stored to be eaten long after harvesting them (ideally, all year round). A third avenue involved attempts to increase rearing of guinea fowl to increase egg

production; for various reasons this element of the intervention was never fully implemented, so it did not receive as much emphasis as the other elements. [15]

For the results presented here there were no minimum thresholds for quantity consumed or frequency of consumption for a child to be counted as having consumed the food item. If the child consumed some of the food item at least once during the 7 day recall period, we count that child as having consumed the food item. To the extent that the children consumed nutritionally negligible quantities of these foods, the survey results may over-estimate the consumption of micronutrient-rich foods. We should also note a change in data collection procedures between 2001 and 2004 that may also influence the results. In 2004 (but not 2001) primary caregivers were specifically asked about the foods included in the food-based micronutrient intervention. Because of this, reported consumption of these foods is likely to be higher in 2004 even if there were no change in consumption patterns. As a result, our measurements may overstate the increase over time in the proportion of children consuming these foods. However, because the data collection methodology was applied uniformly in all communities, comparisons between intervention groups should not be adversely affected.

Among 6-36 month-old children, egg consumption stayed roughly the same in every group except the LMC and the LMCFB intervention groups (see Table 4.15). These two groups experienced an increase in the percentage of children consuming eggs, although the increase was only statistically significant in the LMC intervention group which had a significant positive impact compared to the Control communities, Linkages Only communities, and the LFB communities. The same pattern is observed for 6–12 month old children (Table 4.16).

Table 4.15—Percentage of children 6–36 months old who consumed eggs in the preceding 7 days

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	33.1	27.8	29.5	33.8	30.4	31.1
N (2001)	264	224	258	256	209	1211
Average in 2004	32.3	26.3	44.56	32.6	39.4	34.5
N (2004)	338	277	282	297	249	1443
Avg. change (2004-2001)	-0.8	-1.4	15.0	-1.2	9.0	3.3
Linkages only	0.1					
Linkages+MC	16.8 **	16.8 **				
Linkages+FB	0.7	0.6	-16.1 *			
Linkages+MC+FB	10.2	10.1	-6.7	9.4		

[15] Although orange-fleshed sweet potatoes were part of the food-based micronutrient intervention, we will not include them in our consumption analysis because they were not in season during the data collection period. Information about production of orange-fleshed sweet potatoes is discussed in section 4.6.

Table 4.16—Percentage of children 6–12 months old who consumed eggs in the preceding 7 days

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	7.3	8.6	5.9	10.3	3.8	7.3
N (2001)	61	45	68	53	55	282
Average in 2004	13.3	13.7	32.8	21.7	21.9	20.1
N (2004)	76	72	64	64	73	349
Avg. change (2004-2001)	5.9	5.1	27.0	11.4	18.1	12.8
Linkages only	-1.8					
Linkages+MC	19.4 *	21.2 **				
Linkages+FB	5.1	6.8	-14.3 *			
Linkages+MC+FB	9.6	11.4	-9.7	4.57		

It is surprising that the increase in egg consumption is strongest in the LMC communities, which did not have the food-based micronutrient intervention. These results suggest that educational programs alone are not sufficient to increase young children's egg consumption. It may be that the microcredit intervention increases children's egg consumption by increasing the resources of their caregivers. Why then, do we not see a significant increase in egg consumption in the LMCFB intervention group? One reason could be that by educating caregivers about multiple foods to give to children, not only eggs, the food-based micronutrient intervention could have spread its impact across multiple foods, making its impact less concentrated and more difficult to see.

Children's consumption of red palm oil appears to have increased from 2001 to 2004.[16] The percentage of 6–36 month old children who had consumed red palm oil during the 7-day recall period nearly doubled, from 17 to 31 percent (Table 4.17). Among those 6–12 months old it tripled, from 6 to 20 percent (Table 4.18). There are several possible explanations for this increase, including: 1) the 2004 survey specifically asking about red palm oil in the child's diet, 2) the education portion of the food-based micronutrient intervention that encouraged adding red palm oil to porridge and highlighted red palm oil as a source of vitamin A, 3) personnel from GDCP educating women about red palm oil and encouraging its sale, 4) other groups in the area concerned with vitamin A educating caregivers about red palm oil, 5) higher incomes overall, and 6) greater availability of red palm oil in the market or lower prices.

[16] It is interesting to note that the Control group initially has the highest percentage of children consuming red palm oil. As it does not appear that the age is different from the other groups, the high percentage of children in the Control group consuming red palm oil may be a result of other programs that were operating in Control communities.

Table 4.17—Percentage of children 6–36 months old who consumed red palm oil in the preceding 7 days

	Control		Linkages	LMC	LFB	LMCFB	Total
Average in 2001	20.4		18.2	18.7	14.8	11.4	16.8
N (2001)	264		224	258	256	209	1211
Average in 2004	27.7		31.1	37.9	29.1	33.4	31.5
N (2004)	338		277	282	297	249	1443
Avg. change (2004-2001)	7.3		12.8	19.2	14.3	21.9	14.7
Linkages only	6.0						
Linkages+MC	12.5	**	6.6				
Linkages+FB	7.7		1.7	-4.8			
Linkages+MC+FB	14.8	**	8.8	2.3	7.1		

Table 4.18—Percentage of children 6–12 months old who consumed red palm oil in the preceding 7 days

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	9.2	4.3	5.7	5.7	7.2	6.4
N (2001)	61	45	68	53	55	282
Average in 2004	17.2	20.2	22.2	20.3	21.8	20.3
N (2004)	76	72	64	64	73	349
Avg. change (2004-2001)	8.0	16.0	16.5	14.6	14.7	13.9

The differences-in-differences analysis of associations between intervention groups and children's consumption of red palm oil shows that among children 6–36 months old, the LMC and LMCFB intervention groups significantly increased consumption of red palm oil relative to the Control group (by 12 and 15 percentage points, respectively). This suggests the possibility of an income effect (microcredit gives higher income and so people buy more or better foods). Although there is also an increase in the LFB communities, additional resources from microcredit might be required to put the additional knowledge into action. It makes intuitive sense that the positive impacts from the LMC and LMCFB interventions may be attributable to the additional resources provided by the microcredit or the combination of those resources with education from either the GDCP personnel, Linkages, or the food-based intervention.

The food-based micronutrient intervention also promoted groundnut paste to enrich children's porridge. Although groundnuts contain iron, they are not generally considered to be a good source of iron because the iron has low bioavailability. Nevertheless, groundnuts are a good complementary food because they are calorie-dense, rich in protein, and contribute fat to the diet, which helps absorb vitamin A. Because of the differences in structure of the 2001 and 2004 surveys, we must examine children's consumption of groundnuts and groundnut paste together. As a result, we are unable to disentangle the impacts on consumption of groundnut paste from impacts on the consumption of groundnuts.

As shown in Table 4.19, among 6–36 month-olds, the LFB intervention has a significant positive impact on the percentage of children who consume groundnuts or groundnut paste compared to the Control group. However, as the LFB group does

significantly worse than the Control group among 6–12 month-old children (Table 4.20), we deduce that the increase in children consuming groundnuts and groundnut paste must be among children 12–36 months old. It is noteworthy that across all five groups, the proportion of children consuming groundnuts is considerably higher than the proportion consuming eggs or red palm oil. Between 2001 and 2004 there were also large increases in all five groups, on the order of 20 to 35 percentage points.

Table 4.19—Percentage of children 6–36 months old who consumed groundnuts or groundnut paste in the preceding 7 days

	Control		Linkages	LMC	LFB	LMCFB	Total
Average in 2001	61.1		54.4	55.7	53.8	47.8	54.7
N (2001)	264		224	258	256	209	1211
Average in 2004	80.3		76.4	81.5	82.9	72.0	79.0
N (2004)	338		277	282	297	249	1443
Avg. change (2004-2001)	19.2		22.0	25.8	29.0	24.2	24.3
Linkages only	4.1						
Linkages+MC	8.4		4.3				
Linkages+FB	11.8	*	7.7	3.4			
Linkages+MC+FB	5.6		1.5	-2.9	-6.2		

Table 4.20—Percentage of children 6–12 months old who consumed groundnuts or groundnut paste in the preceding 7 days

	Control		Linkages	LMC	LFB	LMCFB	Total
Average in 2001	12.8		14.2	12.6	27.3	11.3	16.2
N (2001)	61		45	68	53	55	282
Average in 2004	43.6		43.6	48.2	43.3	46.2	44.8
N (2004)	76		72	64	64	73	349
Avg. change (2004-2001)	30.9		29.3	35.6	16.0	34.9	28.6
Linkages only	-4.6						
Linkages+MC	-0.6		4.0				
Linkages+FB	-16.0	*	-11.5	-15.5			
Linkages+MC+FB	-4.1		0.4	-3.6	11.9		

That the LFB interventions are associated with increasing groundnut and groundnut paste consumption among children suggests that the educational component of the programs contributed to the more rapid increase among 12–36 month old children, and also that lack of awareness of the beneficial role of groundnuts in children's diets may be a more immediate barrier to their consumption than lack of income. That said, it is puzzling that the LMCFB intervention does not show similarly positive results. The negative result among 6–12 month old children may be attributed in part to the higher starting point in the LFB communities: the other four groups were playing catch up. Even so, it is difficult to understand why growth was not more rapid in the LFB and LMCFB communities when groundnuts were a key part of the behavior change communication strategy.

The percentages of children who consumed fish or fish powder during the 7 day recall period are shown in Table 4.21 and Table 4.22. Again, because of the differences

in structure of the 2001 and 2004 surveys, we must examine children's consumption of fish and fish powder together. As a result, we are unable to separate the impacts on consumption of fish flesh from impacts on the consumption of fish powder. More children in both age groups and in all intervention groups were consuming fish and fish powder in 2004 than in 2001. The overall increase in fish or fish powder consumption could be the result of our data collection methods, other nutritional programs active in the Savelugu-Nanton District, higher incomes, or part of a general trend. Among 6–36 month old children there are no statistically significant double-differences between the intervention groups. Among 6-12 month-olds, the Linkages Only intervention communities, which initially had the highest rate of fish consumption in this age group, are surpassed by all of the other groups, and significantly so by the Control and LMC groups.

Table 4.21—Percentage of children 6–36 months old who consumed fish or fish powder in the preceding 7 days

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	62.1	59.1	62.7	65.0	56.5	61.5
N (2001)	264	224	258	256	209	1211
Average in 2004	85.7	79.5	84.9	82.9	78.8	82.5
N (2004)	338	277	282	297	249	1443
Avg. change (2004-2001)	23.6	20.4	22.2	17.9	22.3	21.0

Table 4.22—Percentage of children 6–12 months old who consumed fish or fish powder in the preceding 7 days

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	20.2	34.8	16.9	26.0	16.5	22.6
N (2001)	61	45	68	53	55	282
Average in 2004	48.7	44.6	56.3	52.2	51.9	50.4
N (2004)	76	72	64	64	73	349
Avg. change (2004-2001)	28.5	9.8	39.4	26.2	35.4	27.8
Linkages only	-22.1 *					
Linkages+MC	4.9	27.0 **				
Linkages+FB	-3.6	18.5	-8.6			
Linkages+MC+FB	-2.3	19.8	-7.2	1.4		

The green leafy vegetables we are considering here are bra, alefu, and ayoyo. These greens were included in all aspects of the food-based micronutrient intervention. In the educational arm they were noted as being good sources of iron and provitamin A carotenoids[17]. In the production arm of the food-based intervention, women could attend a meeting about their cultivation, and seeds were distributed. The drying of green leafy vegetables in solar dryers was also encouraged in the food-based intervention communities, with the intent of making these greens available for more months of the year, while preserving the greens' micronutrient content.

[17] There is considerable debate about the bioavailability of iron and provitamin A from green leafy vegetables. Although there are clearly other foods that are much richer in iron and vitamin A, their potential contribution should not be overlooked, especially in areas where micronutrient malnutrition is severe. Any positive contribution to iron or vitamin A merits consideration.

There was a general increase in consumption of green leafy vegetables between 2001 and 2004, especially among 6–12 month-olds. Approximately 76 percent of children 6–36 months old were already consuming dark green leafy vegetables in 2001, so the increase experienced in this age group is not particularly large (Table 4.23). However, when we focus on the younger children in the 6–12 month-old age group (Table 4.24), approximately a third more children consumed dark green leafy vegetables in 2004 than in 2001.

Table 4.23—Percentage of children 6–36 months old who consumed green leafy vegetables in the preceding 7 days

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	80.4	77.9	76.6	72.7	70.6	75.5
N (2001)	264	224	258	256	209	1211
Average in 2004	85.2	78.6	86.2	83.8	79.2	82.7
N (2004)	338	277	282	297	249	1443
Avg. change (2004-2001)	4.8	0.7	9.6	11.1	9.1	7.2
Linkages only	-2.8					
Linkages+MC	6.7	9.5 *				
Linkages+FB	8.3 *	11.1 **	1.6			
Linkages+MC+FB	4.9	7.7 *	-1.8	-3.4		

Table 4.24—Percentage of children 6–12 months old who consumed green leafy vegetables in the preceding 7 days

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	27.0	37.2	35.7	29.8	32.9	32.3
N (2001)	61	45	68	53	55	282
Average in 2004	43.4	42.2	48.0	42.1	46.3	44.1
N (2004)	76	72	64	64	73	349
Avg. change (2004-2001)	16.4	5.0	12.3	12.2	13.3	11.8

When we look at significant impacts from the intervention programs, the situation of the two age groups is reversed. Among 6–36 month old children, the LFB intervention group had a significant positive increase of 8–11 percentage points over the Control and Linkages Only groups, while no intervention package appeared to have any impact on the 6–12 month old children. Although more households grew dark green leafy vegetables in 2004 than in 2001, the increase was not significantly different in the LFB group, suggesting that the educational component, rather than the production component, of the food-based intervention may be responsible for the significant increase in the percentage of children consuming dark green leafy vegetables. We also note that the Linkages Only group showed only a very small increase in the percentage of 6–36 month-olds consuming dark green leafy vegetables, and that every other group, except for the Control, was significantly better at increasing children' consumption of dark green leafy vegetables.

4.4.2 Porridge enrichment component of food-based intervention

To gain more insight into the how the porridge enrichment portion of the Food-based intervention influenced caregivers to add or not to add food items to their child's

porridge, we examined the reach of the intervention and the reasons caregivers gave for not adding the food items.

As shown earlier in Table 4.3, approximately one-half of the primary caregivers sampled knew about porridge enrichment. Of caregivers who knew about porridge enrichment, 59 percent (54 percent for caregivers of 6–12 month-olds) had attended a meeting about porridge enrichment in the past 3 years. Approximately 15 percent reported hearing about porridge enrichment from the Mother-to-Mother support groups of the Linkages program, and 42 percent heard about it from "Sister Sodey",[18] UNICEF, or District Health staff, all of which were involved in the food-based intervention. The other main source of information about porridge enrichment was Ministry of Health (Ghana Health Services) workers (33 percent).[19] Some or all of these workers may have been operating as part of the Linkages intervention, but unfortunately we are not certain of the context or capacity in which MoH/GHS workers were discussing porridge enrichment. This means that anywhere from 15 to 48 percent of caregivers were reached by the Linkages program about porridge enrichment (Mother-to-Mother support groups and MoH/GHS workers combined).

To understand the barriers to adding egg, red palm oil, fish powder, or groundnut paste to children's porridge, we examined the reasons primary caregivers gave for not adding these food items to their children's porridge, and have highlighted those reasons that were given by at least 10 percent of primary caregivers. The most common reasons are the same for all food items, and are shown in Table 4.25.

Table 4.25—Most common reasons for primary caregiver not enriching porridge (percent)

	6–36 months-old	6–12 months-old
Didn't think or know to add item	51–58	54–60
Believes child is too young	17–19	22–25
Thinks item is too expensive	10–17	(14% for egg only)

For each of the food items, caregivers were less likely to give "didn't think or know to add [item]" as a reason for not adding a food item to the porridge if they were in one of the LMC, LFB, or LMCFB communities (Table 4.26). It makes sense that a greater percentage of women were aware that the food items could be added to porridge in communities that had the food-based micronutrient intervention, as porridge enrichment was an essential part of that intervention. However, this cannot explain the results in the LMC communities, which had results strikingly similar to the LMCFB communities, and in some respects better than the LFB communities.

[18] This refers to Sawudatu Zakariah, of the Noguchi Memorial Institute for Medical Research, who was one of the leading implementers of the porridge enrichment component of the food-based intervention.
[19] Note that these sources are not mutually exclusive. It is likely that mothers heard about porridge enrichment from more than one source, and the survey questionnaire accommodated this. Therefore the percentages can sum to more than 100 percent.

Table 4.26—Percentage of primary caregivers who gave "Did not think to add [item]" as a reason for not enriching porridge

	Control	Linkages	LMC	LFB	LMCFB	Total
Egg	65.8	56.9	41.3	46.7	41.9	51.5
Red palm oil	72.1	61.6	47.4	54.7	47.1	57.8
Groundnut paste	72.0	64.4	49.0	53.9	46.7	58.2
Fish powder	70.5	59.9	43.9	48.0	47.2	54.9

A key goal of the porridge enrichment portion of the food-based intervention was to increase consumption of egg, red palm oil, groundnut paste, and fish powder in young children's porridges, especially children 6–12 months old. Only the LMC intervention was successful in significantly enriching the porridge contents of children 6–12 months, and this was only for eggs. Except for this result, there is no evidence of an impact of the interventions on the target population of 6–12 month-old children. Small sample sizes for the 6-12 month-old subpopulation may be responsible for not observing statistically significant impacts. However, that the child was "too young" was a common reason for not enriching the porridge among all primary caregivers suggests there may be entrenched beliefs about when children can consume certain foods and that the interventions were not effective in changing these beliefs.

Overall, the results suggest that the main barriers to enriching porridges with egg, red palm oil, fish powder, or groundnut paste are 1) awareness that these food items can be added to porridge, 2) awareness that 6–12 month olds can eat porridge enriched with these items, and 3) the cost of the food items. Eggs seem to be particularly costly. That there is a significant positive impact on children's consumption of eggs associated with being in a group that receives microcredit suggests that cost may be the most immediate barrier to enriching porridge with eggs.

It is also possible that because the intensity of the porridge enrichment portion of the food-based intervention tapered off rapidly in mid-2003, many of the primary caregivers interviewed in mid-2004 had not participated in it, especially mothers of children who were 6–12 months old at the time of the follow-up survey. Therefore, they would be less likely to be familiar with the messages conveyed.

4.4.3 Micronutrient-rich foods

Anemia and vitamin A deficiency are public health problems in Ghana. In 2004, approximately 65 percent of children younger than 5 years suffered from iron deficiency anemia, and approximately 60 percent of children younger than 6 years old were estimated to suffer from sub-clinical vitamin A deficiency (Micronutrient Initiative 2004). The Linkages, microcredit, and food-based micronutrient interventions were implemented with an aim of improving children's overall diet quality, and the food-based intervention was specifically working to improve the iron and vitamin A content of young children's diets.

To examine the impacts of the interventions on young children's consumption of foods rich in iron or vitamin A, we look at the percentage of children in each intervention group who have consumed at least one food that is a good source of either iron or vitamin A in the 7 day recall period. Foods that were considered as good sources of vitamin A or

iron included mangoes, pawpaw, shea fruits, dawadawa fruits, red palm oil, eggs, dark green leafy vegetables, meats and fish, fish powder, groundnuts and groundnut paste, cowpeas, pigeon peas, soya beans, and orange-fleshed sweet-potatoes.[20]

In interpreting the results, there are two important caveats to keep in mind. First, here too, there is no minimum amount of food that must have been consumed and no minimum frequency with which it must have been eaten for a particular food item to qualify as having been consumed. Thus, a very low threshold is being set. Second, part of any increase between 2001 and 2004 in the percentage of children eating a food may be because in 2004, caregivers were prompted for micronutrient-rich foods during the 7 day dietary recall for their child. As a result of both caveats, our measurements may be considered as upper-bound estimates of children's consumption of micronutrient-rich foods.

Roughly 88 percent of children 6–36 months old (Table 4.27) and 56 percent of 6–12 month-olds (Table 4.28) consumed at least one micronutrient-rich food at least once in the 7 days prior to interview. That almost one-half of children 6–12 months old did not consume any micronutrient-rich food whatsoever gives cause for concern, as breast milk alone is unlikely to meet their vitamin A and iron requirements at this age. From 2001 to 2004, there was an increase in the percentage of children 6–36 months old who consumed micronutrient-rich foods. This increase was much more pronounced for children 6–12 months old, perhaps because they were starting from a lower base. But we are unable to attribute the increase to any of the intervention programs. None of the interventions appeared to have a significant impact on children 6–12 month-old children's consumption of micronutrient-rich foods, even though these children were the targeted population for the food-based micronutrient intervention. The smaller sample for 6–12 month children does not explain the lack of statistically significant findings, because the change in the Control group of communities for the 6–12 month age group is about as large as that observed in any of the food-based intervention communities.

Table 4.27—Percentage of children 6–36 months old who consumed at least one micronutrient-rich food in the past week

	Control		Linkages		LMC	LFB	LMCFB	Total
Average in 2001	83.8		83.4		81.4	80.3	78.1	81.4
N (2001)	264		224		258	256	209	1211
Average in 2004	88.9		84.1		90.9	88.9	86.8	87.9
N (2004)	338		277		282	297	249	1443
Avg. change (2004-2001)	5.1		0.7		9.4	8.6	8.6	6.5
Linkages only	-3.2							
Linkages+MC	6.1		9.3	*				
Linkages+FB	5.4	*	8.6	*	-0.7			
Linkages+MC+FB	4.1		7.3		-2.0	-1.3		

[20] These foods were chosen because of their micronutrient content, and not specific links to interventions.

Table 4.28—Percentage of children 6–12 months old who consumed at least one micronutrient-rich food in the past week

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	35.0	43.2	35.6	37.5	40.3	38.1
N (2001)	61	45	68	53	55	282
Average in 2004	51.5	50.3	63.9	56.8	60.1	56.1
N (2004)	76	72	64	64	73	349
Avg. change (2004-2001)	16.5	7.1	28.2	19.3	19.9	18.0

Among children 6–36 months old, the increase in the percentage of children who consumed any micronutrient-rich foods is significantly greater in the LFB communities than in the Control or Linkages Only communities. Although an increase of 5 percentage points in a population where over 80 percent are consuming micronutrient-rich foods is small, it is still useful to try to understand what is driving the impact. Increases across all intervention groups in the percentage of households that grew dark green leafy vegetables or orange sweet potato, and increases in the average number of goats, sheep, and chickens in the household could have contributed to increased availability of micronutrient-rich foods such as dark green leafy vegetables, orange sweet potato, eggs, and meat. However, only the increase in households producing orange sweet potato was significantly associated with the LFB intervention group, and as only 18 children out of the entire sample consumed orange sweet potato, this food cannot explain the greater increase observed in LFB communities. As there does not seem to be increased availability of micronutrient-rich foods specifically associated with the LFB intervention, it appears that the educational component of the intervention may be responsible for the increase in 6–36 month-olds' consumption of micronutrient-rich foods while greater availability may be responsible for the increase in consumption of micronutrient-rich foods across all groups.

The LFB intervention is also associated with a 9 percentage point increase in the percentage of children who consume micronutrient rich foods compared to the Linkages Only group. This supports the idea that the educational component of the food-based intervention may be responsible for more a greater percentage of children consuming micronutrient-rich foods. It also suggests that the educational component of the food-based intervention may be more effective than the Linkages education in increasing young children's consumption of micronutrient rich foods.

The LMC intervention significantly increases the average number of different micronutrient rich foods a child eats by 1.3 foods compared to the Control group (Table 4.29), but it does not significantly affect the percentage of children who consume micronutrient-rich foods (Table 4.27). It could be that the microcredit is disproportionately reaching caregivers who are already acquiring micronutrient-rich foods for their children. If these caregivers have greater resources from the microcredit, they acquire a wider range of micronutrient-rich foods. In this way the number of

micronutrient rich foods consumed would increase, but the percentage of children consuming them would not.[21]

Table 4.29—Average number of different micronutrient-rich foods consumed by children 6–36 months old in the past week

	Control		Linkages	LMC	LFB	LMCFB	Total
Average in 2001	5.0		4.4	4.6	4.6	4.1	4.5
N (2001)	264		224	258	256	209	1211
Average in 2004	6.6		6.2	7.3	6.7	6.6	6.7
N (2004)	338		277	282	297	249	1443
Avg. change (2004-2001)	1.6		1.9	2.7	2.1	2.4	2.1
Linkages only	0.4						
Linkages+MC	1.3	**	0.9				
Linkages+FB	0.7		0.3	-0.6			
Linkages+MC+FB	0.9		0.5	-0.4	0.2		

Table 4.30—Average number of different micronutrient-rich foods consumed by children 6–12 months old in the past week

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	1.1	1.4	1.7	1.5	1.5	1.4
N (2001)	61	45	68	53	55	282
Average in 2004	2.8	3.0	3.6	3.0	3.6	3.2
N (2004)	76	72	64	64	73	349
Avg. change (2004-2001)	1.7	1.6	1.9	1.6	2.2	1.8

Although this set of results showed some positive impact in the LFB and LMC intervention communities, it is somewhat surprising that we do not see any significant impact on children's consumption of micronutrient-rich foods in the LMCFB intervention communities.

4.5 Dietary diversity

4.5.1 Diversity of children's diets

For young children, greater dietary diversity has been found to be associated with nutritionally adequate diets, diets that meet energy and micronutrient needs (Dewey et al. 2004, Ruel et al. 2002). Young children in Savelugu-Nanton tend to have diets that are based on a gruel made from a starchy staple and have few dairy products, meats, or fruits and vegetables.

An index to measure children's dietary diversity was constructed as follows. For each index child the primary caregiver was asked if the child had eaten foods from a list of food items in the 7 days prior to the interview. Caregivers were then asked to name any foods the child had eaten that were not on the list. Foods were divided into 9 categories:

[21] In the next section we will discuss the finding that the LMC intervention was associated with more children consuming eggs and red palm oil. Increases in the consumption of these two foods may be behind the association between LMC increasing the number of different micronutrient rich foods.

- grains
- legumes and nuts
- dairy
- meats (including fish powder) and eggs
- vitamin A rich fruits and vegetables
- other fruits and vegetables
- fats (excluding red palm oil)
- red palm oil
- other foods

Only the first 8 categories were used to make the dietary diversity index. For each food category, the child is given 1 point if he or she consumed one or more foods in that category. The dietary diversity index is the total number of points, so that it has a possible range of 0 to 8 points. To try to better capture the regular elements of children's diets, we also add a frequency threshold to our measure of children's dietary diversity. In order to consider a child as having eaten from a particular food group during the 7 day recall period, the child must have consumed foods from that group at least four times (which could be on different days or the same day).

Dietary diversity of these young children seems to have increased slightly, but as the 2004 survey prompted for a greater number of food items, it is likely that at least a portion of this increase is an artifact of data collection procedures. As the changes in data collection methods were minor and were applied uniformly in all communities, the comparisons between groups are still valid. Also, while the average household dietary diversity index increased by 0.7 (see next sub-section), the average children's dietary diversity index increased by 0.8 (Table 4.31). That the average increase in children's dietary diversity index was at least as large as the average increase in households' dietary diversity suggests that improvements in households' diets are passed along to young children.

Table 4.31—Average diet diversity index for children 6–36 months old (food groups)

	Control		Linkages		LMC	LFB	LMCFB	Total
Average in 2001	3.8		3.7		3.6	3.8	3.5	3.7
N (2001)	264		224		258	256	209	1211
Average in 2004	4.6		4.3		4.8	4.6	4.4	4.5
N (2004)	338		277		282	297	249	1443
Avg. change (2004-2001)	0.7		0.6		1.2	0.8	1.0	0.8
Linkages only	-0.0							
Linkages+MC	0.6	*	0.6	*				
Linkages+FB	0.2		0.2		-0.4			
Linkages+MC+FB	0.3		0.3		-0.3	0.1		

The ICBD interventions show almost no impact on children's dietary diversity. The only statistically significant double-difference is the LMC communities' larger average increase in the dietary diversity index when compared to the Control group and Linkages Only group for children 6–36 months old (Table 4.31). Possible ways that the LMC intervention package may increase children's dietary diversity include greater income or

resources from the microcredit enabling the caregiver to afford a more diverse diet for the child and the Linkages program's education messages promoting dietary diversity. If the educational component were responsible for the increase in diversity, we would expect to see similar increases in the other intervention groups, which is not the case, suggesting that the microcredit may have had a greater, or at least more immediate, role than education in increasing children's dietary diversity. As shown in Table 4.32, when we focus on children 6–12 months old, the average dietary diversity index increases in all groups, with no significant double-differences between groups.

Table 4.32—Average diet diversity index for children 6–12 months old (food groups)

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	1.6	2.3	1.8	2.1	1.9	1.9
N (2001)	61	45	68	53	55	282
Average in 2004	2.2	2.4	2.9	2.6	2.7	2.6
N (2004)	76	72	64	64	73	349
Avg. change (2004-2001)	0.6	0.2	1.1	0.4	0.9	0.6

We also constructed a second form of children's diet diversity index that sometimes appears in the literature. This is a simple count of the number of distinct foods that the child consumes during the reference period, with no grouping by food category. These results are reported in Table 4.33 for children 6–36 months old and Table 4.34 for children 6–12 months old, and show small increases over time in all groups (subject to the caveat noted above) with no statistically significant double-differences between the five groups.

Table 4.33—Average number of different foods consumed by children 6–36 months old

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	16.7	15.6	15.9	16.2	15.0	15.9
N (2001)	264	224	258	256	209	1211
Average in 2004	17.0	16.2	17.6	17.4	16.4	17.0
N (2004)	338	277	282	297	249	1443
Avg. change (2004-2001)	0.3	0.6	1.7	1.3	1.4	1.0

Table 4.34—Average number of different foods consumed by children 6–12 months old

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	6.8	7.8	7.9	8.5	7.6	7.8
N (2001)	61	45	68	53	55	282
Average in 2004	9.2	9.6	10.4	9.6	10.4	9.8
N (2004)	76	72	64	64	73	349
Avg. change (2004-2001)	2.4	1.8	2.5	1.1	2.8	2.0

None of the interventions has an impact on the dietary diversity index of 6–12 month-olds or the number of different foods consumed by the 6–36 month-olds or 6–12 month-olds compared to the Control group. It may be that the effect of the LMC intervention is to change the types of foods that children eat without increasing the number of different foods, and this effect takes place mainly for 12–36 month-old children. It could be that consuming from a food group at least four times per week is too high a standard, especially for children 6–12 months old. However when analysis was conducted without a minimum frequency threshold we did not observe any impacts from

the interventions either. Small sample size cannot in the 6–12 month sub-sample cannot explain the lack of significant impact, as the point estimates for the improvement in the Control group of communities are approximately as large as those for the intervention groups.

4.5.2 Household dietary diversity

Thus far we have kept our analysis focused on children's diets because they were the primary focus of the interventions. However, the interventions may also influence the diets of the household more generally, as caregivers are likely to be involved in selecting and preparing food for all members of the household. Ideally, we would like to know the food consumption and nutritional adequacy of the diet for each person in the household. However, collecting and processing such information can be quite costly and invasive. Instead, we use an index of the household's dietary diversity to proxy for per capita consumption. At the household level, dietary diversity has been associated with per capita consumption and diets that are sufficient in energy and other nutrients (Hoddinott and Yohannes 2002).

The dietary diversity index we use for the household counts the number of different food groups that are found in a household's diet. Foods consumed by the household in the past 7 days were divided into the same 9 food groups used for the children's dietary diversity index. Only the first 8 groups are included in the dietary diversity index. We isolate red palm oil as its own category. The possible range for the dietary diversity index is from 0 to 8. There was no minimum quantity of a food that had to be consumed or minimum frequency of consumption for a food to be counted in the construction of the dietary diversity index. As a result, this index of household dietary diversity may be considered an upper bound estimate.

Because the 2004 survey prompted for a more extensive list of food items, we cannot be sure how much of the observed increase is an actual change in what the household ate or a change in how many foods they reported eating. However, there are still two important observations regarding household dietary diversity. First, as shown in Table 4.35), compared to the Control group, none of the intervention packages had a significant impact on household dietary diversity. This suggests that the interventions did not influence the general composition of the household diet. It may be the case that it is too soon to expect changes in households' diets from the interventions, or it may be that since many of the interventions' messages focused on children's diets that household diets stayed roughly the same while children's diets may have changed. The second point is that the similarity of the children's dietary diversity indices to the households' dietary diversity indices and that the average increase in children's dietary diversity index was at least as large as the average increase in households' dietary diversity, indicate that children's diets are closely tied to household's diets. Any gains in household dietary diversity are likely to be passed to the children.

Table 4.35—Average household dietary diversity index (food groups)

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	5.6	5.4	5.5	5.5	5.4	5.5
N (2001)	306	256	305	291	249	1407
Average in 2004	6.2	6.1	6.3	6.2	6.2	6.2
N (2004)	387	314	332	346	308	1687
Avg. change (2004-2001)	0.6	0.7	0.8	0.6	0.8	0.7

4.6 Production of micronutrient-rich foods

This section evaluates the impact of UNICEF interventions in Savelugu-Nanton on the production of micronutrient-rich foods included in their Food-Based interventions focusing on orange-fleshed sweet potatoes, green leafy vegetables, and guinea fowl. As in the 2001 Savelugu-Nanton survey, the 2004 survey collected information on farm and livestock ownership, number and size of plots, and production, consumption and marketing of crops. Agricultural information was collected for all permanent household members or mothers on *dɔɣ'kuna* [22] who have their own farms or plots. Information on livestock was collected from each permanent household member and all mothers on *dɔɣ'kuna* who own livestock. In addition, the 2004 survey has specific questionnaires related to each intervention, including information on orange-fleshed sweet potatoes, green leafy vegetables, and guinea fowl.

4.6.1 Orange-fleshed sweet potatoes

Orange-fleshed sweet potatoes were part of the food-based micronutrient intervention because they are typically high in beta carotene, an important provitamin A carotenoid.[23] Their calorie content is comparable to other staple foods such as maize, guinea corn, or yam, so they can contribute significantly to meeting food energy requirements. People in Savelugu-Nanton are already familiar with white- and yellow-fleshed varieties of sweet potato, so the introduction of orange-fleshed varieties can capitalize on existing knowledge about production and processing of the crop. Finally, many farmers in the area—especially in Upper East Region—were already growing orange-fleshed sweet potatoes, suggesting a high likelihood of being acceptable to producers and consumers in Northern Region, as well as providing a source of vines for planting.

The percentage of households that grow orange-fleshed sweet potatoes increased significantly between 2000 and 2003[24] in all intervention groups as well as in the control group, as shown in Table 4.36. As expected, the percent increase is higher in the two

[22] *Dɔɣ'kuna* is the Dagomba custom in which a woman returns to her parents' home for an extended period shortly after giving birth to a child. This practice is more common following the birth of a woman's first few children. The amount of time the woman stays with her parents varies, but two to three years is common.

[23] Beta carotene content is highly correlated with the orange color of the sweet potato flesh, although there is considerable variability across sweet potato varieties. Some varieties with deep orange flesh have lower beta carotene content than paler varieties. Unfortunately, we are not aware of any laboratory test results for the beta carotene content of the varieties distributed as part of the food-based micronutrient intervention.

[24] Recall that although the surveys were conducted in 2001 and 2004, the questions about crop production referred to the preceding growing seasons.

groups of intervention that included the food based interventions. The highest increase is found in the LMCFB communities, where more than 26 percent of households grow orange-fleshed sweet potato in 2003, compared to less than 1 percent in 2000.[25] The results of the double-difference analysis shows that the increase in the LFB and LMCFB communities is significantly greater than the increase in the Control communities and the Linkages Only communities, but not significantly greater than the LMC group.

Table 4.36—Percentage of households that grew orange-fleshed sweet potatoes

	Control		Linkages		LMC	LFB	LMCFB	Total
Average in 2001	0.3		0.3		0.3	0.2	0.7	0.3
N (2001)	352		283		336	324	283	1578
Average in 2004	11.3		11.0		16.0	23.9	26.4	17.7
N (2004)	385		309		329	344	307	1674
Avg. change (2004-2001)	11.1		10.7		15.7	23.7	25.7	17.4
Linkages only	-0.4							
Linkages+MC	4.7		5.0					
Linkages+FB	12.6	**	13.0	**	8.0			
Linkages+MC+FB	14.7	*	15.0	*	10.0	2.0		

4.6.2 Green leafy vegetables and guinea fowl

The strategy to increase the consumption of micronutrient-rich foods included promoting the production of green leafy vegetables and guinea fowl, although the guinea fowl part of the program was not implemented by the time of the 2004 survey. The percentage of households growing green leafy vegetables increased between 2000 and 2003 by 13 percentage points (see Table 4.37). At the time of the first survey, the percentage of households growing green leafy vegetables was remarkably even across all five groups, at approximately 25 percent. Somewhat surprisingly, the increase in households growing green leafy vegetables was in the Control group of communities, although their increase was almost matched by the LFB communities. More surprising is that growth was slowest in the LMCFB communities. However, none of the double-differences are statistically significant.

Table 4.37—Percentage of households that produced green leafy vegetables

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	26.3	24.0	25.9	25.6	24.4	25.3
N (2001)	352	283	336	324	283	1578
Average in 2004	42.0	36.6	36.9	40.7	33.6	38.3
N (2004)	385	309	329	344	307	1674
Avg. change (2004-2001)	15.7	12.6	11.0	15.1	9.2	13.0

Although the guinea fowl component of the intervention was not implemented prior to the 2004 household survey, the surveys asked questions about ownership of guinea fowls, in part to understand the potential for guinea fowl eggs and meat to improve diets. Table 4.38 presents the percentage of households in which at least one member owned at least one guinea fowl at the time of the survey. It shows that the percentage of households

[25] The number growing orange-fleshed sweet potatoes in 2000 might be somewhat understated because the 2001 survey did not ask specifically about that crop, whereas the 2004 survey did specifically ask about it.

with guinea fowl declined in the Control, Linkages Only, and LFB groups, but increased in the LMCFB communities. The increase in the LMCFB communities was statistically significant when compared to the Control and Linkages Only communities. Note that this increase in guinea fowl ownership did not appear to translate into higher rates of egg consumption for young children in the LMCFB communities (Table 4.15 and Table 4.16).

Table 4.38—Percentage of households that own guinea fowl

	Control		Linkages		LMC	LFB	LMCFB	Total
Average in 2001	28.8		21.2		27.3	21.4	24.8	24.6
N (2001)	352		283		336	324	283	1578
Average in 2004	26.2		17.4		27.7	18.9	36.4	24.6
N (2004)	387		313		332	345	309	1686
Avg. change (2004-2001)	-2.7		-3.8		0.4	-2.5	11.6	0.1
Linkages only	-1.1							
Linkages+MC	3.1		4.2					
Linkages+FB	0.2		1.29		-3.0			
Linkages+MC+FB	14.3	*	15.4	**	11.2	14.1		

4.7 Use of credit

The 2004 survey asked household members about the use of credit. All permanent household members over the age of 18, women present in the household on *dɔɣ'kuna*, and members who had children were asked if they had had any credit transaction in the 12 months prior to the interview. A credit transaction was defined as either receiving a loan or making a repayment on a loan, whether the loan or repayment was in cash or in kind. To avoid collecting a great deal of information about very small loans, respondents were only asked about loans with a total value of 50,000 cedis or more.[26] Each respondent was asked about up to two different loans that they could have had during the 12 month period, including the possibilities of repaying one loan and then taking another loan, or holding two loans simultaneously. Information was collected about the amount of loans, the purpose of the loans, the source of funds for repayment, and other details, but in this section we will limit ourselves to examining the simple questions. These are: what percentage of households received credit (from any source), what percentage of households received GDCP credit, what percentage of primary caregivers received credit (from any source), what percentage of primary caregivers received GDCP credit, and how do these figures vary in the two periods by intervention group. For all of these double-difference estimates the analysis controls for the size of the household, as larger households presumably have a higher chance of a member obtaining a credit, assuming other things are equal.

[26] In the 2001 survey the threshold was set much lower, at 5,000 cedis. In practice, very few loans less than 50,000 cedis were recorded in that survey, so it was decided to increase the minimum to 50,000 cedis in the follow-up survey. In the results that follow, the few loans in 2001 between 5,000 and 50,000 cedis have been eliminated from the analysis, so that the two survey years may be compared reliably.

4.7.1 Households' use of credit

At the time of the 2001 baseline survey, approximately one-half of households had at least one member who had had a credit transaction, from any source, in the past year. As shown in Table 4.39, the initial percentages were roughly the same across the five groups of communities. In the 2004 follow-up survey the percentage of households receiving credit increased in the two groups of communities that were part of the GDCP microcredit scheme (LMC and LMCFB), while the percentages decreased in the other three groups. This suggests that the GDCP microcredit might have played an important role in extending credit facilities in the communities where it operated. The double differences are significant when comparing the two microcredit groups to the Linkages Only group (which experienced the greatest decline in the percentage of households receiving credit) and when LMC is compared to the Control group. None of the differences are significant when compared to the LFB group of communities.

Table 4.39—Percentage of households in which at least one member received credit

	Control		Linkages		LMC	LFB	LMCFB	Total
Average in 2001	55.4		55.6		53.4	44.5	49.7	51.3
N (2001)	352		283		335	324	283	1577
Average in 2004	45.7		40.7		67.7	38.5	58.3	49.0
N (2004)	387		314		332	347	309	1689
Avg. change (2004-2001)	-9.7		-14.9		14.3	-6.0	8.5	-2.3
Linkages only	-5.2							
Linkages+MC	23.0	*	28.2	**				
Linkages+FB	3.5		8.7		-19.5			
Linkages+MC+FB	16.8		22.0	**	-6.1	13.3		

For any household member receiving credit from GDCP, the percentages obviously are smaller than when credit from any source is considered. GDCP was operating microcredit programs in Savelugu-Nanton, not affiliated with UNICEF, prior to the start of the ICBD program in 2001. This explains the positive, although small, percentages of households receiving GDCP credit in 2001 shown in Table 4.40. Interestingly, use of GDCP credit increased noticeably in all five groups of communities, including those that were ostensibly not part of the microcredit intervention. There are at least two possible explanations for this. One is that GDCP had microcredit operations in those communities that were not part of the ICBD program. The other is that they were ICBD-related activities that were initiated in 2003 or 2004; recall that the allocation of interventions to communities indicated in section 2 applied only to the first year of the ICBD program in Savelugu-Nanton. We were not able to obtain complete information from GDCP about their activities in the Control, Linkages Only, and LFB communities, but the limited information available confirms that at least some of these communities received ICBD-sponsored microcredit programs in 2003 and 2004.

Table 4.40—Percentage of households in which at least one member received GDCP credit

	Control		Linkages		LMC		LFB		LMCFB	Total
Average in 2001	6.0		1.6		3.4		1.4		6.1	3.5
N (2001)	352		283		335		324		283	1577
Average in 2004	16.7		22.7		46.7		18.8		46.5	28.9
N (2004)	383		312		331		341		308	1675
Avg. change (2004-2001)	10.7		21.1		43.2		17.5		40.4	25.3
Linkages only	10.3									
Linkages+MC	32.0	**	21.6	*						
Linkages+FB	6.7		-3.6		-25.3	*				
Linkages+MC+FB	29.0	**	18.7	*	-3.0		22.3	*		

That said, we see that the increase in GDCP credit was much greater in the LMC and LMCFB communities, which is as expected. Over 40 percent of households in the LMC and LMCFB communities had a household member that received or was repaying a GDCP loan (or both) during the 12 months prior to the survey interview. This compares to slightly less than 20 percent of households in the other three groups. The LMC and LMCFB groups of communities each had statistically significant double-differences when compared to any of the other three groups of communities.

4.7.2 Primary caregivers' use of credit

In principle, the GDCP microcredit was targeted to women. We examined how many of the primary caregivers in the sample were involved in credit, from any source, in the 12 months leading up to the survey interview in mid-2004. In 2001, approximately one in eight primary caregivers was involved in credit, with little difference between the five groups of communities (see Table 4.41). The percentage of primary caregivers using credit hardly increased at all in the Control, Linkages Only, and LFB communities, but it approximately doubled, to about 30 percent, in the LMC and LMCFB communities. The increase was especially sharp in the LMC communities, with significant double differences when compared to all except the LMCFB communities. As with the results for all household members (Table 4.39), this suggests that GDCP may have helped expand the availability of credit in the study area.

Table 4.41—Percentage of primary caregivers that received credit from any source

	Control		Linkages		LMC		LFB	LMCFB	Total
Average in 2001	15.7		12.5		11.3		10.1	14.8	12.7
N (2001)	352		283		336		324	283	1578
Average in 2004	17.1		13.7		31.1		12.1	26.9	19.4
N (2004)	387		314		332		347	309	1689
Avg. change (2004-2001)	1.3		1.2		19.9		2.0	12.0	6.6
Linkages only	-0.1								
Linkages+MC	18.5	*	18.6	**					
Linkages+FB	0.6		0.8		-17.9	**			
Linkages+MC+FB	10.7		10.8		-7.8		10.0		

Turning to the use of GDCP credit by primary caregivers, we see once again that use of GDCP credit increased from extremely low levels 2001 to higher levels in all five

groups of communities, with the increase more pronounced in the two groups of communities with the GDCP intervention (LMC and LMCFB). Approximately 25 percent of primary caregivers in the LMC and LMCFB communities were involved in GDCP credit during the 12 months preceding the interview, with significant double differences when compared with any of the other three groups of communities. Of particular note is that in four out of five groups of communities, a large majority of primary caregivers who received any credit received it from GDCP. The Control communities are the sole exception, although even there, almost one-half of the primary caregivers receiving credit received it from GDCP.

Table 4.42— Percentage of primary caregivers that received GDCP credit

	Control		Linkages		LMC		LFB		LMCFB	Total
Average in 2001	2.9		0.4		0.6		0.7		3.2	1.5
N (2001)	352		283		336		324		283	1578
Average in 2004	6.8		8.6		23.9		8.9		24.6	13.7
N (2004)	387		314		332		347		309	1689
Avg. change (2004-2001)	3.9		8.2		23.2		8.3		21.4	12.2
Linkages only	4.3									
Linkages+MC	19.4	**	15.0	*						
Linkages+FB	4.4		0.1		-15.0	*				
Linkages+MC+FB	17.5	**	13.2	*	-1.8		13.1	*		

The survey results show that GDCP was apparently successful in expanding the availability of credit to both primary caregivers and to households more generally. These are some of the most positive results recorded by any of the interventions. Even so, it is also worth noting that even in the LMC and LMCFB communities, approximately one-third of households and two-thirds of primary caregivers were not involved in credit during the year prior to the survey. This could indicate that there is still unmet demand for credit in the study area, even where GDCP is operating. On the other hand, this could simply reflect choices on the part of respondent households, as not everyone wants credit. It is also possible that some households and individuals are not credit worthy.

4.8 Nutritional knowledge and practices

4.8.1 Nutritional knowledge

Giving caregivers more information about food and nutrition is the first step in improving children's diets. Common to all the intervention packages was the practice of providing caregivers with nutritional knowledge. The Linkages program had relatively more general messages: what, when, and how much to feed young children, while the food-based micronutrient intervention specifically encouraged consumption of egg, red palm oil, fish powder and groundnut paste while educating caregivers about vitamin A and iron and what foods are good sources of them. In the food-based micronutrient intervention caregivers were introduced to the terms "iron" and "vitamin A." In the local language iron was said to "give blood" and vitamin A was described as "improving eyesight."

The indicators presented in Table 4.43 and Table 4.44 are the percentages of caregivers who were able to name at least one food that "improves eyesight" or "gives

blood." The number of foods in 2001 that were counted as "improving eyesight" or "giving blood" was fewer than in 2004. In order to assure comparability between 2001 and 2004, our measure only gives credit to caregivers who named a food that was listed in both 2001 and 2004. As a result our measure may somewhat underestimate caregivers' awareness of what foods are good for eyesight and giving blood.

These tables show two general results about the level of caregivers' knowledge of vitamin A and iron. First, caregiver knowledge about foods that "give blood" is more widespread than knowledge about foods that "improve eyesight." Second, none of the interventions had a significant impact on knowledge of foods that give blood over the control group.

Table 4.43—Percentage of primary caregivers who know at least one food that "improves eyesight"

	Control		Linkages		LMC		LFB	LMCFB	Total
Average in 2001	14.6		11.7		15.0		14.0	10.9	13.4
N (2001)	306		256		305		291	249	1407
Average in 2004	6.7		9.3		13.2		14.8	22.3	13.0
N (2004)	387		314		332		346	308	1687
Avg. change (2004-2001)	-7.9		-2.4		-1.8		0.8	11.4	-0.4
Linkages only	5.6								
Linkages+MC	6.2		0.6						
Linkages+FB	8.9		3.4		2.8				
Linkages+MC+FB	19.4	**	13.8	*	13.2	*	10.4		

Table 4.44—Percentage of primary caregivers who know at least one food that "gives blood"

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	49.4	52.6	55.5	57.7	47.8	53.0
N (2001)	306	256	305	291	249.	1407
Average in 2004	51.8	53.6	55.9	54.3	57.1	54.4
N (2004)	387	314.	332	346	308	1687
Avg. change (2004-2001)	2.4	1.0	0.3	-3.4	9.4	1.4

In terms of impacts from the interventions, the only groups to experience an increase in the percentage of caregivers who know foods to improve eyesight were the LFB and LMCFB groups. The only statistically significant impact came from the LMCFB intervention which has a significantly higher impact over the Control, Linkages Only, and LMC groups, but not significantly greater than the LFB group. These outcomes suggest that the educational arm of the food-based intervention was effective in improving vitamin A awareness, but only when the intervention also included microcredit. The higher rates of participation in the LMCFB may help explain the stronger impact in these communities.

Knowing that the food-based intervention had introduced some caregivers to the terms "vitamin A" and "iron," in 2004 we asked caregivers if they recognized the terms. Overall, 23 percent of primary caregivers said they recognized the term "vitamin A," and

10 percent said they recognized the term "iron" (see Table 4.45). Recognition of both terms was significantly higher among caregivers in LFB and LMCFB groups that in the Control, Linkages Only, or LMC groups. This suggests that the food-based intervention is responsible for familiarizing caregivers with the terms "vitamin A" and "iron."

Table 4.45—Percentage of primary caregivers who recognize the terms "vitamin A" and "iron"

	Control	Linkages	LMC	LFB	LMCFB	Total
Observations	387	314	332	344[a]	307	1684[a]
Caregivers who recognize "vitamin A"	8.0	13.0	15.9	33.2	46.1	22.6
Caregivers who recognize "iron"	1.8	4.0	3.6	16.3	28.1	10.5

[a] For the percent of primary caregivers who recognize "iron," the number of observations in is 343 in the LFB group and 1683 in the total sample.

It is curious that in the 2004 survey more primary caregivers recognized the term "vitamin A" than could name a food that is a good source of vitamin A, while the opposite result holds for iron.[27] Of the two, it is arguably more important to know what foods are important for growth, development, and good health than it is to know the English word for a particular vitamin or mineral. On this score it is clear that there is ample room for further nutrition education, especially concerning foods that are good sources of vitamin A. Moreover, in the only intervention group that registered an improvement (the LMCFB group, for knowing iron-rich foods), there is no evidence that the increased knowledge has translated into young children's increased consumption of such foods.

4.9 Household expenditures

One of the objectives of the interventions was to increase household incomes. Income is widely recognized as an important indicator of well being, as it reflects the resources available to a household to satisfy their needs. In settings such as Savelugu-Nanton expenditure is usually preferred over income as a measure of welfare for several reasons (Deaton and Zaidi 2002). It should be emphasized that the definition of expenditure includes not only cash expenditures, but also consumption of household-produced items (e.g., food produced on household or individual farms) and barter transactions.

Respondents tend to find questions about their cash expenditures and consumption of home-produced items less sensitive than questions about income, and thus give more candid responses to survey questions. Expenditure is also less prone to seasonal fluctuations than income, so it is possible to collect more accurate information, and not necessary to have excessively long survey periods or recall periods. Expenditure is also a better measure of "permanent income," which is considered as a more relevant constraint to households than current income. Because household expenditure tends to increase with

[27] It is possible that our choice to ask what foods "improve eyesight" or "give blood" instead of "what foods are good sources of vitamin A or iron" is partially responsible for the discrepancy. However, the wording of the survey questionnaire was guided both by consultations with health and nutrition experts in Ghana and extensive pretesting.

household size, expenditure is usually normalized by dividing total household expenditure by the number of household members, or by the number of "adult equivalent units" (AEU) in the household. For the present analysis we shall report household expenditures per capita.

Food purchases and food produced and consumed by the household accounts for the majority of household expenditure. As such, the more intensive probing about household food expenditure in the 2004 survey would tend to produce higher estimates of household expenditure even if nothing had changed in reality. Although this would tend to exaggerate the increase in expenditure per capita, any exaggeration is similar across the five groups of communities, so that comparisons between communities are still valid. Table 4.46 shows the double-difference analysis for *nominal* expenditure per capita, indicating no significant differences between any of the five groups of communities.

Table 4.46—Household expenditure per capita per year, in nominal cedis (1000s)

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	719.4	696.4	692.1	688.0	655.6	691.0
N (2001)	353	284	339	326	286	1588
Average in 2004	1,013.0	1,048.6	1,187.1	990.7	1,020.8	1,047.3
N (2004)	421	340	365	384	341	1851
Avg. change (2004-2001)	293.5	352.2	494.9	302.7	365.1	356.3
Linkages only	58.6					
Linkages+MC	201.4	142.8				
Linkages+FB	9.1	–49.5	–192.3			
Linkages+MC+FB	71.6	12.9	–129.8	62.5		

The large increase in nominal expenditure per capita is partially attributable to price inflation that occurred between the two surveys. In other words, even though average per capita expenditure increased from approximately 700,000 cedis in 2001 to just over 1 million cedis in 2004, one needs to consider that the purchasing power of the cedi declined over this period. Using the community price surveys that were conducted in both 2001 and 2004, we developed a consumer price index for the inter-survey period, so that expenditures in 2004 could be deflated to their equivalent purchasing power in 2001. The weights for the consumer price index were based on consumption patterns observed in the Savelugu-Nanton sample households, so this price index is much more directly applicable to Savelugu-Nanton than is the national consumer price index published by the Ghana Statistical Service. The price index computed from the Savelugu-Nanton survey data indicated that food prices rose an average of 44 percent between the two surveys.

When adjusted for inflation, expenditure per capita shows only a small increase between 2004 and 2001, averaging 36,300 cedis per person per year (Table 4.47). The increase was greatest in the LMC communities, but as with nominal expenditure, none of the double-differences are statistically significant.

Table 4.47—Household expenditure per capita per year, in deflated 2001 cedis (1000s)

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	719.4	696.4	692.1	688.0	655.6	691.0
N (2001)	353	284	339	326	286	1588
Average in 2004	703.4	728.2	824.4	688.0	708.9	727.3
N (2004)	421	340	365	384	341	1851
Avg. change (2004-2001)	–16.0	31.8	132.2	0.0	53.2	36.3
Linkages only	47.8					
Linkages+MC	148.2	100.5				
Linkages+FB	16.0	–31.8	–132.3			
Linkages+MC+FB	69.2	21.5	–79.0	53.2		

4.10 Asset ownership

Another way to assess the impact of the ICBD interventions is to examine changes in asset ownership since the introduction of the program. Changes in asset ownership can be used to measure the impact of interventions on economic status and well-being of women and households. The most direct pathway for increased asset accumulation would appear to be the microcredit program, which is intended to increase income generating opportunities for participant households. A less obvious pathway is the food-based micronutrient intervention. Although the direct objective of that intervention is to improve the diets and health of young children, there are aspects that should also enhance the incomes of participants, especially from the production-oriented components of the food-based intervention. A claimed advantage of food-based approaches to reducing micronutrient malnutrition is that they can increase income and provide other benefits that are not provided by micronutrient supplementation campaigns or conventional food fortification approaches. Indeed, it is sometimes argued that these additional benefits are sometimes overlooked in evaluations of food-based approaches, so that the relative merits of food-based approaches are not fully valued (Ruel and Levin 2000).

We examine changes in asset ownership for households, and also for women in particular. Information on assets is available in the Savelugu-Nanton 2001 and 2004 surveys and was collected for all adult permanent household members, all women under 18 who have children, and all mothers on *dɔɣ'kuna*. In each survey information was collected on whether each of the persons owned at least one of a list of assets, including: a watch or clock, radio, cassette player, trunks, *makolle*,[28] chop box, cupboard, sewing machine, sofa, television, electric fan, bicycle, motorcycle, and car. For the present analysis, information on individual assets was aggregated into two conceptually similar, but somewhat different, asset indexes. The first index is a simple count of the number of asset categories that a person owns, giving equal weight to each asset category. For example, a person who owns a watch, two radios, and a bicycle receives a score of 3, because he or she possesses three of the assets in the list. The second index gives different weights to each index category, with the weights determined from a factor analysis of the data. The weights from the factor analysis are derived in a manner that preserves the maximum variability in the index score across the survey samples.

[28] A *makolle* is a container with a lid, made from a light metal, in which women keep their valuables.

4.10.1 Household assets

The most commonly owned asset at the household level is bicycles: in both surveys 93 percent of households had at least one member who owned a bicycle. The next commonly owned asset is *makolle* which are owned by 92 percent and 90 percent of households in 2001 and 2004 respectively. Less than 5 percent of households own relatively expensive assets such as televisions, fans, motorcycles, and cars. Using the simple asset index based on an unweighted count of asset categories, Table 4.48 shows that average asset ownership increased slightly in all five groups of communities between 2001 and 2004. The only significant double-difference is the increase in assets in the LFB communities relative to the control communities.[29]

Table 4.48—Household asset ownership, as measured by unweighted asset index

	Control		Linkages	LMC	LFB	LMCFB	Total
Average in 2001	6.12		5.95	6.29	6.32	5.92	6.14
N (2001)	352		283	336	324	283	1578
Average in 2004	6.28		6.34	6.87	6.70	6.18	6.49
N (2004)	387		314	332	347	309	1689
Avg. change (2004-2001)	0.16		0.39	0.58	0.39	0.26	0.35
Linkages only	0.25						
Linkages+MC	0.30		0.05				
Linkages+FB	0.26	*	0.01	-0.04			
Linkages+MC+FB	-0.02		-0.27	-0.32	-0.28		

Table 4.49 presents results for changes in assets at the household level using the weighted asset index constructed using factor analysis. This index ranges from –2.2 to 2.6, with an average of zero. As with the simple index, the average weighted asset index is higher in 2004 in all five groups of communities. However, in this instance none of the double-differences are statistically significant.

Table 4.49—Household asset ownership, as measured by weighted asset index

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	-0.11	-0.17	0.00	0.02	-0.19	–0.08
N (2001)	352	283	336	324	283	1578
Average in 2004	-0.00	0.01	0.26	0.16	-0.04	0.08
N (2004)	387	312	332	347	308	1686
Avg. change (2004-2001)	0.10	0.18	0.26	0.14	0.15	0.16

4.10.2 Women's assets

Ownership of some assets is gender-specific. The most common assets owned by women are trunks and *makolle*, which are owned by 45 and 83 percent of women in 2004 and 33 and 82 percent of women in 2001. Only a very small percentage of women own more expensive assets such as televisions, fans, bicycles, motorcycles, and cars (less than 1 percent). Using the simple unweighted asset index, we see in Table 4.50 that the average asset index increased in all five groups of communities, although by a smaller amount than was observed at the household level (Table 4.48). The only significant

[29] Although the average increase in the LMC communities is larger, it is not statistically significant because it has a higher standard deviation.

double-difference in this index for women is the significantly greater increase in the Linkages Only communities when compared to the Control communities. This result is puzzling, as it is difficult to identify any aspects of the Linkages program that would lead to increased asset ownership by women, or to explain why no increase was observed in the communities that had microcredit and/or the food-based intervention in addition to Linkages.

Table 4.50—Assets owned by women, as measured by unweighted asset index

	Control		Linkages		LMC	LFB	LMCFB	Total
Average in 2001	1.60		1.42		1.51	1.50	1.46	1.50
N (2001)	1115		889		1139	1085	955	5183
Average in 2004	1.70		1.69		1.71	1.72	1.60	1.69
N (2004)	1453		1170		1422	1371	1312	6728
Avg. change (2004-2001)	0.10		0.27		0.21	0.22	0.14	0.19
Linkages only	0.17	*						
Linkages+MC	0.10		-0.06					
Linkages+FB	0.12		-0.05		0.02			
Linkages+MC+FB	0.03		-0.13		-0.07	-0.09		

The results for women's assets are similar when the weighted asset index is used (Table 4.51), but with some subtle differences. First, the average weighted asset index declined in LFB communities. Second, the increase in the Linkages communities is significantly greater than the changes in all the other groups except the LMC communities.

Table 4.51—Assets owned by women, as measured by weighted asset index

	Control		Linkages		LMC	LFB	LMCFB	Total
Average in 2001	-0.04		-0.07		-0.07	0.09	-0.01	-0.01
N (2001)	1115		889		1139	1085	955	5183
Average in 2004	-0.03		0.03		-0.01	0.06	-0.01	0.01
N (2004)	1453		1170		1422	1371	1312	6728
Avg. change (2004-2001)	0.00		0.11		0.06	-0.04	0.01	0.02
Linkages only	0.10	*						
Linkages+MC	0.05		-0.05					
Linkages+FB	-0.04		-0.14	*	-0.09			
Linkages+MC+FB	0.00		-0.10	*	-0.05	0.04		

4.11 Education and literacy

Although education is an important part of UNICEF's mandate, to our knowledge none of the components of the ICBD program in Savelugu-Nanton focused on formal education. Therefore, we do not expect to see significant changes in indicators of formal education related to the ICBD program interventions. Nevertheless, we examine educational indicators in this section because levels of literacy and education are low in Savelugu-Nanton, and this can be an important constraint that limits the success of program interventions. The findings with regard to education can also help in interpreting the results for other outcomes. In addition, because the 2001 and 2004 Savelugu-Nanton

surveys investigated educational levels, we thought it worthwhile to document the findings here.

4.11.1 Education literacy of the head of household

We first examine the information about the head of the household. We would expect few changes in these indicators over the three year interval between surveys, as household heads are adults who have typically completed their studies (if they ever attended school) several years ago. In general, we expect a slow improvement in literacy and educational levels over time, as younger generations (who generally have better educational opportunities than their elders) move up to become heads of households. In this same context, it should also be remembered that the education of the head of household is often not the most relevant measure, as it is often other adults in the household who are most responsible for income generation, child care, and overall management of the household.

The surveys asked if the respondent could read at least a simple sentence.[30] As shown in Table 4.52, the literacy rate among household heads in Savelugu-Nanton is approximately 20 percent. In each of the survey years, the percentage was highest in the LFB communities and lowest in the LMCFB communities. It is somewhat surprising that we see several significant double-differences. The increase in the reading rate for household heads in the Control group was significantly greater than that in LMC communities, where the percentage actually declined between 2001 and 2004. The average increase in the LFB communities was also significantly greater than that observed in the Linkages Only and LMC communities.

Table 4.52—Percentage of household heads who can read

	Control		Linkages		LMC		LFB	LMCFB	Total
Average in 2001	15.84		17.41		20.27		21.21	12.65	17.80
N (2001)	344		276		332		316	275	1543
Average in 2004	22.79		16.94		17.18		26.11	15.01	20.13
N (2004)	387		314		332		345	308	1686
Avg. change (2004-2001)	6.95		-0.47		-3.09		4.89	2.36	2.32
Linkages only	-7.42								
Linkages+MC	-10.04	*	-2.62						
Linkages+FB	-2.06		5.36	*	7.98	*			
Linkages+MC+FB	-4.59		2.83		5.45		-2.53		

The percentage of household heads who can write in any language is slightly lower than the percentage that can read. The only significant double-difference is the increase in the LFB communities relative to the LMC communities.

[30] In 2001, a respondent was asked if he or she could read in any language. If he or she responded affirmatively, they were then asked to read a simple sentence from a sheet of paper (which had sentences in English, Dagbani, and Arabic). They were only recorded as being able to read if they could read the sentence. In an effort to reduce the length of interviews in 2004, respondents did not have to read a sentence, so it is possible that the estimates of ability to read in 2004 are somewhat inflated for all communities and all household members.

Table 4.53—Percentage of household heads who can write

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	12.07	14.15	15.45	17.23	9.80	14.03
N (2001)	344	276	331	317	275	1543
Average in 2004	17.83	16.52	14.82	24.94	12.30	17.84
N (2004)	387	314	332	345	309	1687
Avg. change (2004-2001)	5.76	2.37	-0.63	7.71	2.49	3.81
Linkages only	-3.38					
Linkages+MC	-6.39	-3.00				
Linkages+FB	1.95	5.34	8.34	*		
Linkages+MC+FB	-3.27	0.12	3.12	-5.22		

Less than 10 percent of household heads ever attended primary school, indicating that many of those who learned to read or write must have learned to do so outside the formal school system, such as Koranic school, literacy classes, or informal education (Table 4.54). As expected, with the advancement of younger generations, the percentage of household heads who attended primary school increased slightly between 2001 and 2004, although the rates remain extremely low, and none of the double-differences are significant.

Table 4.54—Percentage of household heads who attended primary school

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	4.36	5.91	5.39	8.03	4.47	5.79
N (2001)	344	276	332	317	275	1544
Average in 2004	9.64	8.48	6.77	11.58	8.44	9.16
N (2004)	387	314	331	345	308	1685
Avg. change (2004-2001)	5.27	2.57	1.38	3.56	3.96	3.37

4.11.2 Education and literacy of primary caregivers

As noted in the report of the 2001 survey, women's education in Savelugu-Nanton is desperately low (Simler et al. 2003). The 2004 survey showed small improvements in all five groups of communities. As with the heads of households, this is in line with expectations, as most (probably all) of the primary caregivers had completed their education several years ago, so any improvement is likely to come from a younger generations that had more schooling moving into the childbearing years. As seen in Table 4.55 through Table 4.57, this increase is very modest. In 2004 the literacy rate among primary caregivers is less than 3 percent, and only about 4 percent had ever attended any primary school. There are no statistically significant double-differences for any of the primary caregivers' educational indicators.

Table 4.55—Percentage of primary caregivers who can read

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	1.72	1.36	0.92	1.85	1.18	1.44
N (2001)	345	280	333	320	274	1552
Average in 2004	2.68	2.77	2.97	2.78	4.18	3.02
N (2004)	381	309	331	344	305	1670
Avg. change (2004-2001)	0.96	1.41	2.05	0.93	3.00	1.58

Table 4.56—Percentage of primary caregivers who can write

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	1.42	1.21	0.60	1.05	0.48	0.97
N (2001)	345	281	333	320	274	1553
Average in 2004	2.42	1.95	2.32	3.17	2.52	2.51
N (2004)	381	309	331	344	305	1670
Avg. change (2004-2001)	0.99	0.75	1.72	2.12	2.04	1.54

Table 4.57—Percentage of primary caregivers who attended primary school

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	1.74	2.08	1.88	2.26	1.94	2.00
N (2001)	345	281	332	320	274	1552
Average in 2004	4.10	3.63	3.49	4.55	6.41	4.39
N (2004)	381	309	331	342	305	1668
Avg. change (2004-2001)	2.36	1.56	1.61	2.29	4.47	2.39

4.11.3 Children's enrollment rates

In contrast to heads of household and primary caregivers, who are adults who have usually completed their education, larger increases are expected in educational indicators for children, albeit not as a result of the interventions being evaluated in this report. Although education indicators among children in Savelugu-Nanton are much better than they are among their adult counterparts, they are still low, and among the lowest in Ghana. We briefly examine children's schooling rates in this section to give an idea of expectations for adult literacy and education levels in the next generation.

As Table 4.58 shows, enrollment rates of children 6–18 years old ranged from 39 to 46 percent in 2001. These rates increased uniformly in all five groups of communities, registering increases of 5 to 7 percentage points. Enrollment rates among boys in this age group are above 50 percent in each of the five groups of communities, and approximately 60 percent in the Control, Linkages Only, and LMC communities (Table 4.59). Enrollment rates among girls increased by roughly the same amount during this period, so that girls' enrollment continues to trail boys' enrollment by a significant margin. As seen in Table 4.60 enrollment rates for girls 6–18 years old are approximately 40 percent in all five communities.

As the increases in enrollment rates are attributable to relatively broad efforts, and not to programs specific to the Savelugu-Nanton ICBD program, it is not surprising that there are no significant double-differences for any of the education indicators in this age group.

Table 4.58—Percentage of children 6–18 years old enrolled in school

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	45.56	45.69	45.66	41.75	39.37	43.55
N (2001)	1282	954	1236	1230	1026	5728
Average in 2004	51.16	51.32	51.69	48.50	44.34	49.38
N (2004)	1554	1073	1367	1316	1377	6687
Avg. change (2004-2001)	5.60	5.63	6.03	6.76	4.98	5.83

Table 4.59—Percentage of boys 6–18 years old enrolled in school

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	56.14	51.71	52.59	48.80	48.43	51.50
N (2001)	739	514	686	654	580	3173
Average in 2004	59.48	59.84	60.19	55.19	50.59	56.99
N (2004)	817	605	718	711	741	3592
Avg. change (2004-2001)	3.34	8.13	7.60	6.39	2.16	5.49

Table 4.60—Percentage of girls 6–18 years old enrolled in school

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	30.98	38.29	37.03	33.55	27.75	33.61
N (2001)	542	438	545	573	445	2543
Average in 2004	41.92	40.50	42.26	40.78	37.05	40.56
N (2004)	737	468	649	605	636	3095
Avg. change (2004-2001)	10.95	2.22	5.23	7.23	9.30	6.95

4.12 Health and hygiene

4.12.1 Index child's health and hygiene

The surveys in 2001 and 2004 asked several questions about health and hygiene of the index child and the primary caregiver. This evaluation report will not explore those findings in detail, but will touch on some of the information regarding the prevalence and treatment of diarrhea. Diarrhea is often associated with the introduction of complementary foods, as the child is potentially exposed to many more pathogens than when she or he is exclusively breastfeeding. Diarrhea is of interest because it can be a cause of growth faltering. It is also useful to examine the results on diarrhea because of evidence from past surveys that some primary caregivers do not give certain micronutrient-rich foods (e.g., mangoes) to children less than 12 months because they perceive them as causes of diarrhea. Finally, diarrhea is of particular interest in Savelugu-Nanton because many households and communities lack access to safe water.

Table 4.61 presents the percentage of index children who were reported (by their primary caregiver) as having had at least one episode of diarrhea during the two weeks prior to the household interview. The first thing one notices is that the incidence of reported diarrhea increased in all five groups of communities. The double-difference estimates of the relative increases between the groups shows some puzzling patterns. For example, diarrhea prevalence increased most sharply in the Control and LMC communities, while the increase was smallest in the LMCFB and Linkages Only communities. The significant double-differences are shown in Table 4.61, but it is difficult to ascribe the pattern observed to any of the interventions. For example, if the behavior change communication messages of the Linkages program helped limit the increase in diarrhea in the Linkages Only communities (and possibly the LMCFB group), why was that effect not seen in the LMC communities? Or, if it was the food-based intervention that accounts for the differing performance in the LMC and LMCFB communities, why are the results in the LFB communities not stronger?

Table 4.61—Percentage of index children who had diarrhea in the preceding two weeks

	Control		Linkages		LMC		LFB	LMCFB	Total
Average in 2001	38.96		46.74		41.04		42.49	47.92	43.22
N (2001)	352		283		336		324	283	1578
Average in 2004	53.36		51.25		54.85		49.71	48.73	51.55
N (2004)	387		314		332		346	309	1688
Avg. change (2004-2001)	14.41		4.51		13.81		7.22	0.81	8.32
Linkages only	-9.90	**							
Linkages+MC	-0.60		9.30	*					
Linkages+FB	-7.18		2.71		-6.59				
Linkages+MC+FB	-13.60	**	-3.70		-13.00	*	-6.41		

Primary caregivers were also asked in both surveys how they treated the index child when she or he had diarrhea, including questions about health-seeking behavior and feeding practices. In one question, primary caregivers were asked if they gave the index child more fluids than usual, about the same amount of fluids as usual, or less fluids than usual when the child had diarrhea. It is important to take more fluids during diarrhea to prevent dehydration. The responses were scored 1 for less fluids, 2 for the same amount of fluids, and 3 for more fluids. The results from the two surveys are presented in Table 4.62. The scores decreased in all of the community groups except for the Linkages Only communities, indicating that fewer primary caregivers are following the recommended practice of giving the child more fluids during episodes of diarrhea. The worsening of practices was most pronounced in the LMC, LFB, and LMCFB communities, which had shown the best practices (on average) in the 2001 survey. In the 2004 survey these three groups of communities went from having the best average scores to the worst average scores, with several significant double-differences registered. Unfortunately, we do not have any explanation for this deterioration in practices over time, especially in the communities that were involved in the food-based micronutrient and microcredit interventions. (The analysis was also repeated, but looking at the change in the percentage of primary caregivers who responded “less fluids” or “more fluids,” rather than the changes in the average score, and those results are consistent with the results in Table 4.62.

Table 4.62—Average score for amount of fluids primary caregiver gave to index child during episode of diarrhea

	Control		Linkages		LMC		LFB	LMCFB	Total
Average in 2001[a]	1.62		1.58		1.84		1.80	1.88	1.75
N (2001)	137		131		137		137	134	676
Average in 2004[a]	1.56		1.59		1.52		1.55	1.53	1.55
N (2004)	205		163		181		176	150	875
Avg. change (2004-2001)	-0.05		0.00		-0.32		-0.25	-0.35	–0.19
Linkages only	0.06								
Linkages+MC	-0.27	*	-0.32	*					
Linkages+FB	-0.20		-0.25	*	0.07				
Linkages+MC+FB	-0.30	**	-0.35	**	-0.03		-0.10		

[a] The primary caregiver’s responses were coded as follows: 1 = less fluids than usual, 2 = about the same amount of fluids as usual, and 3 = more fluids than usual (which is the recommended practice).

Primary caregivers were asked a similar question about how much food they gave the index child when recovering from an episode of diarrhea. Because food intake and absorption declines during diarrhea, it is recommended to feed the child more food after the diarrhea stops. The same scoring system was employed, and the results are shown in Table 4.63. Overall the scores are much higher than observed for the practice of giving extra fluids during diarrhea, with a majority of primary caregivers in all five groups of communities reporting that they give the child more food after an episode of diarrhea. The average score increased slightly in the LMCFB communities, and declined slightly in the Control, Linkages Only, and LMC communities, but none of the double-differences are statistically significant.

Table 4.63—Average score for amount of food primary caregiver gave to index child after an episode of diarrhea

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001[a]	2.81	2.84	2.84	2.75	2.69	2.79
N (2001)	137	131	138	138	135	679
Average in 2004[a]	2.75	2.71	2.74	2.75	2.77	2.74
N (2004)	205	163	183	176	150	877
Avg. change (2004-2001)	-0.06	-0.14	-0.10	0.00	0.07	–0.04

[a] The primary caregiver's responses were coded as follows: 1 = less food than usual, 2 = about the same amount of food as usual, and 3 = more food than usual (which is the recommended practice).

4.12.2 Sources of drinking water

Improving access to safe supplies of drinking water is an on-going effort in Savelugu-Nanton. Although that effort is not directly related to the interventions evaluated here, safe water is clearly an important input to a healthy diet. Survey households were asked about their primary and secondary sources of drinking water. We classified public standpipes, boreholes, and protected wells as "safe" sources of drinking water, with other sources (such as unprotected wells, rivers, streams, ponds, dugouts, and dams) as unsafe sources. As seen in Table 4.64, in 2004 there was a large increase in the percentage of primary caregivers reporting that their primary source of drinking water was a safe source, although the percentage declined in the LFB communities. That none of the double-differences—especially, for example, that between the LMC and LFB communities—is surprising and merits further investigation. Although a large percentage of households still do not have a safe source as their primary source of drinking water, it is unfortunate that the improvement seen in Table 4.64 does not appear to be reflected in the results on children's nutritional status, diarrhea prevalence, and other indicators.

Table 4.64—Percentage of households with safe primary source of drinking water

	Control	Linkages	LMC	LFB	LMCFB	Total
Average in 2001	20.23	22.06	23.53	36.24	21.96	25.54
N (2001)	352	283	336	324	283	1578
Average in 2004	44.26	40.64	62.19	32.05	53.43	45.32
N (2004)	383	314	332	346	309	1684
Avg. change (2004-2001)	24.03	18.57	38.65	-4.19	31.47	19.78

4.13 Summary of findings across different indicators

After approximately 40 pages discussing the findings presented in over 60 tables, this seems a good point to step back and reflect on the results more broadly. Undoubtedly, the dominant impression one draws from the analysis is the apparent lack of detectable impact of the interventions. The majority of the comparisons showed no significant difference between any of the groups. This is especially striking when it is recalled that the statistical testing procedure employed did not adjust for making multiple pairwise comparisons for each outcome variable. As such, the significance levels presented in this section are overestimated, by nearly a factor of ten. To put it another way, adjusting for multiple comparisons would render all of the differences marked with one asterisk as insignificant. Those marked with two asterisks would remain significant at least at the 10 percent level, and possibly higher (i.e., the 5 percent or 1 percent level of significance).

Furthermore, it bears noting that some of the significant differences that are observed are less systematic than one would expect. For example, in some instances the LFB group showed significant improvements, but not the LMCFB group which had the same food-based micronutrient intervention plus a microcredit intervention. In other cases, one of the four ICBD intervention groups appeared to significantly improve when compared to another ICBD intervention group, but not when compared to the Control group.

Part of the lack of measured impact may be attributed to the "contamination" of the control communities described in section 3.4. The introduction of the interventions in the control communities prior to the follow-up survey in 2004 most likely diminished the measured differences between communities in outcomes. This was probably most problematic for the Linkages component, which was introduced in all communities in the district, and which also relied in part on mass media for dissemination—radio broadcasts reach control and intervention communities alike. At the other end of the spectrum, control group contamination was probably not a significant factor for the micronutrient food-based intervention, as it was not implemented beyond the original 26 communities selected for the evaluation. The microcredit intervention occupies a middle ground with respect to contamination, as the GDCP microcredit program was introduced in some, but not all, of the control communities in 2003 and 2004.

Control group contamination or technical issues of statistical testing should not obscure the very troubling finding that the absolute levels of change are often negligible. For example, for most groups the questions about caregivers' knowledge of micronutrient-rich foods and treatment of diarrhea showed steps backwards; this is certainly more disconcerting than finding that an intervention group did not improve more than a control group that had also improved.

As a quick summary of the findings presented in this section, we highlight the following.

- The apparent low levels of participation in the interventions, or even awareness of the interventions, discussed in section 4.1 are most likely an important reason behind the low levels of average impact observed.

- The lack of improvement in anthropometry is perhaps understandable, given the short time between the surveys (3 years), the short time since the implementation of the interventions (approximately 2 years, sometimes less), and the numerous other constraints that exist.

- More difficult to explain is the apparent lack of impact on many of the child care and feeding practices that could ultimately lead to improvements in nutritional status. The interventions had virtually no impact on improving rates of exclusive breastfeeding, timely introduction of complementary foods, or improving dietary diversity. Except for a greater percentage of primary caregivers in the LMCFB group being able to identify a food that improves eyesight, caregivers' knowledge of micronutrient-rich foods did not improve in any of the communities.

- There was some evidence of improvement in children's consumption of micronutrient-rich foods, but with the somewhat perverse result that the strongest impact was seen in the LMC communities, which did not have a food-based micronutrient component. A similarly peculiar result was observed in the treatment of diarrhea, in which the Control group performed better than any of the ICBD intervention groups.

- There are some positive results that emerge. The GDCP microcredit program did appear to increase the use of credit in the communities where it was introduced in 2002 (the LMC and LMCFB groups). The production of orange-fleshed sweet potato increased in the food-based micronutrient intervention communities (LFB and LMCFB), although because of the timing of the survey, it was not possible to determine if the sweet potatoes were being given to young children.

5. Interpreting the survey results in the context of the interventions

In this section we consider the context of the interventions and their implementation, adding an important qualitative component to the largely quantitative approach presented in section 4. Unfortunately, information on the implementation of the interventions is relatively scarce, but we are able to draw from the operations research that the NMIMR team conducted on some aspects of the food-based micronutrient intervention, and the few reports that could be collected on the implementation of the production elements of the food-based intervention and GDCP microcredit program. We will also draw upon responses to questions about the interventions that were included in the 2004 survey to try to fill this gap to some degree. Among the areas addressed are the timing of the interventions in Savelugu-Nanton communities, participation levels in the interventions, and some comments on the sustainability of the interventions.

5.1 Timing of intervention implementation

One of the factors that undoubtedly plays an important role is the timing of the implementation of the interventions. Particularly important is the length of time between the introduction of the intervention and the time of the impact evaluation. Most of the intervention components involve some degree of behavior change, which always takes time, but especially when the subject is something as deeply ingrained as food habits. Food production, processing, and consumption patterns tend to evolve slowly over time. Because of this the food behavior changes in the interventions were deliberately designed to be incremental changes to existing behaviors, rather than radical departures. Nevertheless, it takes time for these changes to be accepted, adopted, and practiced.

As per the original project proposal (Ruel, Levin and Brouwer 2000) the interventions were to begin in September 2001, immediately following the completion of data collection for the baseline survey. Many of the early ICBD operations (introductions, development of Community Action Plans, etc.) did indeed commence around that time. However, there were significant delays in the implementation of several components of the ICBD program. For example, the Linkages behavior change communication program was not fully operational in Savelugu-Nanton District until April 2002, with the intervention introduced in most communities in August 2002 (Armar-Klemesu and Zakariah 2003). Similarly, GDCP did not start disbursing microcredit until May 2002.

The food-based micronutrient intervention was especially delayed, because at the time of completing the baseline survey fieldwork the design of the food-based micronutrient intervention had not been developed yet. There are several reasons for this, the most prominent being that food-based micronutrient strategies were a new area for UNICEF. Whereas Linkages and GDCP were established programs that had been successfully implemented elsewhere, the food-based micronutrient intervention was completely new to all parties involved. Timely design of the food-based intervention was hampered by several factors, with a change in key nutrition staff in UNICEF's Tamale office being especially important. Much of the familiarity with the objectives and planning of the food-based intervention was lost with the departure of the outgoing nutrition officer, and taking on an unfamiliar new initiative with a still undefined

structure was an enormous challenge for a new nutrition officer stepping into an already challenging position. Related to this transition, there were misunderstandings between UNICEF and IFPRI about the allocation of responsibilities for design and implementation of the food-based intervention, which further delayed its initiation.

With these delays, the food-based micronutrient intervention was not completely designed until the second quarter of 2002. The introduction of the porridge enrichment element began in April 2002, but did not reach some communities until November 2002 (Armar-Klemesu and Zakariah 2003). The solar dryers were not distributed to the communities until October 2002 (Abukari 2000b), and the first distribution of orange sweet potato vines and seeds for leafy green vegetables did not take place until August 2002 (Armar-Klemesu and Zakariah 2003).

Even with decision to postpone the follow-up impact survey to 2004[31], the slow start of the interventions means that they were in place in Savelugu-Nanton for only 19–26 months before the follow-up survey began in June 2004. This is an extremely short time frame in which to expect perceptible changes in outcome indicators. The low initial position of these indicators in Savelugu-Nanton (see UNICEF 2000 and Simler et al. 2003) cuts two ways in this regard. On the one hand, it is sometimes easiest to see changes from a low base. For example, if only 10 percent of caregivers follow a recommended practice, it requires a smaller absolute change in behavior to double that rate to 20 percent than it would to double an initial rate of 45 percent to 90 percent. On the other hand, the low level of resources such as potable water supplies, public sanitation, maternal education, and household incomes provides a very weak springboard for the launching of new initiatives. Relieving some constraints to better child nutrition may show little impact if other binding constraints remain.

There is another aspect to the timing of the interventions that bears noting here. In many ways it is the other side of the coin of the intervention delays outlined above. From an evaluation standpoint, it could be argued that some of the interventions were introduced too early in some communities. That is, the grouping of intervention packages shown in Table 2.1 became blurred, as communities became involved in interventions in addition to those shown in the table. For example, the Linkages program was introduced in the Control communities before the follow-up survey was conducted. Similarly, the GDCP microcredit intervention was extended to communities in Control, Linkages Only, and LFB communities before the follow-up survey was done. The sole exception to this practice appears to be the food-based micronutrient intervention, which was not extended beyond the original 26 communities shown in the LFB and LMCFB columns in Table 2.1.

From an evaluation perspective it would have been preferable to delay introduction of additional interventions until after the conclusion of the follow-up survey. As noted in section 3, the measure of the average impact of a program is diminished if the program

[31] The original project proposal and agreement between UNICEF and IFPRI called for the follow-up survey to be conducted in mid-2003. In late 2002 it was mutually agreed that the interventions had been in place such a short time that evaluating them in 2003 would not be worthwhile, and that the follow-up survey should be conducted in 2004.

also affects the control group. That said, from a practical and ethical perspective, the introduction of additional interventions beyond the initial allocation is understandable. The justification for not introducing all interventions in all communities at the outset was based on a lack of resources to do so. As time passes, the resource constraint was eased, and program providers and beneficiaries naturally want to extend the programs more widely. In that light, these comments should not be taken as criticism for extending the interventions more widely, but rather as a partial explanation for why the measured impact is likely to be smaller than the true impact.

5.2 Participation in interventions

As noted in section 4.1, less than one-half of the households or primary caregivers surveyed in the four groups of ICBD intervention communities reported any participation in the interventions. Participation was even lower for some measures, such as primary caregiver participation in GDCP microcredit (less than 25 percent in the LMC and LMCFB communities), planting of orange-fleshed sweet potatoes (about 25 percent in the LFB and LMCFB communities), attendance of a Mother-to-Mother support group meeting in the past three years (about 25 percent in the four ICBD groups), and attendance of a Mother-to-Mother support group meeting in the preceding three months (less than 10 percent). Only about 20 percent of households in the food-based micronutrient communities (LFB and LMCFB) reported attending extension meetings about orange sweet potatoes, and only 25 percent in those communities planted orange sweet potatoes in 2003. The low participation rates impose a ceiling, or upper bound, on the amount of average impact that can be expected from the interventions.

Why was participation so low? Unfortunately, we do not have a great deal of information to answer that question. At the risk of stating the obvious, two important reasons appear to be lack of awareness of the interventions and lack of time. Although there are various media available that can be used to effect behavior change communication, face-to-face meetings are usually the most powerful. This is especially so at the early the stages of communication, when demonstration is important. In the 2004 survey, the most common reasons given for not attending extension meetings—about porridge enrichment, orange-fleshed sweet potatoes, Mother-to-Mother support groups, or others—were that (a) there were no meetings, (b) the respondent was not aware of meetings, (c) the respondent had traveled outside the community on the dates of the meetings, and (d) the respondent was too busy to attend the meetings. Clearly reasons (a) and (b) overlap; given that there were meetings in each community, responding that there were no meetings indicates that the respondent was not aware of the meeting. There is a similar overlap with reasons (c) and (d), as travel is generally for a purpose, and one that in this case was given higher priority than meeting attendance.

The interventions were generally designed to be attractive to the communities, lively, and participatory. The report of the porridge enrichment sessions in Armar-Klemesu and Zakariah (2003) is an example of one participatory approach that made good use of visual aids, food tasting, cooking, singing, and other methods to engage mothers of young children. The porridge enrichment sessions also included a “networking” component, by which those who attended were encouraged to tell at least two friends what they had learned, and bring them to the next session. Yet almost one-half of primary caregivers in

the food-based intervention communities reported not knowing about porridge enrichment, and a large proportion of those that did report knowing about porridge enrichment did not attend any meetings. The results in Table 4.26 show that nearly half of primary caregivers did not know that various micronutrient-rich foods could be added to porridges, so clearly these mothers could benefit from the intervention.

Many of the communities are very small, so it is somewhat surprising that members of the community could not be aware of some of these initiatives. More extensive publicity about the interventions and related meetings could help to increase outreach and attendance, but with the limited information available it is difficult to be more specific than that. It is equally difficult to suggest solutions to overcoming the "too busy" reason for not participating in the interventions. Responsibilities for childcare, cooking, farming, and fetching wood and water fill the day, so the claim that someone is too busy to get involved in the intervention is credible, no matter how beneficial that intervention might be. Perhaps an important message from the responses is that there is considerable need and demand for labor-saving interventions, and unfortunately it would be hard to characterize any of these interventions as labor-saving.

As a side note, one potentially productive area for further examination of the survey data would be to examine the characteristics of those who participated in the interventions. Did they come from larger households, or wealthier households, or better educated households? Were they in communities where there was easier access to water and fuel? In addition to being useful in its own right, identification of such characteristics could help make it possible to analyze the differential impact of the interventions for participants and nonparticipants, which would provide a rough estimate of the potential impact of the current interventions (as opposed to the realized average impact reported here).

5.3 Sustainability and implementing institutions

We would like to conclude the discussion of the context of the interventions with a few words about the sustainability of the interventions. As the interventions have been in place for less than three years, it is too early to provide a definitive picture concerning the long term sustainability of the interventions. Nevertheless, there are some observations on the implementation of the interventions that may provide insight into this area, and raise questions that might help focus efforts on making interventions self-sustaining.

The ICBD model depends to a great degree on local organizations to implement program interventions, and the experience in Savelugu-Nanton has been consistent with this. The Linkages program is funded by the United States Agency for International Development (USAID) and is managed by the Academy for Educational Development (AED), but it works in partnership with local organizations to implement the behavior change communication strategy. In Ghana the main partners have included the Ghana Health Services, District Health Management Teams, and Ghana Red Cross, among others. GDCP is also a local program with international connections: it receives some support from Danida and is jointly run by the Ghana-based Ghanaian Danish Communities Association (GDCA) and the Denmark-based Ghana Friendship Groups. The food-based micronutrient intervention was implemented by NMIMR and UDS, each

of which works with local organizations (such as the District Health Management Team) and receives support from a mixture of Ghanaian and international sources.

AED concluded its Linkages operations in Ghana in late 2004. The intent was to develop a strong Ghana-based network of governmental and nongovernmental organizations to continue implementing the work that had started. At this stage we do not have sufficient information to assess whether or not the transition going smoothly. We have even less information concerning GDCP and its planned time horizon for operating the microcredit program in Savelugu-Nanton and elsewhere in northern Ghana.

NMIMR and UDS are in much different positions than Linkages or GDCP. Both are academic institutions, with NMIMR focusing on medical research and UDS focusing on a mix of teaching, research, and extension in the agricultural and social sciences. As such, they are somewhat unlikely candidates for the implementation of development projects. Their involvement in the implementation phase grew largely out of their involvement in the design of the food-based micronutrient intervention, an academic and practical interest in seeing the intervention put into action, and a genuine interest in the welfare of the communities. It remains to be seen, however, if the efforts can be sustained, especially as their attention returns to the more academic functions that are central to their missions. These comments should not be interpreted as denigrating NMIMR or UDS. On the contrary, they were identified as suitable implementers of the new food-based initiative, and stepped in admirably. However, the prospect of academic institutions continuing to carry out project implementation activities is a pertinent question that should be examined carefully.

NMIMR completed its implementation efforts in 2003. It had worked with the DHMT in an effort to integrate the messages of porridge enrichment, consumption of micronutrient-rich foods, and solar drying into DHMT's existing repertoire. It remains to be seen how successful this integration has been. It was made somewhat more difficult by the departure of the DHMT's nutrition officer for advanced studies in 2003. Indeed, it is possible that the porridge enrichment element of the food-based intervention showed very little impact in the 2004 survey because that effort had already peaked in 2003. In that case, newer mothers might not have participated in that intervention and would not be familiar with micronutrient-rich foods that could be added to porridges. Meanwhile, for those who did participate, the information would not be as fresh.

UDS is in a somewhat stronger position to continue its role because of its greater proximity to Savelugu-Nanton, its closer involvement in activities in Northern Region, and its extension function. Even so, implementing and maintaining such a program appears somewhat peripheral to its mandate, so its continued involvement is likely to depend on continued funding from outside sources (such as UNICEF, which supported the initial effort) and the availability of UDS faculty and staff to participate in the program. This, too, remains to be seen.

6. Conclusions

In this section we will attempt to summarize the main findings of the evaluation, highlighting areas where the interventions succeeded or did not succeed at meeting their objectives. Although the discussion is retrospective in the sense of reviewing experiences of the past four years, it also aims to be forward looking and indicate ways in which the interventions might be refined, or substantially restructured, to achieve greater success. It will also identify areas for further investigation as either more time or more information become available.

6.1 Assessing the intervention process

Since it was first introduced, the ICBD approach has emphasized not only getting results, but the participatory and empowering process by which programs are developed. The ICBD program in Savelugu-Nanton largely followed the approach that was used in other districts in the Northern Region. Some modifications were made to facilitate the introduction of a new intervention for UNICEF, the food-based micronutrient strategy. In addition to the new development activities that formed the food-based intervention (e.g., training on porridge enrichment, solar dryers, production of orange-fleshed sweet potatoes) there was a handful of ancillary activities that accompanied the new intervention and the evaluation. Examples of such ancillary activities are the balloting process to determine which interventions would be allocated to which communities, and the extensive household and community surveys that were conducted in 2001 and 2004.

Although UNICEF and its partners are well-respected and welcomed in the communities in Savelugu-Nanton, an important finding from the surveys is the apparent low participation rate in the ICBD interventions. This was discussed in greater detail in sections 4.1 and 5.2, but it bears repeating. It is possible that low participation rates are attributable to the interventions being in the early stages of implementation, and still not tightly integrated in the communities. On the other hand, new interventions often draw many participants precisely because they are new, with participation tapering off as time passes and some community members lose interest.

Rather than wait to see which of these alternatives will play out in Savelugu-Nanton it may be advisable to seek ways of increasing participation. That many respondents were reportedly not aware of various ICBD activities suggests that improved methods of notifying communities and ensuring that the information spreads throughout communities would be worthwhile. Attracting those respondents who did not participate because of competing time commitments is likely to be more difficult. Over the long term they will have more discretionary time as closer water sources are developed and more labor-saving technologies are adopted, but in the short term it will be necessary to demonstrate more clearly that participation is worth their time. Those who participated in the interventions indicated strongly that they were useful. Although this could be a manifestation of classic Ghanaian politeness, there is no reason to doubt the positive responses. As noted earlier, the surveys can provide additional information about the characteristics of participants and nonparticipants that could be used to help increase participation rates.

As discussed in section 5.1, the short time that the interventions were in place prior to the evaluation increases the difficulty of detecting significant improvements in outcome indicators. Even if all of the intervention components had been launched promptly in September 2001 it is very demanding to expect measurable impact by the time of the follow-up survey less than three years later. Coming from the other direction, the ability to measure impact was also hampered by the deviation from the original evaluation design shown in Table 2.1, i.e., the relatively early introduction of intervention components such as microcredit in the Control and LFB communities. The practical and ethical reasons for this are understood and appreciated, but nonetheless it reduced the power of the evaluation.

It is especially important to note the pilot nature of the food-based micronutrient intervention, which was a new initiative. Although this meant an unusually large amount of resources were directed at launching the intervention, many of those resources were required strictly because it was a new program that was still in its formative stages. It can be expected that future efforts to implement food-based micronutrient programs in other areas will take less time and money to get off the ground. The approaches used in Savelugu-Nanton to identify appropriate entry points for the food-based strategy can be applied elsewhere with modest modification, although it should not be expected that the specific components (solar drying, the particular foods added to enrich porridge, etc.) will be the same in every setting. For example, a food-based micronutrient strategy just a few hundred kilometers further south would probably give much more emphasis to red palm oil, an excellent source of provitamin A that is more widely available and a more integral part of the diet in central Ghana than it is in Savelugu-Nanton. In short, the experience in developing the food-based strategy in Savelugu-Nanton can be a useful model for developing such strategies elsewhere, but they will still require a large degree of customization to local agro-ecological conditions and food habits to arrive at an appropriate strategy for a particular area.

It is probably too early to assess whether the interventions have acquired the momentum to be self-sustaining. Of the three interventions examined, the GDCP microcredit is probably the least cause for concern, as to the best of our knowledge GDCP is continuing operations in Savelugu-Nanton for the foreseeable future. Both Linkages and the food-based micronutrient intervention have marked important organizational transitions in the past year or two that may have implications for their continued effectiveness. The Linkages program in Ghana ended in September 2004, as was originally scheduled. Similarly, NMIMR's and UDS's contributions to the food-based intervention were planned for finite periods, with NMIMR staff departing Savelugu-Nanton in 2003, and UDS operating on a smaller scale than it was at the launch of the intervention in 2002. In each case the strategy was not for the implementing organization to simply drop operations and see if they would fly in the communities. Rather, conscious efforts were made to transfer skills to appropriate persons in Savelgu-Nanton District departments, nongovernmental organizations, community organizations, and community leaders. It would be wise to monitor the activity levels with regard to the interventions evaluated here in the coming years to assess the degree to which they have become integrated into the communities and become self-sustaining.

In discussing the process, one should not ignore the impact of turnover in both UNICEF and IFPRI. Staff mobility is inevitable, so it would be wrong to give more weight to individuals than to organizations. However, it would also be wrong to assume that individuals do not matter. Indeed, one of the important findings of recent studies of community-driven development efforts is that although ideas matter, key individuals can matter much more to the success of a program (see, for example, Mansuri and Rao 2004). The ideas for the food-based initiative came in large part from a few individuals, and many of these individuals left their organizations at early stages of the project. The only real constant was the Reverend Professor Saa Dittoh at UDS. Even though the staff who replaced the project's originators approached the challenge with professionalism and dedication, it would be hard to say that they were perfect substitutes for those who initiated the effort.

6.2 Impact on outcome indicators

The impact of the interventions on a wide range of outcome indicators could be characterized as disappointing. Even using an optimistic approach to testing for differences (that does not adjust for multiple comparisons) there are relatively few significant differences in the intervention communities. Moreover, some of the significant differences that are encountered are either not systematic or are outright counterintuitive.

The most positive results appeared in the expanded use of credit and the more widespread planting of orange-fleshed sweet potatoes. The percentage of households and the percentage of primary caregivers who received credit, from any source, were significantly larger in the communities where GDCP microcredit was introduced in 2002. Most of this expansion can be attributed to the GDCP credit facilities, especially in the case of credit used by primary caregivers. In this report we have only used broad indicators to examine credit use, and have not yet explored much of the richer information about credit use that is available in the survey data, such as activities that were funded by credit, amounts received, borrowers' perceptions about ease or difficulty of repayment, and so forth. This information could provide a more complete picture of the impact of the GDCP microcredit program, and credit more generally, in Savelugu-Nanton District.

Production of orange-fleshed sweet potatoes was almost non-existent in Savelugu-Nanton in 2001, but it increased substantially by 2004 in all five groups of communities, with the increases much larger in the communities that were involved in the food-based micronutrient intervention. This occurred despite logistical difficulties encountered in obtaining and distributing orange sweet potato vines in a timely manner. Unfortunately, because of the timing of the survey, it is not possible to say anything definitive about the consumption side of orange sweet potatoes: all of the preceding harvest had been depleted well before the survey in 2004. It is still unknown how much of this beta carotene-rich food has been added to the diet, for how many months of the year, and whether it is being given to young children. It is equally unknown if the crop's popularity will grow, or even be maintained, especially as the free distribution of planting material is phased out.

The results were not as favorable for almost all other outcome indicators. Detecting significance changes in children's anthropometry in a short timeframe is difficult. Although there was some evidence of LFB communities doing better on average than some other groups, the dominant finding is that none of the four intervention groups did better than the Control group with regard to children's anthropometry. Among mothers there was no improvement in the underweight prevalence, as measured by BMI.

Similarly, there was very little measurable impact on children's diets, especially with regard to increases in consumption of micronutrient-rich foods. Estimates of changes in dietary diversity were essentially identical across all five groups of communities, indicating no advantage for the food-based communities. Despite the Linkages program's attention to appropriate complementary feeding and the food-based intervention's messages about enriching porridge with micronutrient-rich foods the practice of porridge enrichment remained quite low. The only group of communities that showed evidence of children's increased consumption of target micronutrient-rich foods was the LMC group, in which children's consumption of eggs and red palm oil increased, even though these communities were not part of the food-based intervention.

Dietary change can also be a slow process, which is why the food-based intervention had two concurrent paths of action: one to increase knowledge about optimal care and feeding of young children, and the other to introduce new foods or combinations of foods that represented only incremental changes in existing dietary patterns. As noted above, the impact on dietary patterns was small at best. Unfortunately, education element did not produce much better results. On average there was little change in the primary caregivers' responses concerning nutritional knowledge, the lone exception being the LMCFB communities' significant improvement in identifying vitamin A-rich foods. On the care side, knowledge of proper child feeding during and after episodes of diarrhea did not show much improvement, and what improvement was seen was limited to the Control communities and the Linkages Only communities.

6.3 Future perspectives

At the time of drawing up the outline for this report, it was anticipated that this sub-section would discuss strategies for replicating the interventions in other locations and scaling up activities. Given the weak average program impact observed in the present evaluation, such a discussion now seems premature. It also would be premature to conclude that this set of interventions does not hold promise for improving the diets and lives of the participants. Some modification of the interventions may be necessary, and some further investigation may be required to determine the best way to alter the programs for greater success.

There are several steps that could be taken in the short term to help illuminate future directions. A first step could be to learn if program impact is different for participants and nonparticipants when participation is defined at the individual and household level, rather than at the community level as was done here. If there is evidence of positive impacts among participants, a logical subsequent step would be to determine if those who participated in the interventions are somehow different (richer, poorer, better educated, etc.) than those who did not participate. Following from that, it would next be useful to

re-assess the first step (differential impact between participants and nonparticipants) but controlling for different characteristics of participants and nonparticipants. It should be possible to investigate these issues with the data already collected in the surveys. It was not possible to include these deeper analyses in the current evaluation because of time limitations.

Further quantitative analysis of the survey data can only go so far. It will be equally important—or quite likely more important—to review the current state of the interventions from a more qualitative perspective, working with communities to gain a better sense of where the interventions have and have not resonated with community needs and interests. In the same context, it will be useful to see which elements of the interventions have taken hold and become self-sustaining, and to understand why.

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Appendix

This appendix presents some of the technical details of the methodology used to evaluate the ICBD interventions. It is intended to serve as an extension of the discussion in section 3. Section 3 outlines the general characteristics of the household and community surveys that are the basis of the quantitative analysis and introduces the intuition and logic behind the double-difference approach to estimating average impact. This appendix provides more detailed information on sampling methods and the calculation of sample weights. The second part of the appendix presents the double-difference methodology more formally, specifying the regression model that underlies the comparative analysis in the evaluation. The use of covariates as control variables and the incorporation of sample design information into the estimation are also discussed, as are issues related to adjustment of significance levels for multiple comparison tests.

Sample design

In one important sense, the sample design began to take shape when Savelugu-Nanton District officials, UNICEF, and other stakeholders selected the 50 communities that would be in the first round of the ICBD program in Savelugu-Nanton District. As noted in section 3, selection of the 50 communities was purposive, based on several loosely specified criteria. This effectively defined the two strata for the sampling design, with one stratum being the 50 selected communities and the other stratum being all other communities in the district. These can be called the ICBD and non-ICBD strata, respectively.

The various ICBD interventions were allocated and implemented at the community level, suggesting (although not necessarily requiring) a cluster-based sampling procedure in the ICBD stratum. In the non-ICBD stratum, logistical and cost considerations dictated a cluster-based sampling procedure as the only viable approach. In both the ICBD and the non-ICBD strata, each community is considered a cluster, or primary sampling unit. As households tend to be more homogeneous within a cluster than they are across the population at large, observations may be considered independent between clusters, but not within clusters. This affects the calculation of standard errors and confidence intervals, and also severely reduces the degrees of freedom for hypothesis tests.

With four different intervention packages spread across only 50 communities, random selection of clusters within the ICBD stratum was not an option. With an average of 12.5 clusters per intervention group it was necessary to include all 50 communities in the sample.[32] The non-ICBD stratum presented a more common sampling scenario, with many more communities available than were required to form a control group of communities. The communities in the non-ICBD stratum were listed in random order, and starting from the top of the list, communities were added to the sample until the number of households—and equally important, the number of communities—in the non-

[32] In the ICBD stratum, one community was excluded because it was mistakenly used as a site for the 2001 survey pretest, leaving a total of 49 surveyed communities in the ICBD stratum.

ICBD stratum was approximately equal to the number in each of the four intervention groups of the ICBD stratum.[33] Through this process, 15 communities were selected from the non-ICBD stratum to serve as the control group of communities.

Given the objectives of the interventions and evaluation, the population of interest is households with a child less than three years old, with the definition of the household based upon who eats with the index child and her or his primary caregiver. In both 2001 and 2004, a rapid census was carried out in each of the 64 sample communities (49 ICBD plus 15 non-ICBD), enumerating all compounds that had at least one child under the age of three. From the census listing, an index child was chosen in each compound. This was straightforward in cases where there was only one child under three. Where there was more than one child under three, the child whose first name came first alphabetically was selected.

The combination of small populations and large extended households in most communities in Savelugu-Nanton means that in many communities the number of households is not large. Naturally, the number of households with a child less than three years old is even smaller. The median number of such households per community is approximately 20, so it was decided to include all households in the 64 sample communities with a child less than three years old in the sample, with two exceptions. The exceptions were Diare and Zoggu, which are much larger communities with many more households. In each of Diare and Zoggu a subset of households was randomly selected to be in the sample.

The differential sampling rates (i.e., the proportion of selected households out of all eligible households) across communities implies different probabilities of selection for households in different communities. Left uncorrected, this would bias the survey results. Correction for the differential sampling weights is accomplished easily by constructing and using a set of sampling weights. The sampling weights have two components, an *ex ante* component and an *ex post* component. The *ex ante* component is simply the inverse of the probability of selection, conditional on the community being in the sample. For most households this takes the value one; for households in Diare and Zoggu it takes a value greater than one. The *ex post* component adjusts for non-response, e.g., households that are absent from the community for the entire survey period, move out of the sample community completely, or do not consent to the interview. This component is defined as the number of selected eligible households in the community divided by the number of households actually interviewed, and takes a value greater than or equal to one. The total sample weight is the product of the *ex ante* and *ex post* components. Mathematically, it may be expressed as follows.

(1) $$w_c = \frac{p_c}{s_c} \times \frac{s_c}{i_c}$$

[33] In three instances, communities selected from the list were not added to the sample. One community was found abandoned, one refused to participate, and one was excluded because of the risk of it being relocated to accommodate expansion of the Tamale airport. When this occurred we simply moved on to the next community on the list, continuing until the desired number of communities and households was reached.

where: w_c = the sample weight in community c,
p_c = the number of households with a child less than three years-old in community c,
s_c = the number of households selected to be interviewed in community c,
i_c = the number of households interviewed in community c, and
$p_c \geq s_c \geq i_c$.

All of the estimates calculated in this evaluation incorporate the three key elements of sample design discussed in this section: stratification, cluster sampling, and sample weights. The survey estimators available in the software package *Stata* were used for the estimates, particularly the *svymean* and *svyreg* procedures.

Difference-in-differences estimation of impact

As described in the methodology section, the double-difference methodology measures the average program impact by comparing the average change in an indicator over time in the program communities with the average change in the same indicator in communities without the program. As shown in section 3, for a simple example of two groups and two time periods, the double-difference estimate of program impact can be calculated as:

(2) $$impact = (I_1 - I_0) - (C_1 - C_0)$$

where I signifies the intervention group, C indicates the control group, and the subscripts 0 and 1 refer to the periods before and after program implementation, respectively. The extension of this simple case to the five-group, two-period structure of the present evaluation is shown in Table 3.3.

Even though the heart of the analysis is no more complicated than calculating averages and subtracting them from each other in an organized fashion, it can be considerably more convenient and flexible to obtain the double-difference estimates using a multiple regression framework. In particular, the regression approach (or, equivalently, an analysis of variance approach) permits the incorporation of other variables as covariates, to control for potential confounding factors. The double-difference estimates for this evaluation were all based on the following regression equation:

(3)
$$y_{ict} = \alpha_0 + \alpha_1 A_1 + \alpha_2 P_1 + \alpha_3 P_2 + \alpha_4 P_3 + \alpha_5 P_4 + \delta_1 A_1 P_1 + \delta_2 A_1 P_2 + \delta_3 A_1 P_3 + \delta_4 A_1 P_4 + \varepsilon_{ict}$$

where:
y_{ict} = outcome variable of interest for household or individual i in community c in time period t,
A_1 = 1 if the observation is in 2004, and 0 if the observation is in 2001,
P_1 = 1 if community c is in the Linkages Only intervention group, 0 otherwise,
P_2 = 1 if community c is in the Linkages + Microcredit (LMC) intervention group, 0 otherwise,

P_3 = 1 if community c is in the Linkages + Food-based (LFB) intervention group, 0 otherwise,
P_4 = 1 if community c is in the Linkages + Microcredit + Food-based (LMCFB) intervention group, 0 otherwise,
ε_{ict} = unobserved idiosyncratic household error, and
α and δ are parameters to be estimated.

The parameters δ_1, δ_2, δ_3, and δ_4 are the double-difference estimates of the impact of the each of the four intervention packages, compared to the control group of communities. Similarly, differences in impact between two intervention groups may be calculated as the difference between the corresponding pair of δ parameters, e.g., the impact of LMCFB relative to Linkages Only is ($\delta_4 - \delta_1$).

For selected analyses, additional covariates were included on the right-hand side of the regression equation, to control for potential confounding variables. For example, height-for-age z-scores are negatively correlated with age, especially in the first 24 months. If, by chance, the proportion of infants among underfives tended to be larger in one intervention group, that group would tend to present higher mean height-for-age z-scores and lower stunting rates not necessarily because of better nutritional status, but because of differences in the age distribution between intervention groups. Inclusion of covariates helps reduce or eliminate this type of confounding in the evaluation of intervention impact.

On one level, hypothesis tests are straightforward. To compare one of the intervention groups with the control group, the t-statistic and p-value on the corresponding δ parameter estimate indicate whether the absolute value of the double-difference is significantly greater than zero. If so, the null hypothesis of no difference is rejected. To compare two intervention groups one tests the hypothesis that the absolute value of the difference in the δ parameter estimates (e.g., $\delta_4 - \delta_1$) is greater than zero.

However, on another level, hypothesis testing is complicated somewhat because multiple comparisons are being tested. Comparing each of the four intervention groups against the control group is four separate tests, and if one also considers comparisons between the intervention groups there are six additional possible pairwise comparisons, bringing the total number of tests to ten for each indicator. In this situation the true type I error rate is much higher than the nominal 1, 5, or 10 percent that is typically calculated, and the statistical significance of apparent differences is greatly overstated.

There are various statistical approaches to avoiding the overstatement of significance levels, all based on the same theme of adjusting the p-value (significance level) for the number of comparisons. The most conservative is the Bonferroni method, which essentially multiplies the p-value by the number of comparisons. For example, a single test that is strongly significant (p = 0.03, or 3 percent level of significance) would have an adjusted p-value of 0.30, or 30 percent, which is not statistically significant by any normal standard. Other approaches—such as those developed by Sidak, Holm, and Scheffé—give greater weight to individual tests that are more significant, so that the adjustment does not increase the p-value as drastically. Nevertheless, in our analysis of

the Savelugu-Nanton data, adjusting significance levels for multiple comparisons increased the level of the p-values by at least a factor of 7.

Although there is much to recommend the practice of adjusting for multiple comparisons, there are some important trade-offs that also need to be considered. Most notably, in protecting against type I errors (i.e., avoiding overstated statistical significance) the test's type II error rate increases. This reduces the power of the test to detect differences that truly are significant. Striking a balance between type I and type II error rates is a gray area for which there are no absolute rights and wrongs. To preserve the tests' power to detect significant differences, in this evaluation we opted not to adjust p-values for multiple comparisons, but to be conservative in reporting the unadjusted significance levels by (a) explicitly stating that the reported significance levels are overstated, (b) in tables, only highlighting results with a nominal (i.e., overstated) p-value of five percent or better, and (c) in discussion of the results, focusing almost exclusively on those results with a nominal p-value of one percent or better.