

POTENTIAL FOR NUTRITION-SENSITIVE CONSERVATION AGRICULTURE IN ZAMBIA

Final Report of a Study on the Potential of Conservation Agriculture to Improve Nutrition



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ACRONYMS AND DEFINITIONS

ACDI/VOCA	Agricultural Cooperative Development International/ Volunteers in Overseas Cooperative Assistance
BMI	Body Mass Index
CA	Conservation Agriculture
CASU	Conservation Agriculture Scaling Up
CEO	Camp Extension Officer
CF	Conservation Farming
CFU	Conservation Farming Unit
CHV	Community Health Volunteer
COMESA	Common Market for Eastern and Southern Africa
CRS	Catholic Relief Services
CSA	Climate Smart Agriculture
DACO	District Agriculture Coordinator
DHS	Demographic and Health Survey
DNCC	District Nutrition Coordinating Committee
EAS	Extension Advisory Services
EU	European Union
FAO	Food and Agriculture Organisation
FFS	Farmer Field School
FGD	Focus Group Discussion
FHH	Female Headed Household
FISP	Farm Input Subsidy Programme
FNDP	Fifth National Development Plan
FYM	Farm Yard Manure
IAPRI	Indaba Agriculture Policy Research Institute
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFPRI	International Food Policy Research Institute
INGENAES	Integrating Gender with Nutrition in within Agricultural Extension Services
IPRWEF	Integrated Poverty Reduction and Women's Empowerment Programme
IYCF	Infant and Young Child Feeding
KI	Key Informant
M&E	Monitoring and Evaluation
MAL	Ministry of Agriculture and Livestock
MHH	Male Headed Household
MoH	Ministry of Health
NAIP	National Agriculture Investment Programme
NGO	Non-Government Organisation
<i>Nshima</i>	A stiff porridge made from cooked ground maize meal, Zambian staple food
QDS	Quality Declared Seeds
RAIN	Realigning Agriculture to Improve Nutrition
<i>Relish</i>	Accompaniments to nshima; meat, beans, vegetables
SNDP	Sixth National Development Plan
SUN	Scaling Up Nutrition
TOPS	Technical and Operational Performance Support
UNICEF	United Nations Children's Fund
UNZA	University of Zambia
USAID	United States Agency for International Development
WFP	World Food Programme
WHO	World Health Organization

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EXECUTIVE SUMMARY

INTRODUCTION

Conservation Agriculture (CA) requires the application of three basic principles to farming practices: 1) minimum tillage 2) maintenance of soil cover and 3) crop rotation, usually with legumes. CA has been shown to increase productivity, help to build resilience to climate shocks, and protect the soil. It has been accepted as one strategy for “Climate Smart Agriculture” or CSA. Whilst CA could theoretically improve nutrition, there is no evidence to date of this. This study aims to assess the potential of CA to impact nutrition security at the household level with emphasis on pregnant and lactating women and children aged less than two years for prevention of chronic under-nutrition. This is important for addressing the causes of chronic under nutrition which is still 40% in Zambia (Central Statistics Office, Ministry of Health, Zambia 2014).

CA has been supported by various organisations in Zambia for over two decades by various Non-Governmental Organisations (NGOs) such as the Conservation Farming Unit (CFU) and Concern Worldwide. The Zambian government, specifically the Ministry of Agriculture and Livestock (MAL), has recently scaled up its efforts to promote and encourage CA adoption under the CA Scaling-Up initiative (CASU) with bi-lateral support from the United Nations Food and Agriculture Organization (FAO).

METHODS

The study comprised a literature review, key informant interviews, and qualitative focus group discussions (FGDs) with farmers in Central and Western Provinces of Zambia carried out in March 2015. Key informants included promoters of CA, technical staff in the MAL and Ministry of Health, representatives from both national and international NGOs. The sampling for FGDs was purposive rather than random and included four female and four male focus groups of CA adopters, as well as two case studies from the two districts surveyed. The purposive sampling of adopters could mean that any disadvantages of CA were underrepresented in the responses.

NUTRITION SENSITIVE AGRICULTURE

Guidelines and theoretical models have been developed over the past few years to help understand the links between agriculture and nutrition, and these are helpful when trying to understand how CA might impact on nutrition, or how to make changes towards ‘nutrition sensitivity’. These include 10 recommendations for improving nutrition impact of agricultural programmes (FAO 2013). Recommendations from the study are arranged using these guidelines below.

IFPRI and others have described potential pathways from Agriculture to Nutrition based on the developing experience of programmes and policies. (Gillespie, Harris et al. 2012). They describe eight distinct pathways between agricultural production and the impacts on household nutrition:

- Agriculture and direct food consumption.
- Agriculture for income.
- Agriculture and food prices.
- Expenditure of income derived from agriculture.
- Female agricultural labour and power.
- Female agricultural labour, childcare and feeding.
- Female agricultural labour and women’s nutritional status.
- Natural resource management and nutritional quality of foods.

From the literature, key informant interviews, and focus group discussions, it is clear that most of these pathways hold potential to improve nutrition with regards to CA. The exception is Pathway Three, which relates to local, regional or national impacts on food prices through increased production. This pathway was not explored in the assignment.

FINDINGS

PATHWAY ONE: AGRICULTURAL PRODUCTS FROM CA USED FOR DIRECT FOOD CONSUMPTION

Pathway One relates to food security from own production. From the testimonials of FGD participants, food security had improved since adopting CA, even during the current difficult year (2015). All FGDs reported that they increased their consumption of both maize and legumes following CA, particularly groundnuts and beans. Groundnuts were frequently used in complementary foods for children aged 6 to 24 months.

PATHWAYS TWO AND FOUR: RELATION BETWEEN INCOME AND EXPENDITURE FROM AGRICULTURE

Additional sources of food related to agricultural income or production were: 1) Additional on-farm production as a result of time saved and income from CA, and 2) Additional purchases of food resulting from increased income from CA. Farmers attending FGDs reported that they had saved time by practicing CA; this applied equally to men's groups and women's groups. The time saved was spent on the following activities:

- Growing more field crops including maize, cassava, sweet potatoes and groundnuts.
- Vegetable gardening.
- Small business and enterprise.
- Time for resting and recreation.
- Time for care of children.

All the activities could impact on nutrition by increasing food supply, increasing income, and improving maternal and child care.

Most FGD participants reported that they had increased their incomes since practicing CA. The extra income was spent on household foods, productive resources, school fees, household resources, buying animals including for milk and draught, constructing houses, hiring of labour for farm work, and getting married / paying a bride price. The foods that were purchased with the additional income included sugar, fish, meat, cooking oil, rice, tea and flour. During the course of subsequent discussions, instant cereal products for children and refined maize meal (commonly called "breakfast mealie meal") were added to the list. For nutrition, the choice of foods purchased could be positive or negative; whilst the addition of variety and animal sourced foods may meet a gap and improve dietary diversity, excessive consumption of some foods, such as meat, sugar, and refined cereals, could contribute to the increasing problems of over-consumption. The use of income on productive resources, purchase of animals, and other enterprises, have the potential to improve nutrition again through increased availability and diversity of food, or through other pathways. If income is spent on school fees, and this boosts education of children there could be a long term benefit for nutrition because education contributes to prevention of malnutrition through the life course. None of the respondents mentioned increased health expenditure as a result of CA.

The pathways described so far, relate to availability of food to households. Availability of food is not sufficient to ensure food and nutrition security; it was necessary to also explore dietary practices.

CA AND HOUSEHOLD AND CHILDREN'S DIETS

FGDs reported improvements in both quantity and quality of foods consumed by the household following their adoption of CA. For example, increased cooking oil, animal foods, vegetables; some respondents were eating food entirely from their own production. The food for young children aged 6 to 24 months had improved since

adoption of CA. Before adopting CA, many respondents were only giving left-over nshima to children of that age group. Now, they reported that their food diversity has increased and special porridge is prepared with groundnuts and some other foods. However, the diet diversity of most of these children is still not meeting the World Health Organization's (WHO's) recommendation that at least four different food groups are consumed daily. Also, there has been the introduction of various instant cereal products which are of unknown nutritional quality. Nutrition promotion activities and demonstrations of preparations that can be made for young children using local ingredients are needed.

PATHWAYS FIVE, SIX, AND SEVEN, RELATING TO GENDER AND AGRICULTURE

Gender is likely to impact on dietary diversity. The use of inter-crops and crop rotations with vegetables and pulses when under the management of women are likely to contribute to household food security in its full sense including diverse consumption. From the FGDs, several important links between CA and nutrition were highlighted:

- Children were able to attend school.
- Women's workload decreased enabling more time for food preparation.
- Women were less exhausted after adopting CA.
- Women have more time and energy for breastfeeding.
- Women prioritise production of legumes for consumption.

Some factors that affect labour are the use of herbicides, and whether tools for ripping are available. Labour demands in CA can be spread out over a longer period of time compared to conventional practices that require intense bursts of labour to complete land preparation immediately after the rains begin.

PATHWAY EIGHT: NUTRITIONAL QUALITY OF FOOD AND FOOD SAFETY

In theory, improvements in soil fertility lead to improved productivity and nutritional quality of foods (Lal, 2009). The links between CA and nutritional quality of foods could be mediated through soil improvement; for example, the pH of the soil affects nutrient uptake by plants, whereas arbuscular mycorrhizal symbiosis that enhances nutrient uptake by plant roots could be better preserved in minimum tillage practices (Antunes, Franken et al. 2012). By improving nutrient uptake by plants, and the additional soil organic matter could improve nutrient content of grains. The other issues on safety of foods are mycotoxin contamination and possible contamination with herbicides. Food contamination with mycotoxins is a real possibility (Kankolongo, Hell et al. 2009). In this study farmers reported that they sometimes noticed mouldy maize which they dealt with by separating out the grains. CA projects could theoretically reduce mycotoxin contamination by promoting various measures, such as use of lime, farmyard manure and crop residues. This needs to be tested by research trials and also routine testing. Contamination with herbicide residues is also a possibility and this should be tested alongside tests for mycotoxin contamination. Awareness raising on both issues of contamination should be a priority of upcoming CA interventions.

COORDINATION AND COLLABORATION WITH NUTRITION PROMOTION ACTIVITIES

There are many different models that could provide nutrition promotion activities to support farmers with post-harvest handling information, nutrition information, cooking demonstrations and Infant Young Child Feeding (IYCF) support. The delivery of this will depend on the institutional arrangements of each CA project.

SUMMARY OF RECOMMENDATIONS FOR CA PROGRAMMES TO IMPROVE NUTRITION SENSITIVITY

Table 1 FAO guidelines on agriculture programming for nutrition and how these are practiced within CA in Zambia

FAO guidelines on agriculture programming for Nutrition	Nutrition Sensitivity of Conservation Agriculture – as practiced in Zambia
1. Incorporate explicit nutrition objectives and indicators into their design, and track and mitigate potential harms;	Include specific nutrition objectives into CA Projects and means of verification. M&E systems to include consumption indicators and consider nutritional status indicators. Mitigation of possible harm: by introducing testing for herbicides in food, and testing for mycotoxins.
2. Assess the context at the local level, to design appropriate activities to address the types and causes of malnutrition;	In the Zambian context women carry out a large proportion of agricultural labour; the effect of labour on women should always be considered in CA projects; The type of malnutrition is changing and overweight is coexisting with undernutrition. The risks of overweight have to be taken into consideration through nutrition promotion activities; The different agro-ecological zones in the country need tailored CA approaches and farmers encouraged to experiment with cropping systems;
3. Target the vulnerable and improve equity;	Poor farmers need to be included in CA projects and provided with the necessary inputs if these are unobtainable for them;
4. Collaborate and coordinate with other sectors;	Need for CA projects to work with Nutrition/ Health sector to identify synergies and gaps in addressing causes of malnutrition. Nutrition promotion activities are necessary to ensure the gains from CA translate into improved diets;
5. Maintain or improve the natural resource base;	CA is well designed to improve natural resources base particularly conservation of soil and efficient use of water;
6. Empower women;	Women need to be targeted for technical support because they are the gatekeepers for nutrition and often underserved by extension and support services. Recruitment of female extension workers for CA promotion. The use of labour saving tools and support for diverse cropping systems.
7. Facilitate production diversification, and increase production of nutrient-dense crops and small-scale livestock;	Crop rotation/ intercropping with ground nuts and legumes is one of the pillars of CA to be reinforced. Diversification of cereal crops to include sorghum, millet for example. Use of nutritious intercrops and ground cover crops to enhance nutrition. Greater understanding of how to incorporate animals in broader farming systems. The nutritional quality of food produced by CA methods needs investigation through research.
8. Improve processing, storage and preservation;	Support is needed on post-harvest handling of cereals and legumes to extend supply for households and for sale. Testing for aflatoxins and herbicides is necessary. Also post-harvest processing methods to retain nutrients.
9. Expand markets and market access for vulnerable groups, particularly for marketing;	The market for legumes and access to seed needs support because access to seed and markets for selling is limiting production. CA projects to work with agents to supply legume seeds, as well as purchase of produce from small producers.
10. Incorporate nutrition promotion and education.	Traditional food systems and cuisine fit well with CA but more support is needed on utilisation of foods. Infant and young child feeding practices need promotion. Post-harvest handling to reduce contamination. Cooperation with other sectors is necessary to achieve this.

FURTHER RESEARCH

The following is a list of topics arising from the study that could be developed further with research institutes or other researchers:

- Survey of potential impacts on nutrition using random sample of adopters and non-adopters (similar to this current research). This might give a wider range of experiences including those who had experienced more challenges with CA.
- Consumption surveys to compare diets in Conventional and Conservation Agriculture related to production.
- Investigation of income spent on foods, and how these leading to improved nutrition or over consumption of unhealthy foods.
- Further understanding of women's roles and time schedules related to different aspects of CA, than the implications of what might be done to reduce women's labour.
- Operations research on best methods for introducing nutrition promotion.
- Post-harvest mycotoxin testing of crops produced under CA vs. conventional agriculture practices to see if contamination is reduced.
- Research on herbicide residues in crops, food safety and the use of herbicides and occupational health effects related to CA practices in Zambia.
- Farming systems research to understand how to plan cropping for nutritional targets.
- Motivations, limitations and other constraints to diversifying crop systems (e.g. to introduce more variety of cereal and pulse crops).
- Studies on the nutritional quality of different cereals and pulses produced through CA methods compared conventional methods.

1. INTRODUCTION

Conservation Agriculture (CA) has been supported by various organisations in Zambia for over two decades. Since 2010, Concern Worldwide has implemented a CA project in three districts of Western Province. The project works with farming households, predominantly women, to encourage their adoption of CA through training and once-off asset transfers in order to both increase and diversify household crop production of cereals and pulses. The program also provides farmers with a measure of resiliency against droughts that are a frequent occurrence in Western Province.

While there is strong evidence of the potential for CA to increase productivity, CA implementation and research remains largely a production-oriented methodology. The primary goals of CA revolve around the sustainable intensification of agriculture through better soil fertility management. Accordingly, CA research focuses on measuring productivity, and returns on income. Whilst several aspects of CA could theoretically impact nutrition, these impacts have not so far been assessed in evaluations or research to date.

This study is made possible with support from the American people, delivered through the U.S. Agency for International Development (USAID).

2. METHODS

2.1 OBJECTIVES OF THE ASSIGNMENT

- To assess whether CA has the potential to impact nutrition security at the household level and nutrition status of pregnant and lactating women and children under two years of age.
- To identify and describe which pathways between agriculture and nutrition are influenced under the current promotion of CA and to develop a conceptual pathway model for CA and nutrition which outlines potential as well as actual pathways.
- To identify opportunities and make recommendations to increase the nutrition sensitivity of CA interventions and share these widely amongst stakeholders within Zambia.
- To make recommendations for future research related to CA and nutrition.
- To make recommendations on the institutional arrangements for CA for collaboration with other sectors to achieve nutrition improvement.

The study comprised of a desk study and a qualitative field survey. The desk study aimed to review existing literature on the impact of CA on nutrition, key learning from the Realigning Agriculture to Integrate Nutrition (RAIN) project¹ and identify nutrition-sensitive opportunities for CA. The literature review helped to inform the qualitative methods for the field study. The consultant spent three days in stakeholder meetings in Lusaka, and one day for stakeholder meetings in Mumbwa and Kaoma District. The qualitative data assessment included eight focus group discussions and two case studies which took place in rural areas in Mumbwa District (Central Province) and Kaoma District (Western Province) over four days. There were then three days for data analysis and report preparation before a stakeholder review meeting in Lusaka. The detailed of people met can be found in Annex 2 Stakeholders met.

¹ www.concern.net/rain

2.2 METHODS FOR THE LITERATURE REVIEW

The literature review started with a search in Google and Google scholar for 'Nutrition' or 'Diet' and 'Conservation Agriculture' or 'Conservation Farming'. This initial search showed that linking CA and Nutrition is a new area of enquiry. No published papers have been found specifically linking human nutrition outcomes to CA, despite some of these papers utilizing "nutrition" as a key word.

Guidance is, however, available on linking agriculture (in general) to nutrition, both in terms of conceptual models to identify pathways (Gillespie, Harris et al. 2012) and guidance on agriculture programming for nutrition benefit (FAO 2013); (World Bank 2013). These frameworks were used during the review to identify potential ways in which CA could impact on nutrition. It was then possible to examine the relationship between some of the intermediate factors on the causal pathway from agriculture to nutrition. A literature search was carried out linking CA to increased agro-biodiversity, improved dietary consumption, dietary diversity and gender. Further literature was reviewed on the nutrition situation in Zambia. For the links between nutritional quality of foods and CA, again there were no papers. Hence broader issues relating to this topic were explored.

2.3 STAKEHOLDER KEY INFORMANT INTERVIEWS

Interviews with key stakeholders in Lusaka were held during the week of March 16th (for a list of people met, see Annex 2). Key informants in Lusaka included those involved in promotion of CA, technical staff in the Ministry of Agriculture and Livestock (MAL), representatives from International Organisations and Non-Government Organisations (NGO). The purpose of the meetings was to understand the current situation of CA in Zambia and to seek the perspectives of the stakeholders on potential links between CA and Nutrition. These discussions helped to shape the design of questions for focus group discussions with farmers for the field work. Key stakeholders at the districts visited for the field study were also interviewed. A dissemination event was held in Lusaka to present the preliminary findings, and feedback from that event has been included in this final report.

2.4 FIELD STUDY METHODS

The focus group discussions (FGDs) and case studies took place in Mumbwa and Kaoma Districts in Central and Western Provinces, respectively. The sampling was purposive (not random) and planned to select respondents from different categories of the community, specifically smallholder model farmers from female headed households (FHH) and male headed households (MHH). In practice, female groups included both FHH and MHH (i.e., married women). Different socio-economic groups were not purposively selected because the FGD comprised all the farmers who had been invited to attend regardless of wealth. In effect the sample included anyone practising CA for at least 2 years who wished to join the discussion. It was not possible to ascertain socio-economic status or exclude farmers who wanted to join the discussion. Some non-adopters also attended the groups and offered their perspectives on some of the issues.

Question guides for the FGDs and case studies can be found in Annex 3.

Discussions took approximately two hours each. Because there was a wide range of topics for discussion, not all thematic areas were covered by all groups. All groups were asked about the crops grown and the advantages and challenges they experienced with CA before the more specific topics. An independent female translator was employed for each discussion to provide translation from the local language(s) to English. The case study participants were the host farmers from the site of the FGDs, so it was possible to view the farm as part of the case study. The details of the numbers of FGD participants are shown in Annex 4.

2.5 STUDY LIMITATIONS

There is a large volume of literature related to the production and productivity of CA systems and the effects on the environment, particularly soil. A thorough review of that literature is beyond the scope of this assignment. Instead, the review is limited to exploring the range of links between CA and Nutrition.

The study field work was limited to interviews with CA adopters, therefore issues related to non-adoption could not be discussed and any disadvantages of CA could be under-represented. The fieldwork was undertaken during just one week and therefore seasonal issues were not fully explored. Dietary recall is usually limited to a short period of time because people cannot remember what they have consumed. However, for this study interviewees were asked to recall dietary practices even 10 years previously. The women who answered these questions were, however, able to recall their experiences well, so I have made an exception to this general rule for this assignment.

3. LITERATURE REVIEW

3.1 KEY FEATURES OF CONSERVATION AGRICULTURE

There are 3 key principles of Conservation Agriculture: (Kassam, Friedrich et al. 2009)

- Minimum tillage (as much as possible avoiding turning the soil surface in order to allow natural processes to build soil structure).
- Soil cover to reduce erosion and build soil organic matter (e.g. no burning).
- Crop rotation to break up pest/disease cycles and improve soil nitrogen levels.

It is necessary for these three principles to be followed in CA but the ways in which they are achieved can vary. For example, minimal tillage may be achieved through “ripping” (sub-soiling, or making a deep single furrow using a chisel plow) or by digging small basins by hand. Ground cover may be achieved by leaving crop residues in place, adding bio-mass to the soil surface, or by planting cover crops. Crop rotations may include a variety of different legumes. Weed management may be achieved using manual methods such as hand-pulling or hoeing, or by application of herbicides. Soil fertility may be supplied by inorganic fertilisers, animal manure, and/or compost. In Zambia, all the above variations were present in the groups of farmers interviewed.

CA is sometimes referred to as an example of “Climate Smart Agriculture” (CSA) which also includes other methods of agriculture (Food and Agriculture Organisation 2013) and is a way of promoting resilience and sustainability: both extremely important in the mitigation and adaptation to climate change. The key features of CSA are:

- Enhanced food security by sustainably increasing the reliability and productivity of agricultural livelihood activities.
- Increased smallholder resilience and adaptation to the likely effects of climate change.
- Where appropriate, and in the interest of smallholder farmers, reduced greenhouse gas emissions from agriculture and improved carbon sequestration (Africa Climate Smart Agriculture Alliance brochure).

3.2 ORGANISATIONS SUPPORTING CA IN ZAMBIA

Several organisations support Conservation Agriculture (CA)² in Zambia, notably the Conservation Farming Unit (CFU) that works across the country to provide technical support for adoption of CA. The Conservation Agriculture Scaling Up initiative (CASU) is supported by FAO and implemented by MAL. Other NGOs in addition to Concern also implement CA projects.

All organisations follow the principles of CA described above, though there are some differences in emphasis and approach. CFU and CASU promote the use of pesticides (herbicides and insecticides) to reduce the workload involved in weeding, whereas other NGOs train on multiple weed and pest control methods but do not directly

² Also known as Conservation Farming

support pesticides. A number NGOs, most prominently the Participatory Ecological Land Use Management (PELUM), support an organic approach that uses no chemical inputs (pesticides or fertilisers). Poor market infrastructure makes it necessary for many farmers to adopt a low external input approach due to low market access to inputs like seeds, fertilizers, and pesticides.

The implementation strategies also differ. For example, Concern Worldwide targets the extreme poor and Female Headed Households (FHH) using community wealth ranking to prioritise beneficiaries. They also provide small input packs, including fertilizer, cereal and legume seeds. CASU provide support to 'lead farmers' who roll out training to 'follower farmers' through the agriculture extension system. Some inputs are provided to lead farmers by way of electronic vouchers redeemable for agricultural inputs. CFU and other NGOs such as CRS and Concern provide another level of support in the field by employment of Field Extension Officers. In multiple projects, Farmer Field Schools (FFS) or Farmer-Led Demonstration Plots enable practical training and demonstration.

Box 1: The Conservation Farming Unit's approach to CA

The Conservation Farming Unit was founded in 1996 in Lusaka, and has spent the last twenty years dedicated to developing, promoting and training on Conservation Farming techniques and practices appropriate for small and medium scale farmers in Southern and East Africa. It now directs free extension training each year to approximately 200,000 farmers across Zambia, and works with In-Country Partners in Kenya, Malawi, Uganda and Tanzania. It has been solely funded by the Royal Norwegian Embassy for the last eight years.

In Zambia, CFU works along the main maize belt of Agro-Ecological Zone II, along the corridor from Mongu in the West, to Chipata and Lundazi in the East, and from Mkushi and Kapiri in the Centre, down through to Kalomo in the South.

Training on how to convert to Conservation Farming (CF) is transmitted through a Lead Farmer extension system. The CFU's 70-strong field staff works continuously with over 2,000 Lead Farmers to deliver modular, hands-on lessons to farmers in their own communities. Each Lead Farmer trains three different groups of approximately 30 people, on each of the four different modules spaced over the dry season. The training and transfer of knowledge is open and available to anyone who is interested. The lessons are aligned with the agricultural calendar, and cover how to prepare the land, how to apply inputs and seeds, how to manage weeds and apply herbicides, and how to grow Musangu (*Faidherbia albida*) a tree species that provides fertility to the soil over long periods of time.

The CFU trains on CF for different tillage entry points. Training is given on how to do CF as a hoe farmer using basins, on Animal Draft Power (ADP) [oxen] ripping, or on mechanised ripping. By encouraging the growth of farmer to farmer Tillage Service Provision – be it ADP or mechanised – the opportunity for farmers who do not own oxen or tractors to have their fields ripped has become substantially more widespread, and the uptake of CF has been broadened. With the training on CF adaptable to small hoe farmers as well as large mechanised farmers, the CFU actively engages with farmers across the spectrum.

The CFU works also to stimulate and solidify the demand and supply of practical, appropriate CF equipment and inputs, including legume seed, available across the rural agro-dealership networks and to encourage farmer-to farmer in-community agent activity. It has prioritized the growth of Mechanised Tillage Service provision, and has fostered and upheld the linkages between banks, equipment suppliers and farmers to boost tractor and mechanised Min-Till equipment loans for purchase.

So far as food security is concerned: the CFU has over the years tried to encourage the uptake of a wide range of leguminous rotation crops – most of which have failed due to weak supply and poor markets. Since 2007 it has distributed elite cassava and sweet potato planting material to tens of thousands of farmers each year, the largest programme of its kind in Zambia. In 2012 and 2013 alone this involved 100,000 bundles of 100 cuttings each of cassava being distributed to over 16,000 farmers, and over 50,000 bundles (x 15kg) of sweet potato vines being distributed to over 5,000 farmers.

3.3 POLICIES SUPPORTING CA

The promotion of CA is prominent in the country's agricultural policy framework as exemplified in the recently adopted National Agriculture Investment Programme (NAIP) 2014-2018 (Delegation to the European Union Zambia and COMESA 2014). The NAIP, as well as the fifth and sixth national development policies (FNDP and SNDP, 2005 and 2010 respectively) support CA. However, these policies are self-conflicting, as they are still including numerous conventional agriculture practices.

The potential of CA to contribute to the Government's agricultural diversification policy agenda towards increased productivity as well as improved dietary diversity leading to reduced stunting prevalence has attracted increased political attention in recent years. However, active steps to promote nutrition in agriculture-related interventions appear so far to be lacking.

3.4 NUTRITION SITUATION IN ZAMBIA

Chronic malnutrition is still a serious problem in Zambia. 40% of children in Zambia were stunted according to the latest Demographic Health Survey (DHS) report (Central Statistics Office MoH Zambia 2014). Children of malnourished women with Body Mass Index (BMI) <18.5 are more likely to have stunted children (50% stunted) compared to better nourished mothers. Also, better educated and wealthier mothers have children with lower risk of stunting. The stunting prevalence has declined since 2007 when it was 45% and 2002 when it was 53%. The reductions are encouraging, but still there is a long way to go to reduce child stunting in Zambia.

Only 12% of breastfed children aged 6-24 months and only 4% of non-breastfed children were fed according to recommended frequency and diversity. Only 19% of breastfed and 32% of non-breastfed children were fed at least 4 food groups. 46% of breastfed and 32% of non-breastfed children were fed acceptable frequency of meals. Again, better educated and wealthier mothers had better infant and child feeding practices. (Central Statistics Office MoH Zambia 2014).

BMI in women aged 15-49 year shows problems with under-nutrition (10.3%), as well as issues related to over-nutrition or obesity (22.8%). Under-nutrition (and being underweight) is most prevalent in the poorest and least educated groups and over-nutrition/obesity is most prevalent in the wealthiest and better educated groups. (Central Statistics Office MoH Zambia 2014). Under-nutrition in women has reduced since 2002 when it was 15%. On the other hand overweight/obesity is on the rise from 12% in 2002 and 19% in 2007 to its present level of 23%. This change is common in many countries and is known as the 'Nutrition Transition' whereby problems of over-nutrition can occur alongside chronic under-nutrition: the so-called 'double burden'. Issues of dietary quality are likely causes of both types of malnutrition (Drewnowski and Popkin 1997).

The UNICEF model of causes of malnutrition is a useful guide to the likely causes of under-nutrition in Zambia (UNICEF 1990). These are likely to include inadequate diverse food at household level, common childhood diseases, poor breastfeeding practices and complementary foods of insufficient quality, water sanitation and hygiene constraints.

Box 2: Concern Worldwide's approach to CA in Zambia

The project's objective is to increase farm productivity of over 6,000 households. Conservation Agriculture is promoted directly to beneficiaries, while concurrently; the programme encourages growing of local quality declared seed to supply CA farmers, as well as linking beneficiaries to input and output markets.

Promotion of Conservation Agriculture:

- a) **Direct farmer training in CA skills:** 6,000 farmers are directly trained and monitored in CA skills utilizing a lead farmer - beneficiary farmers model, in which lead farmers train beneficiaries in CA practices, while maintaining a demonstration / experimental learning plot. Lead and beneficiary farmers are supported with small vouchers by Concern to purchase inputs from local agrodealers, promoting sector growth at the local level in Mongu, Senanga, and Kaoma Districts;
- b) **Supply chain improvements:** In Zambia, 150 CA farmers from Phase I were trained as seed growers – supplying improved quality seeds to farmers. This will result in a wider choice of crop varieties within project localities, and less dependency on Concern Worldwide to source inputs;
- c) **Expanding the reach of CA:** Working with government staff, five (5) demonstration plots have been developed at peri-urban sites to increase the scale and reach of CA to middle-income farmers, school students and the wider population.
- d) **Public communications:** Promotional materials (pamphlets and videos) are produced to demonstrate the positive impact of CA on people's lives. Programmes have been produced and broadcast on the *Farmer's Hour* programme on Zambian television (reaching 200,000-500,000 people), referring viewers to their nearest model CA farm.
- e) **International learning/advocacy:** Learning and data from the programme are shared with the government, research institutions and NGO networks to build scale at the district and national levels. Concern's goal is to revitalise the CA national task force there too and to standardise adoption metrics, sharing of best practices and lessons learnt with the aim for government to move beyond CA policy promotion to CA implementation. In addition, Concern is a leading participant in the Southern Africa Conservation Agriculture Regional Working Group (CARWG).

3.5 THEORY OF NUTRITION SENSITIVE AGRICULTURE³

Various guidelines and theoretical models have been developed over the past few years to help understand the links between agriculture and nutrition, and these are helpful when trying to understand how CA might impact on nutrition, or how to make changes towards 'nutrition sensitivity'.

Priority objectives to enhance nutrition in agriculture programs have been identified (World Bank 2013);

- Invest in women: safeguard and strengthen the capacity of women to provide for food security, health and nutrition of their families.
- Increase access to year round availability of high-nutrient content food.
- Improve nutrition knowledge among rural households to enhance dietary diversity.
- Incorporate explicit nutrition objective and indicators into agriculture investments.

³ Nutrition-sensitive agriculture is an approach that seeks to maximize agriculture's contribution to nutrition.(FAO)

The FAO has also supported development of recommendations for improving nutrition impact of agricultural programmes (FAO 2013). These recommendations are practical and useful for programme design. We can consider the potential for impact on nutrition of CA using 10 guidelines (Table 2) to help identify questions that can be explored through the field work and stakeholder discussions. Further details on the guidelines are in Annex 1.

Table 2 FAO guidelines on agriculture programming for nutrition, and initial observations related to CA in Zambia.

FAO guidelines on agriculture programming for Nutrition	Conservation Farming – as practiced in Zambia
1. Incorporate explicit nutrition objectives and indicators into their design, and track and mitigate potential harms;	Consider including specific nutrition objectives into CA Projects and means of verification. Consider any possible harmful consequences of CA on health, nutrition or related matters.
2. Assess the context at the local level, to design appropriate activities to address the types and causes of malnutrition;	Conduct a contextual analysis (with a strong focus on gender) and identify types and causes of malnutrition: Which of these causes can be addressed by CA Projects and which need additional programming?
3. Target the vulnerable and improve equity;	How can CA be targeted to the most vulnerable and how can CA be designed to be accessible to vulnerable groups
4. Collaborate and coordinate with other sectors;	Need for CA projects to work with Nutrition/ Health sector to identify synergies and gaps in addressing causes of malnutrition. How do CA and agriculture projects presently work with other sectors?
5. Maintain or improve the natural resource base;	CA is well designed to improve natural resources base particularly conservation of soil and efficient use of water.
6. Empower women;	As shown in the pathways below, women are key to ‘nutrition-sensitive’ CA. The questions arise from whether women are able to adopt and benefit from CA?
7. Facilitate production diversification, and increase production of nutrient-dense crops and small-scale livestock;	Crop rotation/ intercropping with groundnuts and legumes is one of the pillars of CA. The question is how much is this happening in practice and does consumption follow production? How are diets affected? How is the seasonal spread of production? How is the nutritional quality of foods affected by the no-tillage methods of CA?
8. Improve processing, storage and preservation;	What happens to CA products post-harvest? How are they processed- by whom and how well are nutrients retained and/or enhanced? Also what are the food storage and safety issues, for example aflatoxin contamination. Are there any implications related to CA? And are there any problems with storing legumes until next harvest?
9. Expand markets and market access for vulnerable groups, particularly for marketing;	What are marketing arrangements for CA products? Are markets for legumes developed? How well can vulnerable people access the markets? Is there a market for legume seed which is accessible for all including women and extreme poor?
10. Incorporate nutrition promotion and education.	Are nutritious foods utilised by HHs and particularly for children? What are the local knowledge systems, cultures and practices? How does present production fit into traditional food systems?

3.6 PATHWAYS FROM CA TO NUTRITION

IFPRI and others have developed potential pathways from Agriculture to Nutrition based on the developing experience of programmes and policies

Figure 1 (Gillespie, Harris et al. 2012). Described in this schematic are 7 distinct pathways from agriculture to nutrition. These are shown in Table 2 with commentary on the potential links to CA in Zambia.

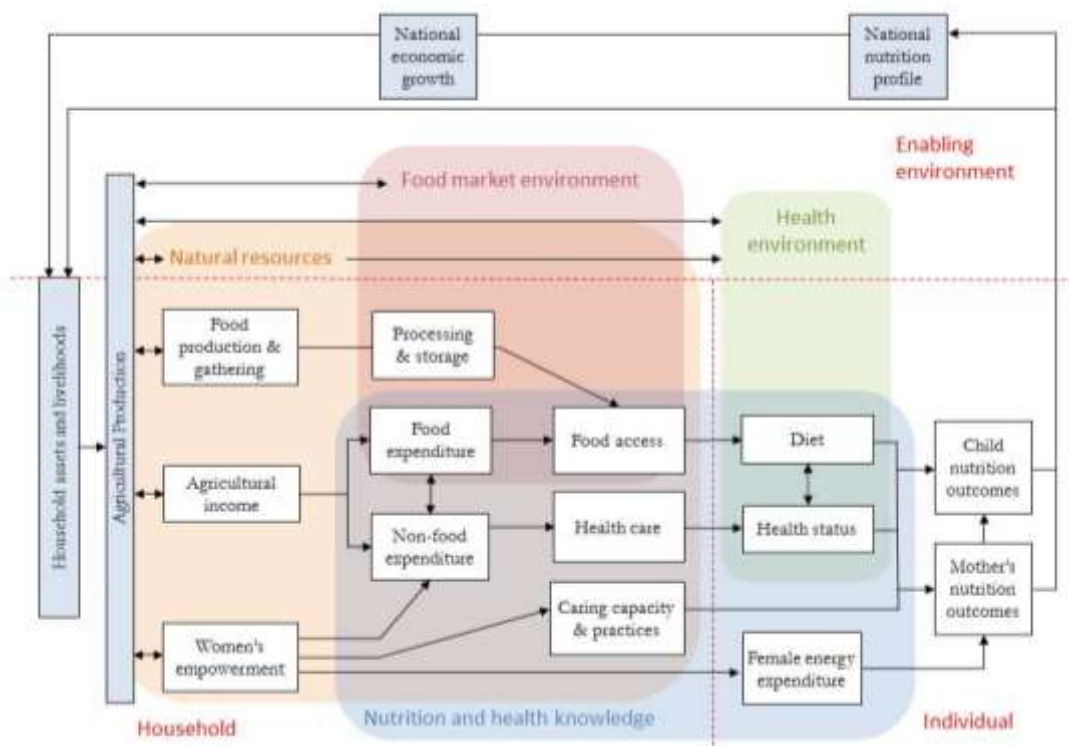


Table 3 Pathways from Agriculture to Nutrition and initial observations on CA in Zambia

Pathways from Agriculture to Nutrition	Conservation Agriculture in Zambia
1. Agriculture and food consumption	Farmers grow food (cereals and legumes in the case of CA) and the food is consumed in the household.
2. Agriculture for income	Farmers sell (part of) their harvest.
3. Agriculture and food prices	Are increased yields due to CA affecting food prices?
4. Expenditure of income derived from agriculture	How is the income spent – is it on nutrition or health related items?
5. Female agricultural labour and resource allocation	Does increased income from CA increases control of women on income? Is it affecting expenditure on health and food?
6. Female agricultural labour, childcare and feeding	Does women's agricultural labour increase or detract from time spent on caring practices and is CA enabling women to improve caring and feeding practices?
7. Female agricultural labour and women's nutritional status	Does women's agricultural labour result in her own nutritional depletion or improvement in nutritional status? And has the women more time to spend on other things such as home gardening and child care?
8. Natural resource management and nutritional quality of foods	How do CA methods affect the nutritional quality of foods produced?

3.7 KEY AREAS FOR LINKING CA AND NUTRITION FROM THE LITERATURE REVIEW

3.7.1 CA AND HOUSEHOLD FOOD SECURITY

Nyanga 2012 (2012) reports improvements in household food security, specifically related to growing and consumption of pulses in Zambia. The authors compared pulse production of adopters and non-adopters of CA and reports higher production and also consumption of legumes amongst adopters. An early green harvest also contributed to reported food security amongst women farmers. The legumes grown were groundnuts, cowpeas, soy beans and other beans with those legumes that are part of the diet being prioritised. Women were also selling pulses to provide income.

Another report from Malawi reports household food security differences in CA adopters vs. non-adopters in terms of meals consumed and whether or not the household had sufficient food for the year. 87% CA adopters vs. 51% non-adopters reported sufficient food for the year and 84% CA adopters vs. 64% non-adopted reported consumption of three meals per day. No mention is made of quality of food or whether all food groups were available, therefore the results are probably for just maize security (Nyambose and Jumbe 2013).

In Zimbabwe, Wagstaff and Harty (2010) reported on improvements to household food security assessed using Household Economy Approach. CA contributed to meeting annual food needs better than in the comparison group and also the diversity of food production for own needs was improved with more emphasis on legumes.

Household food security relates mainly to Pathway One but also Pathways Two, Three and Four (see Table 2.)

3.7.2 Gender and CA

The role of women in agriculture in Zambia covers many of the tasks required under CA such as weeding, digging basins, spreading crop residues, and harvesting. There are differing reports in the literature about the effect of CA on women's agricultural labour demands. Where basins are used, women tend to be responsible for the work of digging basins, whilst men are more involved when ripping is practiced. Basins, however, are prepared over a longer period of time before the rain, so the work is spread out.

The crop rotation choices are also related to gender choices; women tend to have greater control over groundnuts. Production has increased in Zambia and in addition to a large wholesale market these are used primarily for home consumption or sale by women; both of which could impact on nutrition (Nyanga, Johnsen et al. 2012).

Concern's CA projects in Zambia and Malawi have been evaluated for impact on gender dynamics in the households. A project evaluation in Malawi and Zambia concluded that "the benefits of CA are more significant for women as CA has enabled them to prepare their land early and plant on time, which in turn has led to increased yields, an earlier harvest, a shorter hunger gap, and higher household food security." Women reported reduced labour and labour intensity, especially for weeding, the time saved was then used on other crops, vegetable gardens or other income generating activities, extra income to pay school fees, buy school clothes, school books, household items, and improve their children's nutrition especially with the inclusion of groundnuts and soybeans in the diet and enable them to buy productive assets such as livestock or fertilisers. The women are now more self-reliant and have learned new skills and gained knowledge from the CA training which empowers them to improve their own food production and decision making.' (Reid and Chikarate 2013).

Gender issues relate to Pathways Five, Six and Seven (Table 2).

3.7.3 AGRICULTURAL DIVERSITY AND DIETARY DIVERSITY AND CA

No papers were found in the literature search that examined the links between CA and dietary diversity empirically.

The gender issues described above are likely to impact on dietary diversity. The use of intercropping and crop rotations with vegetables and pulses when under the management of women are likely to contribute to household food security in its full sense including diverse consumption.

One advantage for dietary diversity is the increased production of legumes that is associated with the crop rotations. In project areas targeted by Concern Worldwide, CA farmers have achieved higher groundnuts yields than official estimates in an area where groundnut production is particularly challenging. In the 2010/11 season CA farmers produced 31 percent more groundnuts than the provincial average (707 kg/ha compared to 540 kg/ha), and 15% more in 2012-13 (370 kg/ha compared to 320). Crop diversity also increased with production of beans, cowpeas, groundnuts, pumpkins, gourds, melons and okra (Concern 2014).

The weeding can be minimised by the use of herbicides, but some women report a reluctance to use herbicides because these affect intercropping and collection of weeds for green leafy vegetables (Nyanga, Johnsen et al. 2012). The types of plants that grew as soil cover include okra, sweet stalks sorghum, pumpkins, watermelons, African horned cucumber, green vegetables, and also wild amaranthus leaves. The amaranthus leaves are well known to be high in iron, other minerals and vitamins and also contains high lysine, when combined with maize improves the protein quality in the same way as pulses improve the protein quality of maize.

Another link to improved diversity of production is the time that can be saved from CA practices. Some women reported that this time was used to grow other nutrient dense crops, such as vegetables (Reid and Chikarate 2013).

The use of trees in CA systems is considered particularly important for increasing diversity of systems, however dietary diversity links to CA are not specifically mentioned in this article (Bissdeleua and Niang 2013).

For nutrition improvement it is important to understand to what extent the legumes and other crops are consumed, particularly by infants and young children under 24 months old for the prevention of stunting. Evidence from the RAIN project suggests that, greater agricultural diversity was associated with improved dietary diversification and those households with greater agricultural diversity had fewer stunted children (Kumar, Harris et al. 2014). This is hopeful information for finding a positive link between agricultural and dietary diversity.

Agricultural diversity and dietary diversity links potentially to all pathways (Table 2).

3.7.4 NUTRITION QUALITY AND SAFETY OF FOODS PRODUCED

What is the relationship between the method of agricultural production and nutritional quality of food produced? In theory, improvements in soil fertility lead to improved productivity and nutritional quality of foods (Lal 2009). To what extent is CA as practiced in Zambia influencing the nutritional quality of cereals and pulses grown?

Figure 2 Availability of plant nutrients related to soil pH

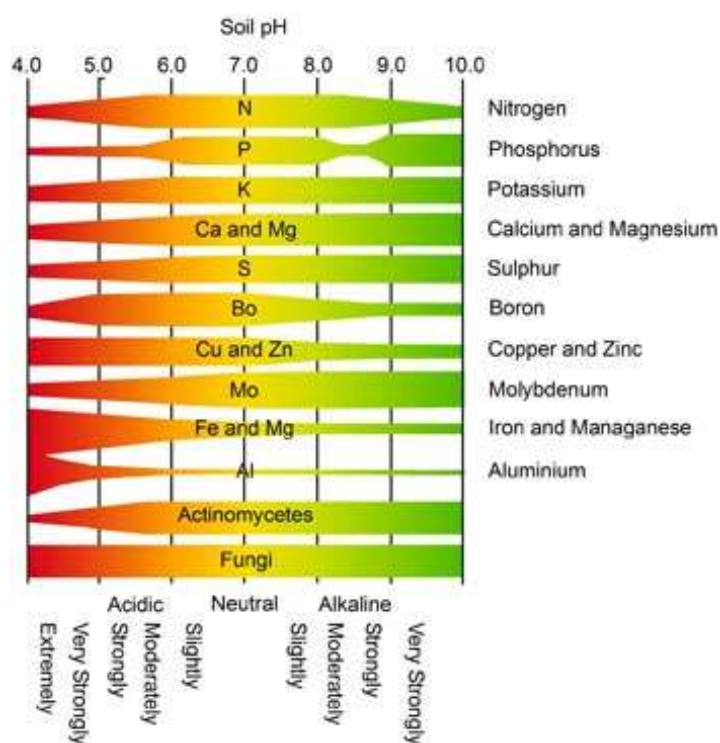


Figure 2 shows that nutrients are most available to plants in neutral pH. Fertile soils tend to have neutral pH, offering best opportunity for plant uptake of nutrients. Does this translate to better nutritional quality of foods? Except for the dambos, which are often basic, soils in Mumbwa and Kaoma tend to be acidic (pH <6). This limits availability of nitrogen, phosphorus, calcium, and magnesium to plants, potentially reducing yields of carbohydrates, and the availability of calcium in plant foods and in fodder that subsequently becomes milk. There has been an increase in soil pH under CA in Malawi, with higher phosphorous levels which should improve nitrogen fixation by legumes, and therefore both the yield of beans and the yield of subsequent crops grown in the rotation (Wagstaff 2015).

Arbuscular mycorrhizal fungal symbiosis helps to provide nutrients to plants in the soil by increasing root surface area and hence, ability of plants to absorb nutrients. These natural symbiotic relationships are detrimentally affected by repeated ploughing and indiscriminate application of inorganic fertiliser so, in theory, CA practices should improve natural mycorrhizal relationships to benefit plant nutrition. There were no studies found in the literature on free-living mycorrhiza, so studies of inoculation with mycorrhiza shed light on the benefits these naturally occurring symbiotic relationships could have in CA systems. Inoculation studies show improvements in various minerals for various crops, (Antunes, Franken et al. 2012). For example, iron, manganese and zinc were increased in maize shoots following inoculation. Research on this topic is much needed because this could be a useful way to improve human micronutrient deficiencies. In practical terms, it is important to preserve the natural mycorrhiza to help provide essential nutrients to the plant root, and CA plausibly should benefit this relationship.

There is some evidence on difference between conventional and organically produced foods that would support the theory that improved organic matter in the soil improves nutritional quality of foods, particularly antioxidants (Baraski, Srednicka-Tober et al. 2014). Again, more research is needed on the links between agricultural practice and nutritional quality of food.

Another way to improve nutritional quality of foods is through genetic approaches where nutrient dense varieties of grains are selected or specifically bred. Biofortification has received much more research attention than environmental methods, for example orange-fleshed sweet potatoes, orange maize, and iron- and zinc-

enriched beans. Biofortified crops only improve the nutrient content of one nutrient in one crop at a time, but nevertheless can be useful if the varieties are acceptable to farmers, the nutrient content is available in different soils, the nutrient is bioavailable in usual diets, and the nutrient is not lost in processing or cooking.

If the nutritional quality of the grain can be enhanced through either genetic or agronomic methods it is important that the quality be maintained through all the processing steps. There is potential for improving micronutrient dietary intake through a series of nutrient retaining steps in the value chain. Nutrient-retaining steps would include ensuring the nutrients in the soil are available for plants, using varieties that are nutrient dense, retain nutrients during storage and processing, and utilization of cooking methods to preserve nutrients. An example of this approach is available for rice and zinc in Bangladesh (Mayer 2011). In this approach the potential improvements in the zinc content of rice were examined at each step from soil to human nutrition.

On the food safety aspect, mycotoxins that are produced when maize and groundnuts develop a mould (*Aspergillus sp*) are a risk for liver disease and are also associated with higher levels of stunting. There has been research on aflatoxins in Zambia (but not related specifically to CA) to help farmers decide on mitigation strategies. The following range of levels was found in Zambia. (Kankolongo, Hell et al. 2009): fumonisins: 0.02 and 21.44 ppm; aflatoxins 0.7 and 108.39 ppb. Fumonisin was more pronounced in villages in forest areas and mycotoxin was highest in valley and forest areas in Zone IIa. ICRISAT reported reductions in mycotoxin contamination at the field level through agronomic practices⁴ : The use of lime, farm yard manure, and crop residues are all mitigation strategies against mycotoxin infection are promoted as part of CA, implying that CA could significantly reduce the risk of *Aspergillus* infection at the field level.

There is a risk of herbicide contamination of crops. This is a concern that might increase in the future because Glyphosate (widely used in CA systems) has been classified as a 'probable carcinogen' in March 2015 by the WHO research body on cancer (International Agency for Research on Cancer 2015).

Nutritional quality of foods relates to pathway 8 (Table 2).

⁴ Lime is a fungicide; farm yard manure will ensure that the crops have adequate access to nutrients and antagonistic fungi in the FYM may inhibit or out-compete *Aspergillus*, crop residues used as mulch will reduce the risk of water stress, an important factor in *Aspergillus* infections. Results: Lime application can reduce aflatoxin contamination by 72%; Farm Yard Manure (FYM) by 47%; Cereal crop residue by 28%; Combination of FYM and lime by 84%; Combination of lime and residue by 82%; Combination FYM, and residue by 53% ; Combination of FYM, residue, and lime by 85%. (ICRISAT)

4. FINDINGS

4.1 MAIN FINDING FROM KEY INFORMANT DISCUSSIONS

The stakeholders highlighted challenges and opportunities for CA, particularly for nutrition improvement in Zambia. The following is a summary of some of the topics discussed with key informants and challenges and opportunities raised by them.

4.1.1 FOOD SECURITY & AGRONOMIC ISSUES

- CA needs to be adapted to different regions in Zambia according to the climate and soils. There are various ways of doing this, e.g. by promotion of agro-forestry species that help to provide mulch, by working with local seed companies that produce seeds that are adapted to the local environment, and by adapting the ridge system to plant according to the moisture in the soil.
- On the issue of weeds in CA systems, there were different opinions. For farmers, the main challenges are the weeds and the labour required initially to set up the CA system; without herbicides it is very hard work. However, training farmers in the safe use of herbicides is one of the challenges in CA promotion. Some of the herbicides being used are banned for use in Europe and cannot therefore be promoted in Zambia by agencies receiving EU funding. Some organisations are promoting alternatives such as use of deep mulches and cover crops.
- There is an assumption that farmers have time available during the dry season for working on basins and ripping; however this time is traditionally used for recovery, cultural activities and other tasks so it is necessary to test the assumption that farmers will be able to prepare fields during the dry season and that land preparation does not distract from other cultural activities or much needed rest. On the other hand, others mentioned that the start of the dry season is a suitable time for agricultural labour because it is a food secure period. The dry season offers an opportunity for CA because peak labour is required at a time of food security.
- CA is not harder work than conventional agriculture. Farmers often use 'Service Providers', e.g. schemes that rent tractor-rippers to rip a field or persons who are paid to spray herbicides, and this is often cheaper than conventional alternatives. Even making basins saves time, but for the most part where possible farmers will adopt ripping.

4.1.2 GENDER AND CA

- Women's influence over farming decisions is seen as a key challenge. Women have little control over resources on the shared/household land although there is greater control where they have their own area to cultivate. Women grow food for home consumption, for men the emphasis is on sale. Resources for cultivation are a challenge, for example, women do not always have access to animals and rippers for cultivation.
- With conventional agriculture there is a heavy workload in late December and January resulting in lack of time for caring practices. The work includes ploughing, sowing, then weeding. With CA the workload is spread thus making caring practices more manageable.
- Women are adopting CA in almost equal numbers to men, although a much smaller percentage of lead farmers are women, possibly related to their lack of experience in a leadership role.
- Organisations, such as 'Women for Change' are introducing labour saving tools for women, e.g. treadle pump, and appropriate tools for hoeing.

- There are opportunities for mainstreaming gender in CA in the design, implementation, access to inputs, and to include in monitoring and evaluation (M&E) to capture decision-making in CA.

4.1.3 DIETARY DIVERSITY & CROP DIVERSITY

The challenges to growing and consuming diverse crops in CA were discussed with Key Informants. Several opportunities were mentioned:

- At the policy level there needs to be support for legume production through promotion of markets for legumes. Some commercial seed companies are working on promotion of legumes and establishing local outlets and markets. Some farmers want to grow grains other than maize but they have problems obtaining seeds. Concern works with better off farmers to grow Quality Declared Seeds to provide a source of seed locally for other farmers. The use of small packets of seeds helps promote production of some legumes, e.g. beans. School garden/school meal projects can link with markets for legumes produced by CA for example the home-based school feeding supported by World Food Programme (WFP) that purchases cowpeas from local farmers.
- CA fits well with traditional food systems because it includes rotation with legumes, maize and can incorporate green vegetables as cover crop. The inclusion of wild or cultivated amaranthus to provide nutritious vegetable is one example. This fits with the traditional diet of parts of Zambia of nshima, beans and vegetable relish; however this knowledge has been getting lost along with some of the traditional farming practices that produced more diverse foods. Households need reminding on basic nutrition knowledge. Nutrition information needs to be given to farmers about the various crops and their value in diets. CA could increase more diverse foods into cropping system and work towards incorporating livestock in a wider farming system for fuller nutrition benefit.

4.1.4 NUTRITIONAL QUALITY AND SAFETY OF FOODS AND POST HARVEST ISSUES

- Biofortified crops such as orange maize, high iron/zinc beans are available to some farmers, but mainly where a project has supported their introduction, for example in the RAIN project.
- There was concern expressed by some key informants about herbicide contamination of crops and post harvest mycotoxin contamination; testing is not routine for either.
- Post harvest equipment is needed such as shellers, mills and silos to prevent deterioration of crops. This needs to be developed for legumes as well as maize. Farmers know little about neither the nutritional value of the crops they are growing nor the effect of storage and processing on it. It would help farmers to receive training on post-harvest processing.

4.1.5 CA IMPLEMENTATION AND OPPORTUNITIES TO INTRODUCE NUTRITION PROMOTION ACTIVITIES

- There are several parallel systems of support to farmers, for example through CFU, NGOs and MAL and these need better coordination including coordination on messages to farmers. There is a perception that CA is for 'the big boys' and needs costly inputs. KI reported that some lead farmers have been given inputs for CA; this has given the impression that CA needs inputs before it will be feasible for farmers.
- It is difficult to receive information on CA in the rural areas. One KI remarked that the only farmer field days available in her locality relate to growing cotton and are supported by particular companies. There is a lack of capacity of Agricultural Extension workers to support CA adequately due to poor coverage, and lack of transport to reach farmers. For CFU, however, training is advertised on local radio and is open to all; the limit is the vast rural areas and farmers achieving access to information in practice.

- Nutrition has been neglected in CA so far by all agencies involved in CA. Food security (e.g., staple food production) is considered but not nutrition security (e.g., sufficient diversity in food production). Nutrition has been sidelined compared to production requirements for sale. There are insufficient Nutrition Officers within both MAL and MCDMCH. Nutrition expertise in the rural areas is scarce, at the health posts there is no one who is employed as a specialist nutritionist.
- Several Key Informants suggested ways to improve nutrition focus of CA. It was suggested to train CA field officers on nutrition and also/or to set up collaborations so training could be delivered to farmers by other specialised nutrition agencies. The District Nutrition Coordination Committee (DNCC), a body set up in some parts of Zambia to coordinate between sectors for Nutrition, is a possible vehicle to coordinate health and agriculture aspects of CA. In Mumbwa the SUN movement and CASU have combined forces with mothers groups at FFS where they can discuss and have demonstrations on nutrition, IYCF, cooking and production by working with CHVs and CEOs. 'Nutrition training gives people the incentive to grow diverse foods such as legumes and will create demand'. Also the INGENAES a USAID programme will assist 'Feed the Future' missions to strengthen gender and nutrition integration within agricultural extension and advisory services. Concern's RAIN project uses groups of pregnant and lactating women as a way to converge agriculture training to encourage production of micronutrient rich crops (delivered by an NGO in conjunction with MAL staff) with behaviour change communication around Infant and Young Child Feeding (delivered by Community Health Workers).

4.2 MAIN FINDINGS FROM FIELD WORK

4.2.1 GENERAL

Maize was grown by all farmers. More soybeans, cowpeas, and cotton were grown in Mumbwa compared to Kaoma, while in Kaoma more farmers were growing cassava. There were no marked gender differences in the crops grown. In Mumbwa, married women were more likely to have a separate piece of land to farm themselves than in Kaoma where this practice was unusual. All the farmers reported that their yields had increased following adoption of CA practices.

Table 4 Crops grown by the participants of FGD and the approximate percentage growing these crops in the past year in each location

Crops grown	Kaoma (%)	Mumbwa (%)
Maize	100	100
Groundnuts	90	86
Soy beans	16	71
Cow peas	16	50
Beans	36	39
Cassava	32	5
bambara nuts	2	0
Cotton	0	43
Sunflower	0	13
Pigeon pea	0	2

Obtaining seeds was a limitation to the growing of legume crops in addition to access to markets, particularly in Kaoma where the distance to the market was further.

In addition to the crops already grown in CA systems, farmers also wanted to expand their production to include a range of other crops: soybeans; sunflower; beans; ground nut; cowpea; upland rice; cotton; pearl millet; sorghum. The usual reason for not growing these crops was unavailability of seed. Irish potatoes and sweet potatoes were also mentioned but these would not necessarily fit in the minimum tillage aspect of CA.

4.2.2 ADVANTAGES OF CA REPORTED BY FGD GROUPS

Farmers reported many advantages of CA. The most frequently mentioned advantages included the following:

- Drought toleration/maintains moisture.
- Less requirement for fertiliser as it does not leach out of the soil.
- Higher yield of maize and/or legumes.
- Reduced soil erosion/soil conservation/increased soil fertility.
- Possibility of early planting/early harvest.
- Reduced less labour and inputs costs.

It was also mentioned by single FGDs that CA also achieves the following:

- An increases in income.
- It saves time to grow other crops.
- It reduces hunger.
- It makes weeding easier.
- It is more sustainable.
- It results in more vigorous growth due to nitrogen availability.
- It is possible to practice CA even without equipment.

- It enabled support for child's education.
- It reduced the time spend in the field on a day.
- There is no need to migrate to another location to find fresh soil.

4.2.3 CHALLENGES OF CA

Farmers reported many challenges of CA. The challenges most frequently mentioned were as follows:

- The late availability of government subsidized (Farmer Input Support Programme or FISP) inputs for early planting.
- Lack of tools, animals or tractors for ripping.
- Bushfires destroying soil residues.
- Lack of money to buy herbicides.
- Difficulty in obtaining legume seeds.
- Limited labour to make basins for a large area.
- The difficulty of digging basins in dry, hard soil.
- Lack of commodity market for soybeans and other legumes.
- More weed pressure when ploughing is not utilized.
- Weeding is hard work.

4.3 ANALYSIS OF LINKS BETWEEN CA AND NUTRITION

The Eight Pathways from Agriculture to Nutrition described in the methods section were explored through FGDs with communities.

4.3.1 PATHWAY ONE: DIRECT FOOD CONSUMPTION OF THE AGRICULTURAL PRODUCTS FROM CA

All FGDs reported that CA increased their consumption of both maize and legumes, particularly groundnuts and beans. Women's FGD groups reported that consumption of homemade soybean products such as flour, milk and sausages also increased. This was related to the special training they had received on preparation of soy products. Groundnuts were being used in complementary foods for children aged 6 to 24 months. Male FGD participants emphasised the sale of soybeans and also a lack of understanding on processing of legumes for consumption.

An additional source of food related to CA is the consumption of leafy weeds and any intercrops grown in addition to legumes or maize. There were mixed reports on this. Women who reported use of herbicides had reduced their collection of leafy weeds and some mentioned that consumption of these leaves had decreased. Others who were not using herbicide had not made changes. However, the use of herbicides did not preclude collection of these edible weeds because for some there was an area which had not been sprayed and could still supply leaves for consumption. Few FGD mentioned that they were planting inter-crops or edible ground cover. Vegetables were usually grown elsewhere on the farm.

4.3.2 FOOD SECURITY AND CA

The question was posed 'Given this stressful rainy season who of the farmers estimates they would still be able to feed families up to April 2016, i.e. a year from now?'

Most of the CA adaptors estimate that their yield will be able to take them to the next harvest even though they have experienced a very stressful rainy season. The CA adopters also feel that conventional farmers will experience more problems in achieving good harvests and they clearly indicated the CA adopters are more resilient to unfavourable rain conditions.

Pathway One relates to Food Security from own production directly related to CA; and from the testimonials of FGD participants, food security had improved since adopting CA and even during this difficult year (2015).

4.3.3 CA AND AGRICULTURAL AND DIETARY DIVERSITY

Direct consumption of food produced by CA system is one way in which diets might be affected by CA. Other food availability is affected by: 1) Additional on-farm production as a result of time saved and, 2) Additional purchases of food resulting from increased income from CA.

4.3.3.1 CA and time saving

Farmers attending FGDs reported that they had saved time by practicing CA; this applied equally to men's groups and women's groups. The savings in time were related to the spread of work for land preparation, quicker planting, and earlier weeding. For those with equipment for ripping, there was a large saving compared to ploughing. The group of women who used basins and hand weeding also said that CA farming takes less time than conventional agriculture, but for those with larger areas and no herbicide, or ripper, or the money to hire one, the land preparation and weeding were time consuming and hard work.

Those who had saved time by practising CA spent their time in various activities. The main activities, starting with the most frequently mentioned were:

- Growing of more field crops, including maize, cassava, sweet potatoes, and groundnuts.
- Vegetable gardening.
- Small business / enterprise.
- Growing of cash crops.
- Time for resting and recreation.
- Time for planning/ learning from others.
- Time for care of children.

All the women's groups reported that they had spent more time on growing field crops, but only 2 of the 4 male FGDs mentioned this. More time for care of children was not mentioned until further probing. All the activities could impact on nutrition by increasing food supply, increasing income and improving maternal and child care.

4.3.3.2 CA and income expenditure

Most FGD participants reported that they had increased their incomes since practicing CA. The extra income was spent on various things: These are listed starting with the most frequently mentioned:

- Purchase foods
- Productive resources: fertilisers, spray, seeds, tools
- School fees
- Household resources; e.g. mattress, clothes, soap
- Buy animals including for milk and draught power
- Build house/ buy a new roof
- Pay labour for farm work
- Getting married/ paying a bride price [*lobola*]
- Start enterprise or small business
- Extend fields for more growing area

The foods that were purchased with additional income were sugar, fish, meat, cooking oil, rice, tea, and flour. During the course of subsequent discussions, instant cereal products for children, and refined maize meal (commonly called breakfast mealie meal).

For nutrition, the choice of foods purchased could be positive or negative. Whilst the addition of variety and animal sourced foods may meet a gap and improve dietary diversity, over-consumption of some foods, such as meat, sugar, and refined cereals could contribute to the increasing problems of overweight. Overweight in women is now more prevalent than underweight (see section 2.4). Zambia is at risk of moving into a 'Nutrition Transition' with risks for both stunting and overweight (Drewnowski and Popkin 1997).

The use of income on productive resources, purchase of animals, enterprises have the potential to improve nutrition again through increased availability of food or other pathways. If income is spent on school fees, and this boosts education of children there could be a long term benefit for nutrition because education contributes to prevention of malnutrition through the life course. None of the respondents mentioned health expenditure increases as a result of CA although this is emphasised as a key link between agriculture and nutrition in the IFPRI framework (Figure 1).

The pathways described so far, Pathways One through Four, relate to availability of food to households. Availability of food is not sufficient to ensure food and nutrition security. Other causes of malnutrition also need to be addressed, such as limitations to adequate care and limitations to healthy environment. There are more ways in which CA could impact on nutrition and these are described below.

4.3.4 CA AND HOUSEHOLD DIETS

Respondents were asked what their current diets were and how had these changed since they had started practicing CA.

'During the time of Conventional Farming I was very thin, consuming just nshima with okra and pumpkin leaves. Now I have milk, egg and fish. I have bought cows and buy fish and sugar' (male respondent from Mumbwa)

All participants of the FGD mentioned that the frequency and/or the quantity of food consumed increased. Also, most of the participants indicated that the quality of foods consumed increased by purchasing cooking oil, animal products (meat, fish, milk, eggs), more diverse crops (including vegetables) grown on the farm, more legumes (groundnuts, soy beans) and that CA enables them to increase the number of food groups consumed (see Annex 5).

4.3.5 FOODS FOR CHILDREN AGED 6 TO 24 MONTHS

Both male and female FGD participants were asked what foods they gave young children and whether there had been changes since adopting CA.

'Now we give [the] baby porridge, groundnuts and soy milk twice a day and nshima twice per day. During the time of conventional agriculture, we used to give plain porridge with salt if time to prepare, otherwise leftover nshima for breakfast and lunch, no money to buy anything else'. (Women's group member Kaoma)

'Before children were malnourished. Now they eat beans, cassava, and sweet potatoes. In the old times they were very dull compared to now. These days, children are bright and alert'. (Men's group Mumbwa)

The foods reported by FGD for young children 6-24 months had improved since adoption of CA. Before adopting CA, many respondents were only giving left-over nshima to children 6-24 months. The participants mentioned that the main changes in the diet for young children were the increased meal frequency, the ability to enrich porridge with eggs, groundnuts, cowpeas or soy, the ability to buy commercial cereal and the ability to enrich their child's diet with foods such as pumpkins, cooking oil and fish. However, the diet diversity of most of these children is still not meeting WHO recommendations of at least four food groups daily. Also there is introduction of instant cereal products which are of unknown nutritional quality. Nutrition promotion activities and

demonstrations of preparations that can be made for young children using local ingredients are needed (see Annex 5).

4.3.6 FINDINGS RELATED TO GENDER AND CA

Pathways Five through Seven relate to gender and agriculture. Issues related to these pathways were directed to the women's FGDs primarily but also to some men's groups. Questions related to time for care, breast feeding practices and the women's own well-being.

Pathway Five: Female agricultural labour and power (power over purchasing decisions, for example)

Pathway Six: Female agricultural labour, childcare and feeding; and

Pathway Seven: Female agricultural labour and women's nutritional status.

Question: *'Do you think there is a difference between CA and conventional farming in the time you have available during the year for child care?'*

'During the Conventional Farming time we had less time for children and even stopped our children going to school to help with the farm. We were hungry because of poor harvest. Husbands were getting angry with us and unity between husband and wife was poor due to hunger. We felt panic if the weeding was not finished that husbands would be angry. Husbands used to say we were being lazy breastfeeding when we should be working. Now it is possible to spend more time with children.' (Women's focus group Mumbwa)

'During the time of conventional farming, I was weeding from morning to night and had no time to care for children, there was too much work. The children were thin and mothers also. We fed the children left-over nshima. Now it is much better, we can rest. Mothers look healthy: there is time to rest, time to eat. The mothers now add groundnuts to porridge for children.' (Woman's group Mumbwa)

'Before when we practiced conventional farming we fed children twice per day in the morning and evening when we returned from field to breastfeed. Children were not fed properly or had clothing; there was no sugar for children, no cooking oil. Now we feed 3 to 5 times per day and breastfeed several times.' (women's group 2, Mumbwa)

From the discussions several important links between CA and nutrition were mentioned.

- School fees paid, children able to attend school
- Women's workload decreased enabling more time for food preparation
- Women less exhausted, less energy expenditure on farming
- Women have more time and energy for breastfeeding
- Household income available for food purchases
- Women prioritise production of legumes for consumption

Questions still remain, even after these positive testimonials: Has CA reduced the inequality of women? How can women's inequality be addressed through CA?

4.3.7 NATURAL RESOURCES MANAGEMENT AND NUTRITIONAL QUALITY OF FOODS

Through the interviews it was not possible to further explore the topic of nutritional quality of food related to CA because farmers are unaware of the nutritional quality of food consumed. This is always going to be a constraint to promoting nutrition quality of foods because the benefits are invisible. However, farmers can be made aware of best practices once research findings are in place.

Biofortified foods were not used apart from isolated cases where they had been supplied by NGOs, such as Concern's RAIN project.

Food contamination with mycotoxins is a real possibility because farmers reported that they sometimes noticed mouldy maize when separating out the grains. CA projects should theoretically reduce mycotoxin contamination by promoting various measures, such as use of lime, farmyard manure and crop residues. This needs to be tested by research trials and also routine testing. Contamination with herbicide residues is also a possibility and this should be tested alongside tests for mycotoxin contamination. Awareness raising on both issues of contamination should be a priority.

4.3.8 'DO NO HARM' – IDENTIFY AND MITIGATE AGAINST POSSIBLE DETRIMENTAL CONSEQUENCES

Are there any possible harmful consequences of CA, foreseen and not foreseen?

- The widespread use of herbicides with possible health consequences for dangerous practices and/or food contamination could be affecting health of consumers and farming communities.
- Are there labour consequences related to the use of herbicides? This applies to those who are reliant on day labour for whatever reason.
- With increased income, households purchased more processed foods, such as 'breakfast mealie meal' and 'instant commercial cereal foods' for children with lower nutritional value than home prepared.

4.3.9 COORDINATION AND COLLABORATION WITH NUTRITION PROMOTION ACTIVITIES

It is not possible to recommend a single model for introducing nutrition promotion activities but the following offer some ideas:

- There are many different models that could help provide nutrition promotion activities to support farmers with post-harvest handling information, nutrition information, cooking demonstrations and IYCF support. The delivery of this will depend on the institutional arrangements of each CA project. For example, the Nutrition officer within MAL could train the Camp Extension Officers (CEO) on nutrition, but it is up to the CEOs to train farmers and nutrition is just one of many subjects, therefore time is limited. There are several platforms for training; farmer field schools could be an entry point for nutrition education, some CEOs offer cooking demonstrations at FFS. With NGO involvement training can be intensified by introducing more support for CEOs and also Community Health Volunteers (as happens in Concern's RAIN project).
- Whilst it is advisable that CEOs are trained and understand nutrition issues, the delivery of nutrition messages to farmers can be supported through the MoH and MAL nutritionist at the district level who work with the Health Facility staff who themselves train Community Health Volunteers (CHVs). Appropriate targeting of farmer group members by including more pregnant and lactating women (PLW) and encouraging linking the CHVs to the farmers group could be an effective way to link nutrition promotion activities to CA.
- At the district level the District Nutrition Coordinating Committee (DNCC) offers coordination structure between Agriculture, Health and other key line ministries at the District level. Scaling up Nutrition (SUN) has supported coordination structures and technical support for nutrition. This is a good place for coordination to take place. One outcome of coordination could be improved targeting where CA works more with women who are pregnant or lactating. There should be lessons for coordination from the USAID INGENAES project once it is rolled out. INGENAES will assist Feed the Future missions to strengthen gender and nutrition integration within agricultural extension and advisory services (EAS).
- There are causes of malnutrition that are not addressed through CA such as promotion of healthy environment and support for health services and it is important for CA projects to link with other health-oriented projects to address the range of causes of malnutrition.

4.4 SUMMARY OF RESULTS

4.4.1 POTENTIAL IMPROVEMENTS TO NUTRITION FROM CA PRACTICES AND PROJECTS

This is a summary of some of the ways in which CA could impact nutrition drawn from the testimonials and examples that the farmers have shared during FGDs.

1. Dietary improvements relating to:
 - Increased own production of CA crops (cereals and legumes).
 - Production of livestock products, and vegetables due to additional time available.
 - Purchase of other foods with extra income derived from CA.
 - Possible improvement of nutritional quality of food grown on improved soils.
 - Possible improvements in post-harvest contamination with mycotoxins.
 - Possible negative consequences from the introduction of highly processed foods and excess animal products through food purchases.
 - Possible negative consequences of herbicide contaminated foods.
2. Nutrition of different population groups:
 - **Children 0-24 months:** improved quantity and quality of foods, and improved breastfeeding and caring practices.
 - **Women:** improved diets and reduction in energy expenditure, which is particularly important for Pregnant and Lactating Women.
 - **Farmers and other HH members:** improved diets and reduction in energy expenditure.
 - **Wider community:** support available for other members of community through surplus production of some CA farmers.

4.4.2 GAPS FOR NUTRITION

CA will not be able to answer all the needs for nutrition improvement. One key gap is Nutrition knowledge which needs to be addressed through Nutrition Promotion activities. This is particularly the case with IYCF practices. There is a potential for CA to support extra production or availability of food to the household, however, this needs to be made into appropriate foods for the most vulnerable groups (PLW and children 6-24 months). From the FGDs, knowledge, or other behaviour constraints are getting in the way of adequate feeding practices.

Other causes of under and malnutrition in these populations might be outside the scope of CA projects and therefore wider integrated projects working with other sectors will be necessary, notably Health sector and also Gender empowerment. Depending on the context other aspects to consider will be water, sanitation and hygiene promotion, for example. A full description of allied projects is beyond the scope of this assignment.

5. RECOMMENDATIONS FOR PROGRAMMES

Although respondents have highlighted many positive impacts of CA, there are several entry points for improvements in Nutrition through CA projects. Many questions still need to be answered.

5.1 ENTRY POINTS FOR IMPROVEMENTS IN DIET

- Production of legumes is already part of CA, but there are challenges such as lack of markets for sale, availability of seeds, availability of suitable varieties, knowledge on processing, questions over palatability, and post-harvest storage. These challenges need to be addressed using the particular advantages of different organisations.
- What other crops can be brought into CA to provide additional nutritional benefit? For example amaranth, pumpkin and other indigenous crops that can be grown in the systems. Consideration to planting nutritious cover crops that are gathered for a useful yield. The farmers expressed wishes to grow a range of other crops in their CA systems or in their farms. How to address the constraints (mostly seed availability) to production of crops farmers aspire to grow?
- How to improve nutrition knowledge especially use of locally produced foods to create demand for the production of nutritious crops? Traditional knowledge systems are available so they should be promoted and adapted to current farming systems. It would be good to build on the traditional food combinations, such as nshima, beans and vegetables that should provide balanced nutrition. Nutrition promotional activities are needed on preparation of suitable foods for 6 to 24 months old children to prevent stunting. Women have started to improve the feeding practices by making special porridges but more food groups could be added. We know that households now have a variety of foods available that could be used for complementary feeding with this knowledge.
- Who is best placed to support farmers on Nutrition? Expecting Camp Extension Officers who are agricultural specialists to provide training on nutrition might be inappropriate (according to key informants). Nutritionists in MAL have been working with the Integrated Poverty Reduction and Women's Empowerment Programme (IPRWE) of Concern Worldwide on cooking demonstrations, so perhaps that is a model to reproduce for CA projects? Or is it better to make links with Health sector, perhaps by supporting CHVs as was done in the RAIN project? Further support is needed to the different organisations supporting CA to set up the necessary collaborations for this to happen.

5.2 ENTRY POINTS FOR GENDER AND CA

CA already supports many improvements in the situation for women, as shown by the positive testimonies offered by women and men in FGDs. Additional improvements could be made, for example

- Improve gender-balance staffing for extension/ field staff and lead farmers/ beneficiary farmers. Women farmers trained in CA will be likely to benefit nutrition through the various pathways described. Women leaders are more likely to attract women farmers (Maher 2012).
- Development of appropriate technology for women farmers, e.g. processing equipment. Some organisations are working on this, (Women for Change was mentioned by one KI) and the learning from their projects could be shared and scaled up.
- Introducing collaborative working relationships between Agriculture and Health Sector, perhaps using the DNCC or other coordinating structures at District level. Women's groups within communities are a good entry point for bringing agriculture and nutrition information together with links to Community Health Volunteers for nutrition training.

- Build in awareness raising on gender equality to projects, through information communication, simple messages within training materials or training for extension staff to help them become more gender aware.
- The time saving aspect of CA has a major potential on improving nutrition outcomes, by having more time available for producing vegetables, additional crops and child care. However, not all stakeholders agree that CA is time saving, therefore, exploring options to increase time/labour saving of CA is still important.

5.3 ENTRY POINTS FOR NUTRITIONAL QUALITY OF FOODS AND CA

This is an under-researched area and could be the topic for several research projects (see section below).

5.4 ENTRY POINTS FOR PROJECT DESIGN

- Collection of evidence through M&E systems that incorporate nutrition objectives and indicators. A positive impact is more likely when specific objectives are set and followed through project M&E. Also adding to global learning on ways to improve nutrition would be very useful for those tasked with design of programmes and policies linking agriculture and nutrition.
- Nutrition education/ promotion is necessary to provide guidance on ways to prepare foods, especially for complementary foods.
- CA can be used as a vehicle to improve gender equality by encouraging more women's participation and supporting child care needs (see above).
- Also attention to post-harvest systems of storage, processing to maintain nutritional quality and safety of grains. This appears to be under represented in support offered to farmers. In 2007, 15% of the maize harvest in Central Province was lost post harvest, so this is a key factor to improve food security (African postharvest loss information system 2015).
- Farmers can be treated as researchers and innovators to adapt and trial different systems to provide wide range of foods including useful cover crops and to adapt systems to local environments. Farmer to farmer training can help to spread innovations.

5.5 SUMMARY OF RECOMMENDATIONS

Table 5 FAO guideline on agriculture programming for nutrition and recommendations to improve nutrition sensitivity of CA in Zambia

FAO guidelines on agriculture programming for Nutrition	Nutrition Sensitivity of Conservation Agriculture – as practiced in Zambia
1. Incorporate explicit nutrition objectives and indicators into their design, and track and mitigate potential harms.	Include specific nutrition objectives into CA Projects and means of verification. M& E systems to include consumption indicators and consider nutritional status indicators. Mitigation of possible harm: by introducing testing for herbicides in food, testing for mycotoxins.
2. Assess the context at the local level, to design appropriate activities to address the types and causes of malnutrition.	In the Zambian context women carry out a large proportion of agricultural labour; the effect of labour on women should always be considered in CA systems. The type of malnutrition is changing and overweight is coexisting with undernutrition. The risks of overweight have to be taken into consideration through nutrition promotion activities. The different agro-ecological zones in the country need tailored CA approaches and farmers encouraged to experiment with cropping systems.
3. Target the vulnerable and improve equity.	Poor farmers need to be included in CA projects and provided with the necessary inputs if these are unobtainable for them.
4. Collaborate and coordinate with other sectors.	Need for CA projects to work with Nutrition/ Health sector to identify synergies and gaps in addressing causes of malnutrition. Nutrition promotion activities are necessary to ensure the gains from CA translate into improved diets.
5. Maintain or improve the natural resource base.	CA is well designed to improve natural resources base particularly conservation of soil and efficient use of water.
6. Empower women.	Women need to be targeted for technical support both because they are vulnerable to exploitation and because they are the gatekeepers for nutrition. The recruitment of female extension workers for CA promotion, use of labour saving tools, support for diverse cropping systems that are for food security.
7. Facilitate production diversification, and increase production of nutrient-dense crops and small-scale livestock.	Crop rotations/ intercropping with ground nuts and legumes is one of the pillars of CA. This is to be supported. Also diversification of cereal crops to include sorghum, millet. Use of nutritious intercrops and ground cover crops to enhance nutrition. Greater understanding of how to incorporate animals in broader farming systems. The nutritional quality of food produced by CA methods needs investigation through research.
8. Improve processing, storage and preservation.	Support is needed on post harvest handling of cereals and legumes to extend supply for households and for sale. Testing for aflatoxins is necessary. Also post harvest processing methods to retain nutrients.
9. Expand markets and market access for vulnerable groups, particularly for marketing.	The markets for legumes and access to seed needs support because these are limiting production. CA projects to work with seed companies that support purchase of seeds and sale of produce from small producers.
10. Incorporate nutrition promotion and education.	Support to improve utilization and processing foods is needed to improve infant and young child feeding practices and raising awareness on healthy diets. Risk of overweight and health food choice should be taken into account promotional activities.

5.6 PROPOSED RESEARCH PROGRAMME

The present research has examined the opinions of a purposive sample of adopters of CA who are likely to be more positive about CA than non-adopters. Some of the findings might not reflect the general experiences of those who try CA methods (including those who were not so successful as this sample). Therefore it would be useful to carry out some further research using random sampling of adopters and non-adopters to examine some of the questions raised in more detail.

The following is a list of topics, which could be developed further with research institutes or other researchers:

- Mixed methods to study in order to study the potential impacts on nutrition using random sample of adopters and non-adopters (similar to this current research). This might give a wider range of experiences including those who had experienced more challenges with CA.
- M&E systems to include indicators of agricultural diversity, and consumption indicators, such as diet diversity and IYCF.
- Consumption surveys to compare diets in Conventional and Conservation Agriculture related to production.
- Investigation of income spent on foods, are these leading to improved nutrition or over consumption of unhealthy food choices?
- Further understanding of women's roles and time schedules related to different aspects of CA. What does this imply for the widespread practice of Conventional Agriculture as well as CA. What can be done to reduce the labour burden?
- Operations research on best methods for introducing nutrition promotion.
- Post harvest mycotoxin testing related to CA. Do the mitigation practices result in less contamination?
- Research on herbicide residues in crops, food safety and the use of herbicides and occupational health effects related to CA practices in Zambia.
- Farming systems research to understand how to plan cropping for nutritional targets.
- What are the motivations, limitations and other constraints to diversifying crop systems (e.g., to introduce more variety of grain crops).
- Studies on the nutritional quality of grains produced through CA methods compared to others using different seed varieties.
- Examination of the nutritional quality of grains through the value chain from production to consumption to determine where the best interventions for nutritional quality are to be found.

6. CONCLUSIONS

The research conducted with adopters of CA practices has shown that CA already has the potential to improve nutrition in the first 1,000 days and also for other demographic groups. Several of the 'Eight pathways' from agriculture to nutrition could have a role to play. Of particular interest are the pathways related to gender, diversification of diets and post-harvest issues. Improvements to increase the effectiveness of these pathways are possible and need further development. Nutrition education is needed to fill a gap in nutrition knowledge, particularly IYCF practices and utilisation of the foods that are now locally available through CA.

ANNEX 1 KEY GUIDING PRINCIPLES ON AGRICULTURE PROGRAMMING FOR NUTRITION

Agricultural programmes and investments can strengthen impact on nutrition if they (FAO, 2013):

- 1. Incorporate explicit nutrition objectives and indicators into their design, and track and mitigate potential harms**, while seeking synergies with economic, social and environmental objectives.
- 2. Assess the context at the local level, to design appropriate activities to address the types and causes of malnutrition**, including chronic or acute under nutrition, vitamin and mineral deficiencies, and obesity and chronic disease. Context assessment can include potential food resources, agro-ecology, seasonality of production and income, access to productive resources such as land, market opportunities and infrastructure, gender dynamics and roles, opportunities for collaboration with other sectors or programmes, and local priorities.
- 3. Target the vulnerable and improve equity** through participation, access to resources, and decent employment. Vulnerable groups include smallholders, women, youth, the landless, urban dwellers, the unemployed.
- 4. Collaborate and coordinate with other sectors** (health, environment, social protection, labour, water and sanitation, education, energy) and programmes, through joint strategies with common goals, to address concurrently the multiple underlying causes of malnutrition.
- 5. Maintain or improve the natural resource base** (water, soil, air, climate, biodiversity), critical to the livelihoods and resilience of vulnerable farmers and to sustainable food and nutrition security for all. Manage water resources in particular to reduce vector-borne illness and to ensure sustainable, safe household water sources.
- 6. Empower women** by ensuring access to productive resources, income opportunities, extension services and information, credit, labour and time-saving technologies (including energy and water services), and supporting their voice in household and farming decisions. Equitable opportunities to earn and learn should be compatible with safe pregnancy and young child feeding.
- 7. Facilitate production diversification, and increase production of nutrient-dense crops and small-scale livestock** (for example, horticultural products, legumes, livestock and fish at a small scale, underutilized crops, and biofortified crops). Diversified production systems are important to vulnerable producers to enable resilience to climate and price shocks, more diverse food consumption, reduction of seasonal food and income fluctuations, and greater and more gender-equitable income generation.
- 8. Improve processing, storage and preservation** to retain nutritional value, shelf-life, and food safety, to reduce seasonality of food insecurity and post-harvest losses, and to make healthy foods convenient to prepare.
- 9. Expand markets and market access for vulnerable groups, particularly for marketing** can include innovative promotion (such as marketing based on nutrient content), value addition, access to price information, and farmer associations. **Nutritious foods** or products vulnerable groups have a comparative advantage in producing.
- 10. Incorporate nutrition promotion and education** around food and sustainable food systems that builds on existing local knowledge, attitudes and practices. Nutrition knowledge can enhance the impact of production and income in rural households, especially important for women and young children, and can increase demand for nutritious foods in the general population.

ANNEX 2 STAKEHOLDERS MET

Name	Organisation	Position	Location
Danny Harvey	Concern Worldwide	Country director	Lusaka
Marjolein Mwanamwenge	Concern Worldwide	Nutrition Coordinator	Lusaka
Carl Wahl	Concern Worldwide	CA coordinator	Lusaka
Paul Wagstaff	Concern Worldwide	Agriculture advisor	Lusaka
Rosie Pilcher	CFU		Lusaka
Collins Nkatiko	CFU		Lusaka
Peter Aagard	CFU		Lusaka
Frederich Mahler	EU delegation	Agriculture and rural development advisor	Lusaka
Marion Michaud	EU delegation	Agriculture and rural development advisor	Lusaka
Brian Mulenga	IAPRI	Research associate	Lusaka
Emily Burrows	CRS	Chief of Party	Lusaka
Karen Mukuka	MAL	Chief nutritionist	Lusaka
Misael Kokwe	FAO	Climate Smart Agriculture Technical Coordinator	Lusaka
Pamela Marinda	UNZA	Nutritionist	Lusaka
Elijah Phiri	UNZA	Senior lecturer Land and Water management	Lusaka
Muketoi Wamunyima	PELUM	Country Director	Lusaka
Wilfred Miga	PELUM	Regional Coordinator	Lusaka
Kanyata Musonda	MAL	Senior Agriculture Officer	Mumbwa
Bright Chikopa	MAL	Agriculture Extension Officer	Mumbwa
Joyce Kunda	MoH	District Community Nutrition Officer	Mumbwa
Everista Mumba	MAL	Assistant Marketing Officer	Kaoma
Chimbi Chungu	MAL	District Marketing Dev. Office	Kaoma
Sharon Lieto	MAL	Nutrition Officer	Kaoma
Aubrey Chanda	MAL	DACO	Kaoma

Focus Group Discussion Guide (male and female farmers)

Location:

Date:

Sex of participants:

Case study/ FGD:

Farmer(s) interviewed:

Introduction

- Thank for time
- We are carrying out some research on CA and how it affects households
- Time taken should be about an hour
- Your participation is voluntary and we will not be paying you for your time today
- Helping with this research does not mean we will be able to fulfil your wishes
- Your names will not be attached to the research in any way
- Is everyone/ are you happy to take part?
- There are some questions, and we'd like you to feel free to respond – there is no right or wrong answer and we are interested in everything you'd like to say – both positive and negative.
- We would like everyone to have a chance to speak and we will try to summarise what you have said to make sure we have understood correctly
- Is everyone/ are you happy to continue?

General

1. Are you practicing CA?
2. What type of CA are you practising? (Minimum till/ Min till plus crop residues/ min till crop residues and crop rotation/ all three plus trees)
3. What do you see as the main advantages of CA for your HH?
4. What do you see as the main disadvantages of CA for your HH?

Crop diversity

5. What crops are you growing in your CA system?
6. What other crops are you growing outside the CA system?
7. Are you using rotation/ intercrop with legumes in CA – why/ why not?
8. How easy is it to save/ obtain seeds for these crops (maize, legumes, others etc)
9. Which crops do you want to grow as part of CA project (ones not already grown)? What are the challenges to grow these?

Use of weeds/weeding issues

10. Do you use herbicides to suppress weeds? Why or why not?
11. Are weeds collected from CA plots used for making leafy condiments? If so which ones and who consumes them?

Workload – now thinking about the implications for workload on the farm

12. How does CA affect the time man, woman, children of HHs spends on farming – does it take more or less time than conventional agriculture? What aspects take most time?
13. What are the opportunities/ Challenges in introducing minimum tillage?
14. What are the opportunities/ Challenges in introducing use of crop residues/ mulch?
15. What are the opportunities/ Challenges in introducing legumes as intercrop/ rotation in the system?
16. How do you manage the weed issue? What is the impact on work of man, woman, children of HHs
17. Would you say your work involved in CA is light, moderate or heavy compared to conventional farming work? Why?
18. Which season(s) require the most time on CA activities for you personally ? How does this compare to conventional agriculture?
19. How have you spent any time saved? (probe – income generating, etc)
20. (WOMEN ONLY) Are there times in the year when you have less time to care for your children and nurse your baby? Do you think there is a difference between CA and conventional farming in the time you have available during the year for child care?

Economic & food security- now thinking about the effects on your household economy:

21. Has CA increased your yield of maize/ other crops?
22. Has CA enabled you to meet own food needs for cereals and legumes for longer/ shorter compared to conventional agriculture?
23. Has CA enabled you to cope with climate shocks/ variations? How?
24. Given this stressful rainy season who of the farmers estimates they would still be able to feed families up to April 2016, ie a year from now?
25. What affects decision on sale or consumption? (main field/ women's fields)
26. What are the main things that income from CA has enabled you to purchase? (probe any changes in food purchase)
27. What inputs do you use for production? Do you think it is possible to manage without inputs in an organic system?

Dietary consumption

28. Do you feel that since adopting CA you are able to provide enough food for yourself, your children and your family compared to conventional ag?

29. How are diets affected by any changes to production following CA?
30. Are legumes utilised by HHs and particularly for children as complementary foods.
31. What foods do you give to your child aged 6 to 24 months?
32. Has there been any change in the way you feed your children now you practice CA compared to conventional farming
33. How do you think CA can be adapted to provide for a full nutritious diet?

Decision making

34. Who decides on crops grown in CA system?
35. What about decisions regarding sale/ consumption of maize? Regarding legumes?
36. Who decides on food purchases for home consumption?
37. How does practicing of CA affect money spent on food
38. How has involvement in CA affected your role in the community?

Post harvest

39. Do you have any problems with post harvest handling of maize, or legumes?
40. Is processing of maize to flour happening in the communities? (is it roller, super-roller and breakfast)
41. What are marketing arrangements for CA foods. Are markets for legumes, groundnuts and other developed? Are these accessible to all?
42. Do you experience problems with infestation or spoilage with fungus post harvest? What is done to prevent this? – are there any differences noticed for CA produced food?
43. Are there any other issues relevant on post harvest related to CA?

Long-term

44. Do you see any long term benefits for CA? what?
45. How would you like to develop your CA practice in the future (eg new crops, new methods etc)

Case Studies Guide (male and female farmers)

Location:

Date:

Sex of participants:

Case study/ FGD:

Farmer(s) interviewed:

Introduction

- Thank for time
- We are carrying out some research on CA and how it affects households
- Time taken should be about an hour

- Your participation is voluntary and we will not be paying you for your time today
- Helping with this research does not mean we will be able to fulfil your wishes
- Your names will not be attached to the research in any way
- Is everyone/ are you happy to take part?
- There are some questions, and we'd like you to feel free to respond – there is no right or wrong answer and we are interested in everything you'd like to say – both positive and negative.
- We would like everyone to have a chance to speak and we will try to summarise what you have said to make sure we have understood correctly
- Is everyone/ are you happy to continue?

General

1. Are you practicing CA? How long since you started?
2. What were you doing before?
3. What size land holding do you have? How much do you cultivate in total?
4. Approximately what proportion of your cultivatable land do you use for min tillage (ripping or basin)?
5. How much do you use for rotation? Eg beans
6. What type of CA? (Minimum till/ Min till plus crop residues/ min till crop residues and crop rotation/ all three plus trees)
7. Have you received any training on CA – from whom? Any training on post harvest?
8. Have you received any other inputs for CA – from whom? Any help with post-harvest?
9. What do you see as the main advantages of CA for your HH?
10. What do you see as the main disadvantages of CA for your HH?

Crop diversity

11. What crops are you/ your wife growing in your CA system?
12. What other crops are you/ your wife growing outside the CA system?
13. Are you or is she using rotation/ intercrop with legumes in CA – why/ why not?
14. How easy is it to save/ obtain seeds for these crops (maize, legumes, others etc)
15. Which crops do you want to grow as part of CA project (ones not already grown)? What are the challenges to grow these?
16. What knowledge and skills have you learnt from CA and how applied to growing other crops
17. What varieties of maize are used in CA? any option for Biofortification- are only hybrids grown or can local varieties, landraces be part of cropping system in CA?

Use of weeds/ weeding issue

18. Do you use herbicides to suppress weeds? Why or why not?
19. Are weeds collected from CA plots used for making leafy condiments? If so which ones and who consumes them?
20. What inputs do you use for production? Do you think it is possible to manage without inputs in an organic system?

Workload- Now thinking about the implications for workload on the farm:

21. How does CA affect the time man, woman, children of hh spends on farming – does it take more or less time than conventional agriculture? What aspects take most time?
22. What are the opportunities/ Challenges in introducing minimum tillage? What is the impact on work of man, woman, children of HH?
23. What are the opportunities/ Challenges in introducing use of crop residues/ mulch? What is the impact on work of man, woman, children of HH?
24. What are the opportunities/ Challenges in introducing legumes as intercrop/ rotation in the system? What is the impact on work of man, woman, children of HH?
25. How do you manage the weed issue? What is the impact on work of man, woman, children of hh
26. Would you say your work involved in CA is light, moderate or heavy compared to conventional farming work? Why?
27. Which season(s) require the most time on CA activities for you personally ? How does this compare to conventional agriculture?
28. Are members of the hh exposed to any particular health risks by practicing CA?
29. If time is saved, what do you do with any time saved? / if it takes more time, what do you have to cut back on to make time for CA activities?
30. (women only) Are there times in the year when you have less time to care for your children and nurse your baby? Do you think there is a difference between CA and conventional farming in the time you have available during the year for child care?

Economic & food security- now thinking about the effects on your household economy

31. Has CA increased your yield of maize/ other crops?
32. Has CA enabled you to meet own food needs for cereals and legumes for longer/ shorter compared to conventional agriculture?
33. Has CA enabled you to cope with climate shocks/ variations? How?
34. Given this stressful rainy season who of the farmers estimates they would still be able to feed families up to April 2016, ie a year from now?
35. Are foods grown under CA practices for home consumption, sale or both? (main field/ women's fields)
36. What affects decision on sale or consumption? (main field/ women's fields)

37. How many months does the crop of maize last your family for home consumption? (main field/ women's fields)
38. How many months do the legumes you grow last your family for consumption? (main field/ women's fields)
39. What are the main things that income from CA has enabled you to purchase? (probe any changes in food purchase)

Dietary consumption

40. What is your usual diet in the household? (good season/ hungry season)
41. Do you feel that since adopting CA you are able to provide enough food for yourself, your children and your family compared to conventional ag?
42. How are diets affected by any changes to production following CA?
43. Are legumes utilised by HHs and particularly for children as complementary foods.
44. What foods do you give to your child aged 6 to 24 months?
45. Has there been any change in the way you feed your children now you practice CA compared to conventional farming
46. How do you think CA can be adapted to provide for a full nutritious diet?

Decision making

47. Who decides on land used for CA?
48. Who decides on crops grown in CA system?
49. Who decides on what should be done with the harvest from main fields and woman's plot?
50. What about decisions regarding sale/ consumption of maize? Regarding legumes?
51. Who decides what to do with the cash from sales?
52. Who decides on food purchases for home consumption?
53. How does practicing of CA affect money spent on health care?
54. How has involvement in CA affected your role in the community?

Post harvest

55. Do you have any problems with post harvest handling of maize, or legumes?
56. How are foods (maize, legumes) processed- by whom in the community
57. Is processing of maize to flour happening in the communities? (is it roller, super-roller and breakfast)
58. What are marketing arrangements for CA foods. Are markets for legumes, groundnuts and other developed? Are these accessible to all?
59. Do you experience problems with infestation or spoilage with fungus post harvest? What is done to prevent this? – are there any differences noticed for CA produced food?

60. Are there any other issues relevant on post-harvest related to CA?

Long-term

61. Do you see any long term benefits for CA? what?

62. How would you like to develop your CA practice in the future (eg new crops, new methods etc)

ANNEX 4 FOCUS GROUP DISCUSSIONS PARTICIPANTS

FGD	Location	Village	participants
Female (F1)	Kaoma	Chitwa	12
Male (M2)	Kaoma	Mwanche Central	9
Female (F3)	Kaoma	Kalumwange Scheme	13
Male (M4)	Kaoma	Kalumwange Central	15
Female (F5)	Mumbwa	Mulendema	17
Male (M6)	Mumbwa	Chicanda	23
Female (F7)	Mumbwa	Kabesha	19
Male (M8)	Mumbwa	Mukabe	16
		Total	124
Case Studies	Location	Village	participants
Female 1	Kaoma	Kalumwange	1
Female plus Male	Mumbwa	Chicanda	2

ANNEX 5 FIELD FINDINGS

Table 6 Household dietary practices and changes after adopting CA

Dietary practices		Changes since CA started	
Focus group	current adult diets	quantity of food	quality of food
1F	Quantity has increased but problems with relishes	increased	cooking oil, fish bought by some
2M	nshima, fish, cassava leaves, sweet potato, groundnuts for vegetables	from 1 to 3 meals per day now	Some buy more meat and fish and anything they want; others are not able to improve diet
3F	roller nshima, cassava leaves, beans, meat, soy sausage	Increased	animal milk available, more variety available at farm
4M	sweet potatoes, tea, pumpkin, roast groundnut. roller nshima fish eggplant vegetable	Increased	Grow more food and can buy everything want from town previously only nshima
5F	All use legumes e.g. special foods from soy	Increased	Can eat all year from production
6M	Eat we have, enough food now; was insufficient	increased	more peanut butter, soy beans and eggs
7F	eat what we want: vegetables, egg, fish, chicken, goat, beans, milk	now eat 5 times per day	now very varied diet with all food groups; beans, milk from cow, peanut butter, vegetables grown
8M	eat a wide range: peanut, vegetables, fish, sugar, meat, milk	increased	now very varied diet with all the food groups

Focus group	Current foods for child 6-24 months	Number of food groups	changes in foods following CA
1F	porridge, nshima, pumpkin, sweet potato, commercial cereal	2	buy commercial cereal for children
2M	ground nut in porridge, commercial cereal, mostly porridge	2	improved, from 1 to 3 meals per day. Now buy commercial cereal
3F	groundnut porridge with maize	2	now 3 meals per day now prepare special porridge with ground nuts, before just left-over nshima
4M	porridge with ground nuts, pumpkin banana guava vegetable soup, eggs, oil commercial cereal	5	now have groundnuts for porridge, plus commercial cereal, cooking oil
5F	porridge with soy or ground nut. Nshima and beans, one respondent mentioned fish made into paste with groundnut and beans	2-3	Before just left-over nshima
6M	porridge, ground nuts, soy	2	add soy to porridge
7F	groundnut in porridge, with maize, soy, pumpkin, ground fish (just one mother)	3-4	before just nshima,
8M	porridge with groundnut cowpea, eggs	3	they used to have left-over nshima

ANNEX 6 REFERENCES

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1. Imakando Kangwa, Kaeya (Senanga), by Carl Wahl. 2012;
2. Diverse foods cultivated and displayed in Mumbwa by Gareth Bentley, 2013

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