Ministry of Foreign Affairs of the Netherlands

IOB Study

Improving food security

A systematic review of the impact of interventions in agricultural production, value chains, market regulation, and land security

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December 2011

Preface

Since the publication of the World Development Report on 'Agriculture for Development' in 2008 and the growing concerns about the effects of rising food prices in subsequent years, food security has gained renewed interest from the international donor community. Consequently, the Dutch government has planned for substantially more emphasis on food security in its development cooperation for the period 2012-2015.

The Policy and Operations Evaluation Department (IOB) of the Ministry of Foreign Affairs has taken the initiative for conducting this systematic review of food security interventions, with the objective to inform policy makers on the available evidence regarding the effectiveness of different types of policy instruments. The main research question of this review is: '*what is the evidence for, and nature of, the impact of development interventions on food security in developing countries?*' The review is focused on four themes that are likely to contribute to food security, particularly interventions in the areas of agricultural production, value chains, market regulations, and land tenure security.

The format of a systematic review was selected to enable a careful selection of cases that satisfy the criteria for a sound empirical counterfactual analysis, thus excluding many interesting albeit not conclusive other evaluation studies. From the initial search of more than 300 studies published since 2001, only 38 studies finally qualified for inclusion. The results from the selected case studies have been enriched with information from literature reviews in order to complement and balance the limited information base.

The execution of this systematic review has been undertaken by IOB within the framework of an agreement with the OECD-DAC Evaluation Network (EvalNet) to enhance the availability of evidence-based information in key policy areas that can be helpful to support the use of evaluation outcomes for informed policy-making. In addition to other international efforts to improve access to systematic information and evidence regarding development effectiveness, this review is meant to inform program and policy design in developing cooperation in the area of food security.

This review does not pretend to deliver generic conclusions regarding which interventions have worked best and what interventions are most recommended to improve food security. Successes in the past were often the result of combined interventions that matched a specific context. Rather, by presenting much of the information in a disaggregated form, the review draws attention to specific sets of constraints and opportunities that need to be considered for generating impact in any particular area or country, thus asking attention for the requirements for tailor-made sets of interventions.

The study has been conducted by dr. Ferko Bodnár and dr. Bart de Steenhuijsen Piters (Royal Tropical Institute, KIT - Amsterdam), with assistance from Jisse Kranen (IOB research assistant) contributing to the search and first selection of the evaluation reports and other review documents. The study has been accompanied by dr. Henri Jorritsma, deputy director of the Policy and Operations Evaluation Department (IOB) of the Ministry of Foreign Affairs

and prof dr. Eric Smaling, director of the Development Policy and Practice Department of the Royal Tropical Institute. Comments on the draft report were received from dr. ir. Prem Bindraban (Wageningen University and Research Centre, the Netherlands) and prof. dr. Andrew Dorward (Imperial College, London, UK). Collaboration from colleagues at the Sustainable Economic Development Department (DDE) at the Ministry of Foreign Affairs is gratefully acknowledged. Editorial assistance has been provided by Dorothy Myers. IOB is responsible for the report's content.

We sincerely hope that this review provides a useful contribution to the design and appraisal of effective food security policies and programs that enable the more than 900 million poor people in developing countries to sufficient and sustainable access to food.

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Acronyms and abbreviations

3IE	International Initiative for Impact Evaluation
ADB	Asian Development Bank
AfDB	African Development Bank
AVRCD	The World Vegetable Centre
CGAP	Consultative Group to Assist the Poor
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	The International Maize and Wheat Improvement Centre
DAC	Development Assistance Committee
DEReC	DAC Evaluation Resource Centre
DFiD	Department for International Development (United Kingdom)
Evalnet	DAC network on Development Evaluation
ERR	External Rate of Return
FAO	Food and Agriculture Organization
FLO	Fairtrade Labelling Organisation
GAFSP	Global Agriculture and Food Security Program
GDP	Gross Domestic Product
GNI	Gross National Income
HH	Household
ICARDA	International Center for Agricultural Research in the Dry Areas
ICRAF	The World Agroforestry Centre
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICS	Internal Control System
IDB	Inter-American Development Bank
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
IOB	Policy and Operations Evaluation Department
IPM	Integrated Pest Management
IRR	Internal Rate of Return
IRRI	International Rice Research Institute
KIT	Royal Tropical Institute
MDG	Millennium Development Goal
MV	Modern Varieties
NGO	Non-Government Organization
NPV	Net Present Value
NRM	Natural Resources Management
OECD	Organisation for Economic Co-operation and Development
OPV	Open Pollinated Varieties
PARC	Pan African Rinderpest Eradication Campaign
PETT	The Peruvian Rural Land Titling Programme
SSA	Sub-Saharan Africa
WB	World Bank
WDR	World Development Report
WFP	World Food Programme

Summary

There is renewed interest in food security as one of the key themes in international development cooperation since the World Bank published its World Development Report 'Agriculture for Development' and subsequently food prices and the number of malnourished people in the world peaked in the same year, 2008. In order to support future food security policy making, the DAC EvalNet meeting in 2010 expressed the need for a systematic review of recent evaluations and other research that would provide evidence-based information on successful approaches. The Netherlands, through its evaluation agency IOB, proposed that it should take the lead in preparing this systematic review and the Royal Tropical Institute was invited to carry it out. The main research question of this review is: *'what is the evidence for, and nature of, the impact of development interventions on food security in developing countries?'*

The food security concept was therefore defined and delimited, after which the different pathways leading to food security were identified and some were selected for consideration in the review. The FAO distinguishes four aspects of food security: food availability at local or national level, food access (consumption) at household and individual level, stability of food access over time, and food utilisation resulting in a good nutritional status – the ultimate goal. From a large number of plausible impact pathways, four were selected for this review: interventions aimed at increasing agricultural production, developing value chains, reforming market regulation, and enhancing land tenure security. This review focuses on food access and access stability as impact indicators, household income and food security as proxy-impact indicators, while each of the four different impact pathways have their own specific outcome indicators.

Digital libraries of the major development organisations and scientific articles were searched for evaluation studies published since 2001. Many of the large agricultural development efforts that were undertaken in the 1980s have most likely been evaluated and reported in the 1980s and 1990s, and may thus have been excluded from this review selection. Studies were selected based on appropriate indicators and on a counterfactual analysis. From the 300-plus studies found after the first search, only 38 studies qualified for this review. Evaluation results were coded and organised into tables in order to find patterns explaining the level of impact. However, the 38 studies were so diverse that it was not possible to do a meta-analysis. Selected case studies were complemented with information from other reviews.

The limited number of qualifying studies, covering such a large and complex subject such as food security, prohibits drawing generalised conclusions. Successes in improving food security can often be attributed to a combination of interventions, impacting through different pathways, and under variable pre-conditions. Attributions to individual pathways can only be indicative.

Of the 38 selected studies, nineteen studies evaluated interventions aimed at increasing production as their main pathway, in Asia and Africa. Of these nineteen, ten impacted through research and extension, four through irrigation, and five through input provision

as the main strategy. Modern crop varieties developed through research were the basis for improved food security, especially in Asia. International collaboration and free germplasm exchange were key aspects explaining these successes. Research on avoiding production losses has been successful, especially in Africa. Irrigation in Asia not only increased production but also the stability of production between years and seasons. Increases in yield and labour productivity reduced production costs and farm gate food prices in Asia. This improved food security for consumers while farmers compensated their low prices with higher yields and off-farm income. Compared to the progress in Asia, sub-Saharan Africa lags behind because of its agro-ecological diversity and high transaction costs, notably in land-locked countries. Lowering input prices had substantial effects on production.

Six selected studies evaluated interventions aimed at developing value chains, one for the domestic market and five for the export market. Value chain development has successfully increased farmer net income when farmers joined experienced commercial partners and when gradual improvements were well planned. Substantial numbers of farmers participated in domestic and export value chains of simple bulk products, while only few farmers participated in export of perishable products. The risks associated with volatile markets required flexibility in products and buyers. Vulnerable people did not specifically benefit from value chain development.

Seven selected case studies evaluated interventions aimed at reforming market regulation in Africa and Asia - three through policy, two through organising output markets and two through organising input markets as their main strategy. Market regulation reform, in its simplest form, meant reduced trade barriers. This often coincided with an abrupt reduction of government support to the domestic agricultural sector; it has benefited countries that were competitive in the export market, but has discouraged farmers in many African countries where agriculture was not competitive. In contrast, gradual market reform, in combination with support to farmers, local market development or improved land security, has had significant results. Trade reform has reduced production costs through lower prices for inputs and equipment. Acute food production shortfalls are best mitigated by reduced trade barriers and private import of food.

Six selected case studies evaluated interventions improving land tenure security, all through policy reform. The transition from collective to family farms in China and Vietnam strongly encouraged production. Households obtained land use rights rather than ownership titles. However, land reform cannot be separated from the larger transition from a planned to a market economy which contributed spectacularly to the worldwide progress in food security in the 1980s and 1990s. Formalising informal land rights through land use certificates in Ethiopia or land titles in Peru did not improve access to credit but encouraged farmers to invest in agriculture. The land redistribution in the Philippines increased land access to poor households. Income was modestly improved especially where the new land owners also received other agricultural support. There is evidence that poor households obtain better access to land from land rental markets than from land sales markets.

Of the 38 selected case studies, ten studies provided sufficient information about intervention costs, numbers of beneficiaries and quantifiable benefits, from which costs and benefits per household could be calculated. Costs per beneficiary varied significantly from $2 per household per year for breeding disease-resistant crops, to $3,660 per household for those receiving a milk cow and access to cooling equipment. The interventions with the best benefit-cost ratios were research interventions that reduced production losses from cassava mealy bug and cassava brown streak virus, both in Africa, and supported disease-resistant wheat breeding worldwide. A large-scale land titling project in Peru also had benefits that exceeded project costs within one year. Good benefit-cost ratios were found in value chain development of traditional export crops. The lowest benefit-cost ratios were found in the free or subsidised fertiliser and seed programmes in Zimbabwe and Malawi, with high recurrent annual costs. However, project costs were still lower than the costs would have been for the import of food aid in case of national food shortage.

From the 38 selected case studies, 33 gave information about the expected sustainability. For ten interventions, there were doubts whether benefits would continue because annual recurrent costs were high, new technologies gave insufficient benefits, or donor policy conflicted with government policy. For four interventions, environmental problems including water pollution, land degradation, and soil mining undermined the sustainability.

In Africa, production increases have been achieved mainly by expansion of the cultivated area rather than by agricultural intensification. However, the selected case studies include successful interventions in Africa, notably in reducing production losses by introducing disease resistant crop varieties and other control of plant and animal diseases, and by setting up profitable value chains.

Good results in the past are no guarantee for the future. Impressive results from research were often based upon functional extension services, many of which have been cut back in recent decades. Climate change and more frequent droughts call for more emphasis on water efficiency. Increased land pressure from domestic and international investors requires better protection of local farmers and improved land tenure security, even in countries where land conflicts were not common in the past.

From this systematic review, it is not possible to conclude that one particular pathway will be more likely than another to have an impact on food security - for two reasons. First, not all impact pathways to food security were included in this review, and some included pathways were underrepresented by the lack of good evaluations. Secondly, improvements in food security were often the result of synergies between different interventions and pre-conditions: production, markets and land security, for example. Each area, country or region has its own unique set of constraints and opportunities. This review can provide background for specific situations, through the 38 examples presented, but without giving generalised recommendations.

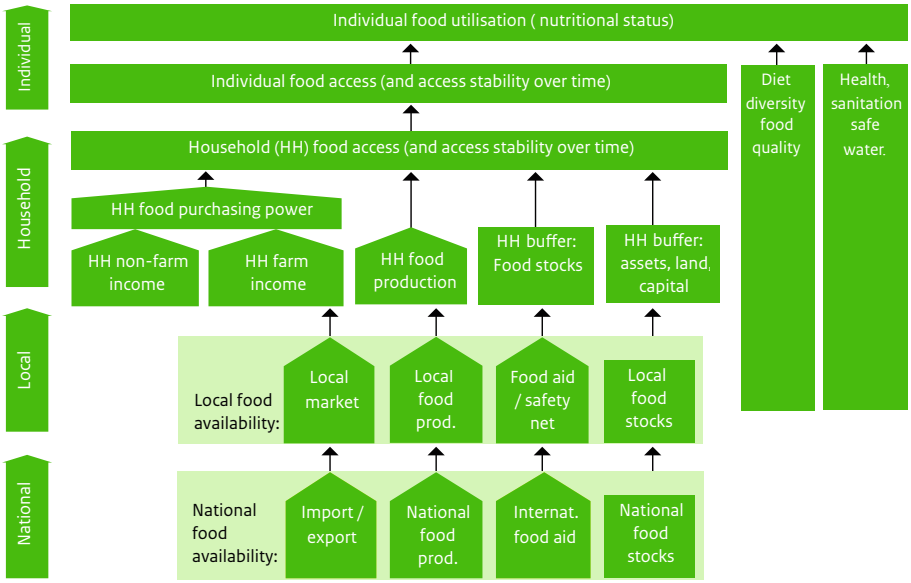
1

Background for the review

There is renewed interest in food security as one of the key themes in international development cooperation. Food security exists 'when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life' (Rome, World Food Summit, 1996). This goal was at the heart of the Rome Declaration on World Food Security, and formed the basis of the first Millennium Development Goal.

Four aspects of food security are distinguished by FAO: food availability[1], food access (consumption) at household and individual level, stability of food access over time, and food utilisation resulting in a good nutritional status – the ultimate goal. Figure 1 schematises the relation between national food availability (import + national production + food aid + food stocks), via local food availability, to household food access that is determined by farm and non-farm income, household food production, household food stocks and other assets that serve as buffer. Household and individual food access (and its stability over time) need to be accompanied by good diet diversity and food quality, good health, sanitation and safe drinking water in order to contribute to individual food utilisation that results in good nutrition status.

Figure 1 *Food security: relation between individual food utilisation and national food availability*

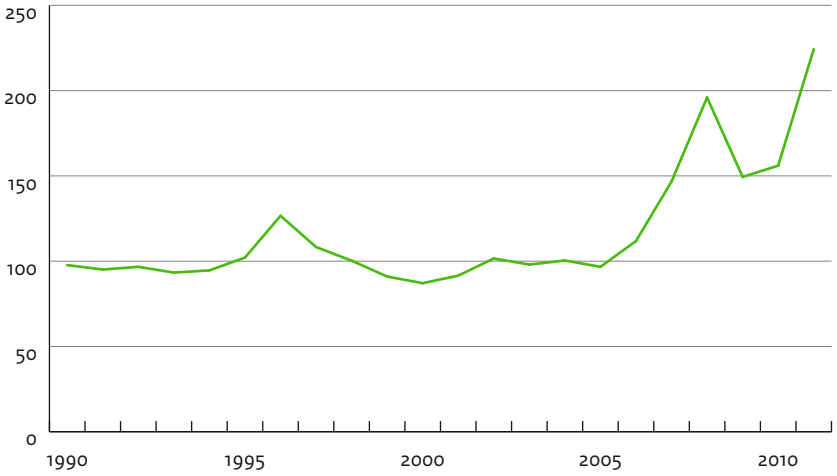


[1] This review avoids using the term 'national food security'. Some use this incorrectly for a sufficient 'national food availability', but strictly speaking a country is only food secure if 100% of its inhabitants is individually food secure.

The roots of today's food insecurity go back 25 years, when investment in agriculture started to decline. Aid to agriculture was 17% of total assistance in the late 1980s, but declined to 6%, representing $7.2 billion in the year 2007/08 (OECD-DAC, 2010). In developing countries, government investment in agriculture also fell in this period, by one-third in Africa and by as much as two-thirds in Asia and Latin America. In many low-income developing countries this was accompanied by policy reforms that dismantled public institutions that supported agriculture.

When global food prices almost doubled between September 2006 and June 2008, it became apparent that the world was facing a new era of uncertainty. Indeed, volatility returned to some food commodities markets in 2010-2011 (Figure 2) (FAO, 2011).

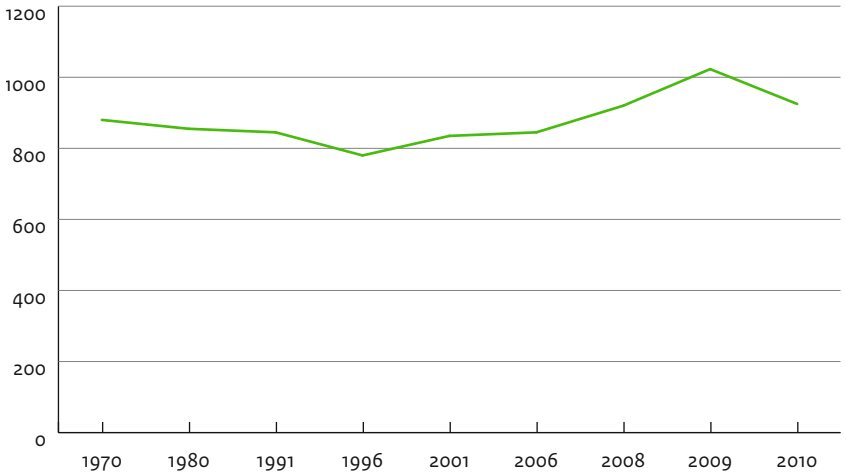
Figure 2 *Cereal price index, 1990-2011*



Source: FAO, 2011; deflated prices; index 2002-2004=100

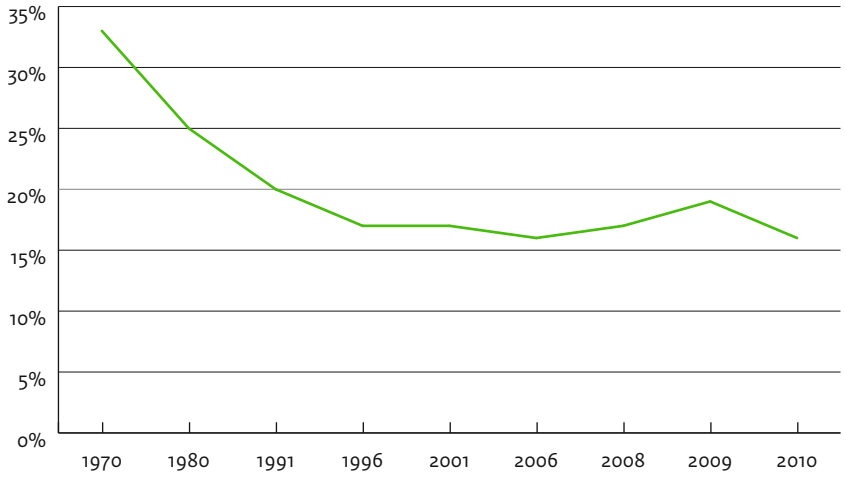
The number of undernourished people had reached an historical high 1,023 million in 2009 and is expected to decline to 925 million in 2010, a similar number as in 2008, which is about 16% of the people living in developing countries (Figure 3 and 4) (FAO, 2010).

Figure 3 *Number of undernourished people (millions) in the world, 1969/71 to 2010*



Source: FAO, 2010

Figure 4 *Proportion undernourished people in developing countries, 1969/71 to 2010*



Source: FAO, 2010

The majority of the undernourished, 62%, live in Asia, while Africa has the highest percentage of its population, 30%, being undernourished (FAO, 2010). Targeted investments for reinforcing food security are needed, along with comprehensive policy frameworks at global, regional and national levels. In July 2009, the G8 summit produced a Food Security Initiative, promising to mobilise more than $20 billion to strengthen global food production and security. In 2010, the Global Agriculture and Food Security Program (GAFSP) was established as a multilateral financing mechanism to help implement these pledges.

The report is structured as follows:

- Chapter 2 describes the objectives and research questions of this review.
- Chapter 3 describes the methodology, notably the delimitation of the evaluation subject, the criteria for evaluation quality, and the method of coding, analysis and presentation of results.
- Chapter 4 presents the quality of the evaluations found with respect to the indicators and counterfactual analysis.
- Chapter 5 presents the results of food security impact in detail for four selected impact pathways: increasing production, developing value chains, reforming market regulations, and improving land tenure security. For each of the four impact pathways, the case studies and additional reviews are summarised, followed by conclusions.
- Chapter 6 presents a comparison of costs and benefits for a limited number of case studies that provided sufficient information.
- Chapter 7 presents the indications found for sustainability: the continuation of benefits and environmental impact, and indications of scaling up.
- Chapter 8 presents an overview of the four impact pathways and the evaluation criteria: outcome, impact, sustainability, and costs and benefits.
- Chapter 9 gives conclusions in a broader context, and the implications for future food security interventions.

2

Objectives of the review

The objective of this review is to guide donors and policy makers in their choices of development interventions aimed at improving food security in developing countries.

The main research question of this review is: *'what is the evidence for, and nature of, the impact of development interventions on food security in developing countries?'*.
This review will use the following definitions:

- Interventions: projects, programmes and policies by government, multilateral, international and national non-governmental organisations, and UN agencies.
- Food security: out of the four aspects of food security - food availability, food access, stability in food access, and food utilisation, this review focuses on food access (often presented as energy consumption per person per day, or percentage of the population meeting energy requirements) and stability in food access at the household and individual level (mostly presented as the number of months per year with sufficient access), as impact indicators.

The specific research questions that will be answered are:

1. What was the intervention logic, i.e. what impact pathways were followed by development interventions, and what is the evidence of impact for each of these impact pathways? An impact pathway describes the link between the intervention and impact, i.e. between the intermediate outcome of interventions (including production volume, production value, markets, and land tenure security), via proxy impact (household food production, household income, and household food stocks, assets and capital), to food security impact (household and individual food access and stability in access).
2. To what extent is the impact different for different subgroups in the population, in terms of food insecurity? In other words, to what extent has the intervention specifically targeted and impacted the most food insecure people (including women and other vulnerable groups)?
3. What is the efficiency of the intervention: comparing the benefits for beneficiaries (considering the number of beneficiaries and the impact per beneficiary) with the total intervention costs?
4. Is there any proof of sustainability and scaling-up for the different types of interventions?
5. Why did an intervention work or not? Are there patterns in success or failure factors?

3 Methods of the review

For this systematic review, the guidelines and procedures mentioned in the protocol of the Campbell Collaboration were followed. Campbell Collaboration is a researcher network that produces and supports systematic reviews[2]. Key components of this protocol are: (i) clear inclusion/ exclusion criteria; (ii) an explicit search strategy; (iii) systematic coding and analysis of included studies, and (iv) meta-analysis (where possible). Procedures were defined and agreed upon in advance with an advisory group, and regular peer review by the advisory group was part of the process. The advisory group consisted of qualified independent researchers Bart de Steenhuijsen Piters and Eric Smaling of KIT, and Henri Jorritsma of IOB, who controlled the reviewers' methods and results.

A main difference with other systematic reviews is that the information from selected case studies is complemented by information from other reviews, presented separately, that the reviewers judged to be useful. This broadens the information base and reduces the narrow focus that could result from a poor harvest of selected case studies.

3.1 Inclusion and exclusion criteria

This review used two types of selection criteria: criteria related to the evaluation subject and criteria related to the evaluation quality.

Criteria related to the evaluation subject

The first step was to construct a set of pathways between development interventions and food security impact, after which the food security aspects and the impact pathways were delimited.

Construction of pathways to food security

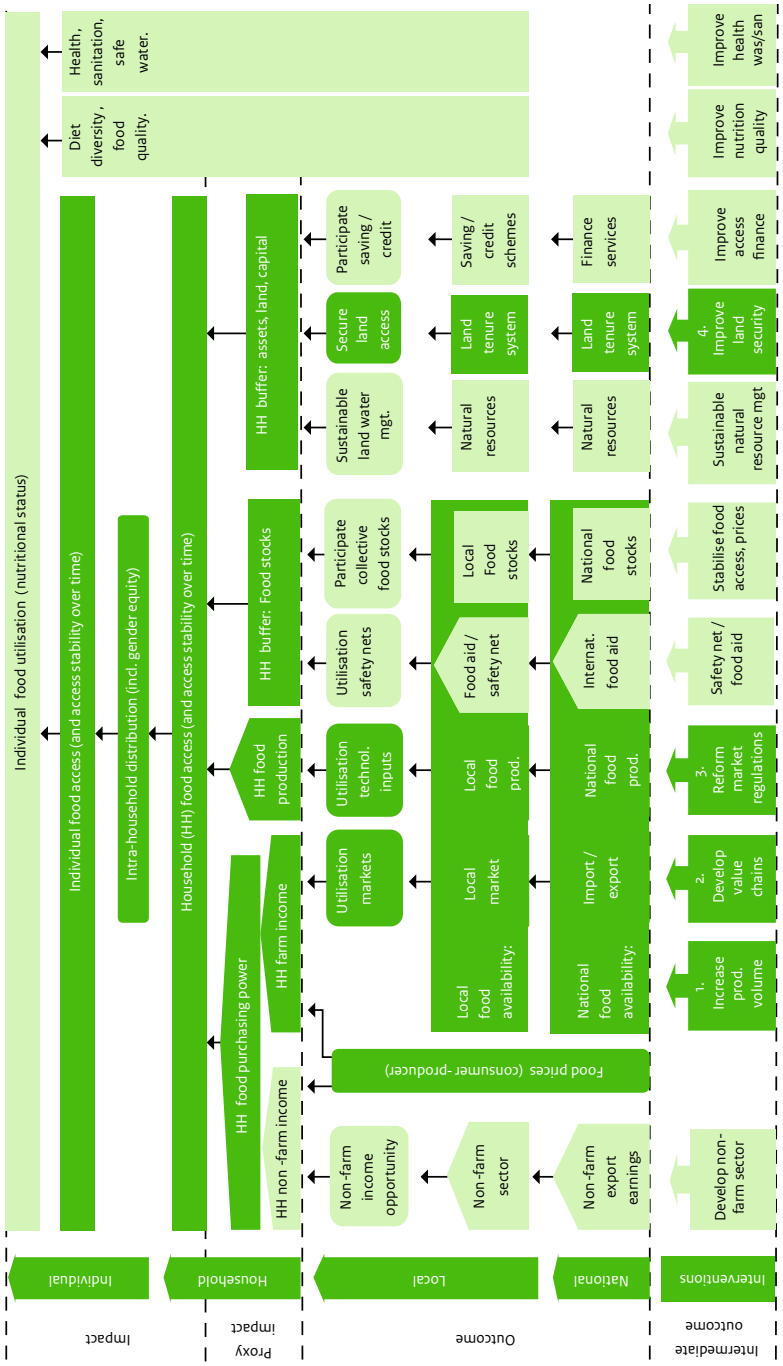
The constructed pathways between development interventions and food security impact are presented in Figure 5. Individual food utilisation, at the top, is the ultimate food security impact. It is often expressed as percentage of the population that does not suffer from malnutrition. This is not only determined by the amount of food eaten (food access), but also by a diverse diet with a good balance of macro and micro nutrients, safe drinking water and hygiene.

Individual food access, often expressed as daily energy intake or as percentage of the population meeting a minimum energy requirement, is determined by household food access and intra-household distribution.

Stability in household food access is often expressed as the number of months in a year with adequate food access.

[2] www.campbellcollaboration.org

Figure 5 *Impact pathways between interventions, from bottom going up via intermediate outcome, outcome, and proxy impact, to impact on food security*



Household food access is determined by the combination of household food production, household income, and household assets (food stock, other assets and capital) that may serve as a buffer in periods of food shortages.

Food prices play a complex role in food security. Higher prices may increase income for net producers, but may reduce food security for net consumers. It will be important to consider trends in food prices relative to wages or other price indices. The effect of interventions through food prices on food security will be discussed first for each pathway, and later under the overall conclusions.

Food availability, at local or national markets, does not guarantee food access at the household level, e.g. if the household lacks purchasing power. National food access is mostly expressed as tons of food in the country, which is the total of food imports, domestic food production, international food aid and food stocks.

Interventions aiming to improve food security (at the bottom of Figure 5) may enter at individual, household, local or national level. Interventions in this figure are simplified[3] and have only one 'intermediate outcome' or 'intermediate objective'. Most projects and programmes will have more than one intermediate outcome. The long list of eleven pathways[4] initially considered is given below:

1. Development of the non-farm sector, contributing to household income. A recent review is given e.g. by Haggblade, Hazell and Reardon (2010).
2. Increasing production volume, e.g. through research and extension, improved seed and inputs, and infrastructure as irrigation, roads, etc.
3. Develop value chains of cash crops, contributing to farmer income.
4. Reforming market regulation by governments, reducing barriers between producers and consumers.
5. Safety nets, distributing food or cash to the most vulnerable households. Good background and a review is given by Barrett and Maxwell (2005) and Bhattamishra and Barrett (2010).
6. Stabilisation of food prices and food availability at the national level by the government, e.g. by maintaining national food stocks or a marketing monopoly and subsidising food prices; or at village level by communities or farmer organisations, e.g. through cereal banks.
7. Sustainable natural resource management, ensuring that the productivity potential (of land, water, vegetation) does not deteriorate.
8. Improving land tenure security, by governments, which encourages land users to invest in agricultural production.

[3] The pathways are simplified to enable a good overview, but this simplification does not do justice to all relations. For example, finance and sustainable land management are also used to increase production, and not only to maintain a household buffer.

[4] These eleven pathways cover also the four entitlements (production based, trade based, own labour, inheritance and transfer) defined by Sen (1981).

9. Improved access to finance, facilitating investments in agriculture. The CGAP Gateway to microfinance contains two systematic reviews, by Duyvendack et al. (2011) and by Stewart et al. (2010).
10. Improved nutrition and food quality, necessary for good food utilisation. A systematic review was done by Masset et al. (2011).
11. Improved access to safe drinking water and improved hygiene, necessary for good food utilisation.

Interventions that addressed conflict, migration, or climate change, which also affect food security, were not included in this long list.

Delimitation of levels between interventions and food security impact

Impact: the review considers the impact up to the level of food access including stability in food access, and excludes the level of food utilisation (nutrition status). Proxy impact: household food production and household income, and household buffers (food stock, capital, assets). Food price is also considered as a proxy-impact indicator.

Outcome: because not all studies consider the whole pathway from intervention to food security impact, some studies consider an intermediate outcome indicator as indicator for the achievements of an intervention. Outcome indicators are specific for each intervention. For example, for increased production volume this could be changes in national food production; for developing markets this could be the food price difference between countries.

Delimitation of pathways leading to food security

It would not have been possible to systematically review interventions in all eleven pathways in the time made available for this review. Considering the other reviews that already had been undertaken, the reviewers and advisory group decided to prioritise and delimit four pathways that are strongly related:

1. Increasing production: government and non-governmental interventions that support agricultural production directly, through e.g. research and extension, seed and other inputs, irrigation, organisation of producers, organisation of output markets.
2. Developing value chains: interventions mainly by non-governmental organisations, farmers and the private sector, increasing product prices and farmer income through value addition and linking producers to new markets.
3. Reforming market regulations: government interventions to make markets more efficient, to open up markets for consumers, sometimes also to protect domestic production, through domestic trade regulations and adjustments in import and export trade barriers.
4. Improving land tenure security: government interventions, often piloted with donors funding, encouraging farmer investment in agricultural production through policy aimed at formalising informal land use rights or land ownership, or redistributing land.

The included impact pathways and aspects of food security are marked in dark green in Figure 5.

In addition, attention is given to two cross-cutting issues:
- The effect on vulnerable groups, including women, women-headed households, small and poor farmers, and other vulnerable groups.
- The effect on the environment, including water, soil and vegetation.

The review covered studies published in the last ten years (2001-2011) and evaluated interventions in low income countries (defined by the World Bank as GNI below $1,006) or lower-middle income countries (GNI between $1,006 and $3,975).

Criteria related to the evaluation quality

The most important criterion, which excluded the majority of evaluation reports, was that the presented results should be attributed to the intervention by a plausible counterfactual analysis. Preferably this is done by presenting both a comparison of 'before-after' intervention and a comparison of 'with-without' intervention. It is also possible to attribute observed changes to the intervention by modelling and multivariate analyses, which are often used in evaluations of country-wide interventions.

Eleven other quality criteria were derived from a format that IOB uses to assess the quality of evaluation:
1. clear definition of research questions;
2. suitable study design;
3. suitable research methods;
4. definition and demarcation of evaluation object;
5. reliability of information sources;
6. representativeness of results;
7. clear indicators and steps in pathway;
8. outcome indicators assessed;
9. clear description of intervention strategy;
10. consistency between results and conclusions;
11. usefulness of conclusions.

Based on the overall score for these eleven criteria, the reviewer could judge the overall evaluation quality and place it in the following categories:
1. Good quality evaluation: no doubt about conclusions.
2. Good quality evaluation, but the limited number of beneficiaries limits the reach of conclusions.
3. Quality of evaluation is only just sufficient; take conclusions as indications only.
4. Quality of evaluation is not sufficient: rejected (three or more out of eleven quality criteria scored insufficient).

3.2 Search strategy

This systematic review started with the search for studies that evaluated the impact of agricultural interventions on household or individual food security, published in English (and a few in French) between 2001 and 2011.

Data sources

The easiest data source was peer-reviewed scientific publications: they are concise and usually good at attributing effects to treatments. However, effort was made to search for so-called 'grey literature' - evaluation reports available from development organisations and institutions websites, together with portals of donor governments. First, this reduced positive-result publication bias, and secondly these reports often provided more complete information on project set-up, interventions and costs, compared to more concise journal articles. The number of studies found after the first key word search, and after the first screening of title and abstract is presented per source in Table 1.

Table 1 Number of studies found after the initial key word search and after the first screening on title and abstract

Type	Portal	1. Key word search	2. Screening title and abstract
Scientific journals	Web of Science	373	55
Development institutions	ADB[c]	32	24
	AfDB[ab]	49	17
	CARE[a]	44	12
	FAO[b]	93	29
	IDB[b]	139	12
	IFAD[a]	89	39
	IFPRI	43	23
	WFP[b]	15	9
	Worldbank[b]	120	59
Intermediate portals	AgEcon	58	24
	DEReC	268	37
	Eldis	46	25
	3ie	3	0
	Search4Dev	1	0
Total studies		**1369**	**365**

[a] *no advanced search possible, per topic only (food production and agriculture & agro-industries)*

[b] *select document type: evaluations, journals and documents, food security analysis papers only*

[c] *search on 'food security' only*

Steps in the search procedure and coding of reports

Two reviewers were involved in the search and selection procedures. The selection process is presented in Figure 6 and described below.

Step one: keyword search

A Searching scientific journals and Web of Science

Keywords in title and topic:

'food security' AND 'impact' AND ('agricultur*' OR 'production' OR 'production value' OR 'production costs' OR 'markets' OR 'trade' OR 'prices' OR 'prices' OR 'safety net' OR 'women' OR 'gender' OR 'environment' OR 'finance' OR 'value chain')

B Searching development organisation evaluation portals

Keywords in title and topic:*

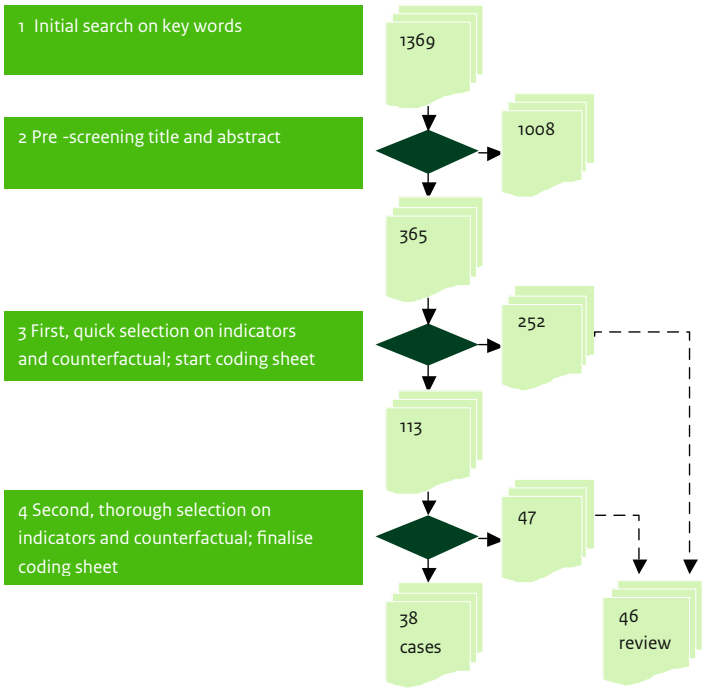
'food security' AND 'impact' AND 'eval*' AND ('agricultur*' OR 'production' OR 'production value' OR 'production costs' OR 'markets' OR 'trade' OR 'prices' OR 'prices' OR 'safety net' OR 'women' OR 'gender' OR 'environment' OR 'finance' OR 'value chain')

*In case no advanced search option was available, search per agriculture related topic only

*In case of a large variety of document types, included evaluations and food security analyses only

*In case of very limited results search on 'food security' only

Figure 6 *Numbers of studies during the subsequent search, screening and selection procedures*



Step two: screening of title and the abstract only: did this article seem to evaluate and assess the impact of an agricultural intervention on (household) food security?

- Some reports were obviously not relevant and excluded.
- Some reports seemed to qualify and were accepted for quick-screening on methodology.

Step three: quick-screening on methodology. Did the article/report use a reliable counterfactual analysis (e.g. by a 'with/without' intervention)?

- Reports that did not use a reliable counterfactual analysis were excluded; reports provided such counterfactual analysis were included for first coding.
- Note: a large number of reports were rejected at this stage.
- The first reviewer filled in first part of coding sheet: minimum criteria (indicators used, comparisons made and type of the intervention)
- Reports that did not score sufficient on the minimum criteria were excluded.
- Reports that scored sufficient on the minimum criteria were forwarded to the second reviewer.

Step four: the second reviewer completed coding sheet and assessed the overall evaluation quality of report

- Reports that did not score sufficient on the quality criteria were excluded.
- Reports that score sufficient on the quality criteria were used for analysis. The report plus coding sheet were classified:
  - evaluation of food security impact of intervention;
  - evaluation of intermediate outcome of intervention;
  - correlation between intermediate outcome indicator and food security.
- Data was extracted (details of intervention, outcome, impact, and summary) for further analysis.

In some cases, reviews or evaluations referred to other promising reviews or evaluations that were not found in the initial search. Exceptionally, such references have been added to the selected studies. The number of studies per subject through the subsequent screening rounds is presented in Table 2.

Table 2 Number of studies per subject after the different screening rounds

	2. Screening	3. Screening	4. Screening Quality 2	
	Title and abstract	Quality 1	Case studies	Other reviews
Production	94	55	19	11
Value chain	27	8	6	5
Market regulations	57	24	7	12
Land security	19	10	6	5
Other subjects	168	16		13
Total	**365**	**113**	**38**	**46**

The final selection included 38 qualified case studies: nineteen for the pathway 'production', six for 'value chains', seven for 'markets' and six for 'land security'. In addition, 46 other review studies and meta-analyses were judged useful, which were either found directly from the systematic search, or indirectly from references in selected case studies. These were not treated in coding sheets or presented as selected case studies, but were simply summarised and presented separately under 'other review'. An overview of the 38 case study summaries and their scoring is presented in Annex 4. The geographical coverage of the 38 case studies is presented in Figure 7.

The large share of about 90% of evaluations that were excluded, after the first screening on title and abstract, is not exceptional in systematic review. The DFID systematic review of agricultural interventions that aimed to improve the nutritional status of children, initially found 7,239 studies from the first search, of which 307 studies passed the first selection criteria on year of publication, country of interest, and suitable outcome indicators. Of those 307, only 23 studies passed the second selection criteria of the study methodology including a control group (Masset et al., 2011).

A World Bank review of 161 agricultural water management projects between 1994 and 2004, with an average budget of $35 million, found that only 11% of the projects had both good indicators at outcome and impact level, and the tools (baseline and control group for counterfactual analysis) to do a valid impact assessment (World-Bank, 2006).

A benefits-costs meta-analysis of CGIAR research investment projects used a certain flexibility in their selection criteria based on transparency and attribution. Of the several hundreds of studies published between 1989 and 2002, only four qualified under the strictest criteria, while fifteen qualified under the less strict criteria (Raitzer, 2003). In a similar meta-analysis of CGIAR research in Africa, between nine and 23 studies qualified, depending on the strictness of the selection criteria. The selected 23 studies represented only 5% of the total CGIAR research investment in Africa (Maredia and Raitzer, 2006).

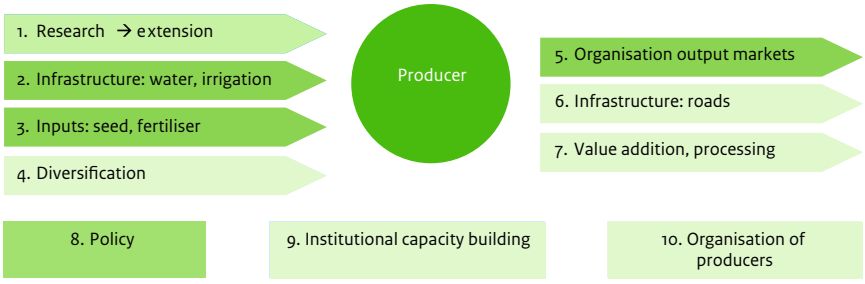
Figure 7 *Geographical coverage of the 38 selected case studies*

The small number of 38 selected case studies is a narrow basis for drawing conclusions on such a large subject with four pathways to food security. Therefore, the additional other review plays an important role to put the case study results in perspective.

3.3 Coding of included studies

A 'coding sheet' was developed that reflects the selection criteria and the indicators derived from our research questions. The coding sheet is presented in Annex 3. For each selected evaluation report, one coding sheet is used to extract the essential information for further analysis. Apart from the different impact pathways between development interventions and food security impact, different strategies were considered that characterise the intervention and its relation to the targeted producer. The aim was to better understand what intervention characteristics contributed to success or failure. Ten strategies were considered, but not all strategies were relevant for each pathway (Figure 8).

Figure 8 *Strategies characterising development interventions*



A simplified score was added to each evaluation for the criteria: impact, impact on vulnerable households, proxy impact, sustainability and scaling up, and costs and benefits, see Table 3.

Table 3 Scoring of impact, proxy impact, outcome, sustainability, and costs and benefits

Evaluation criteria	Judgement
Impact	+ Any positive impact 0 Negligible impact
Proxy impact	+ Any positive impact 0 Negligible impact - Negative impact
Outcome	+ Any positive outcome 0 Negligible outcome
Effect on vulnerable people	+ More impact, proxy impact or outcome on vulnerable people = Equal impact, proxy impact or outcome on vulnerable people - Less impact, proxy impact or outcome on vulnerable people
Sustainability	B+ Benefits continue after funding stops B- Benefits stop after funding stops E+ Environmental impact positive E- Environmental impact negative Scale and scaling up: yes/no
Costs and benefits	+++ Annual benefits outweigh project costs ++ Cumulative benefits outweigh project costs within five years + Cumulative benefits outweigh project costs within ten years - Cumulative benefits outweigh project costs in more than ten years

3.4 Analyses and presentation of included studies

Systematic reviews may include a meta-analysis ideally using few uniform quantitative indicators or using normalised indicators based on diverse quantitative or semi-quantitative results which can be compared across the individual evaluations. For this systematic review of food security interventions, it was foreseen that results would be presented using many different quantitative and qualitative indicators, which would be difficult to normalise without losing much of the information. Therefore, this review did not foresee using a real meta-analysis to come to conclusions.

The food security results (impact, proxy impact, outcome, and effect on vulnerable people) are presented in detail for each case study. For each of the four pathways there is a results-section presenting the case study summaries complemented by other review information. Within each results-section per pathway, the case studies are grouped per main strategy. This gives a first impression of what combinations of pathways and strategies have worked where and for whom.

The environmental impact, the sustainability and scaling up, and the comparison of costs and benefits are presented in separate chapters, looking at patterns across development pathways and strategies, without re-presenting the individual case studies again.

3.5 Retrospective of the systematic review methodology

Having undertaken this systematic review on interventions aimed at improving food security, we would like to critically review the methodology used and to come up with a few recommendations for those who consider using a systematic review methodology.

The evidence base from selected case studies is too thin

The subject 'food security' is too comprehensive to be covered by 38 case studies alone, even though food security was delimited to just four pathways: production, value chains, market reform, and land tenure. For example, only six case studies for the pathway 'land tenure security' – which in itself covers several subjects in very different contexts – is too meagre to draw more general conclusions. This gives the uncomfortable feeling that the small number of case studies seemed to be an arbitrary sample of those interventions that by coincidence happened to be evaluated according to our minimum standards. Had other interventions been well evaluated, how different would our conclusions have been? If other information sources would have been used, such as PhD theses, other NGO libraries, or a longer period of publication data, more case studies could have been included. One recommendation we would not make is to loosen evaluation quality criteria, because this would reduce the added value of a systematic review over a normal literature review.

Period of publication bias

Studies were only included if published between 2001 and 2011. This meant than the majority of evaluations (26 out of 38) reported on interventions that started after 1990. Between 1990 and 2011 the ODA share spent on agriculture declined. Many of the large agricultural development efforts that were undertaken in the 1980s were thus only thinly covered in the evaluations published from 2001 onwards. Large scale interventions in the 1980s include regarding strategic food reserves and studies on the effects of reserves and food aid on food prices, farmer organisation and empowerment, small-scale irrigation as opposed to large-scale dam-based irrigation, and soil and water conservation.

Systematic review works better with more homogeneous case studies

Meta-analysis can be a useful analysis component in a systematic review. All selected case studies were coded and entered into a statistical database. Unfortunately, analyses failed because the selected case studies were too diverse in two ways. Firstly, the cases varied in input and output indicators. Secondly, the cases varied in scale and complexity. A systematic review would work better with more homogeneous cases: in subject (e.g. land tenure projects only); in complexity (e.g avoiding agricultural reform, consisting of many interrelated interventions); in scale (e.g. avoid comparing village-level interventions with national level interventions); and using at least partly the same indicators of outputs (production, income, food security) and inputs (donor costs, other costs, labour).

Hybrid review methodology

For this review, a hybrid methodology was used. It combined a systematic review protocol with a more general summary of other reviews. The latter provided comprehensive 'common knowledge' to confront and balance case study results. What is the added value of using this hybrid methodology compared to a regular systematic review – without additional review, or than a 'normal' literature review – without strict selection criteria?

A normal literature review could have summarised most likely over 200 studies with the same effort now used for 38 case studies and 46 other reviews. It would probably have resulted in repeating long-standing conclusions without critically verifying whether the evidence is based on good evaluation methodology. In addition, it would be difficult to compare studies on a similar set of indicators, and to draw more generic conclusions. Conversely, limiting the review to the few, systematically selected case studies, without confronting this to broader review, could have resulted in conclusions that are too much determined by the coincidence that an intervention happened to be evaluated properly.

In conclusion, we think that this hybrid method of systematic review using strict selection criteria, plus a summary of other reviews to confront and balance case study results can help us to move forward towards more evidence-based conclusions, and, at the same time, to reduce the narrow information base caused by the evaluation quality criteria. A recommendation for future use of this hybrid systematic review methodology is that a good delimitation will allow the use of sufficient homogeneous studies, in terms of subject, complexity, scale, and indicators reported on.

4

Indicators and counterfactuals in selected evaluations

This chapter gives an overview and discusses the appropriateness of the assessed indicators and the counterfactual analyses used in the 38 qualifying evaluations.

4.1 The appropriateness of the assessed indicators

Indicators should ideally reflect food security itself (impact), reflect the underlying household income or household food production (proxy-impact), or reflect the lower outcome level. Outcome indicators are specific to the interventions chosen as the pathways to food security for this review (outcome: agricultural production, production value, markets, land tenure security).

Indicators for food security

The level of food security is understood as the percentage of the population meeting minimum food requirements (e.g. eating more than 2200 kcal/day), a so-called 'head-count indicator', and not as the average food intake for a whole country. The latter may be interesting as long as the majority of the population is not food secure, but the national average food intake may camouflage the persistence of a food insecure group at the bottom of society.

The hunger index as used by IFPRI, Concern Worldwide and Welthungerhilfe (Von Grebmer et al., 2010) reflects the highest food insecurity level. It uses a combined indicator: the percentage of the population that is malnourished plus the percentage of children under five that is malnourished plus the percentage of children that dies before the age of five (Table 4, indicators 1 to 4).

At the start of the review, it was not clear which indicators were used in the evaluation of food security interventions. Therefore this review was initially open to any indicators that could represent food security. Table 4 gives an overview of food security indicators used for food utilisation, food access and stability in access. It presents ideal indicators, acceptable indicators found in our selected cases, and rejected indicators that did not qualify in the review.

Out of 38 selected case studies, thirteen used food security impact indicators, of which three used ideal 'head count' food security indicators and nine used acceptable indicators based on target group averages.

'Average energy intake' and 'number of months per year of household food security' are acceptable food security indicators as long as the majority in the population has an energy intake below the minimum requirement, or is not yet food secure for twelve months of the year.

Three selected case studies reported on child malnutrition. None of the studies presented intra-household differences in food security.

Table 4 Food security impact indicators: ideal, accepted and rejected indicators				
nr	**Aspect**	**Ideal indicators***	**Accepted for review**	**Rejected for review (examples)**
1	Hunger index	Combination of indicators 2+3+4		
2	Food utilisation	• % population malnourished (2)		
3		• % children under 5y malnourished (2)		
4		• % child mortality under 5yrs.		
5	Food access	• % population meeting energy requirements (1)	• Average energy intake (5) • % eating 3 meals/ day (1)	• Diet diversity score** • Consumption one nutrient** • % population food secure extrapolated from average income • % population food secure extrapolated from national food production
6	Food access stability	• % households being food secure all year	• Number of months per year that household declares itself food secure (6)	

** Number of selected case studies using the indicator in brackets*

*** Diet diversity score and consumption of specific nutrients were outside the scope of this review.*

The variation in food security indicators used in evaluations poses problems in comparing evaluations in terms of effectiveness and impact. Of all indicators used, child malnutrition is probably the most objective one, with well documented and standardised methodology (age, height, weight of children under five years old, with reference tables per country).

Food security impact is not only captured by the above indicators, but also by the scale of intervention and the number of beneficiaries. Of the 38 selected case studies, 22 presented numbers of beneficiaries, nine studies explained that the whole country benefited, four studies gave only a rough indication, and three studies did not present numbers of beneficiaries.

Proxy-impact: household income, food production and food price

Household food security is determined to a large extent by household income and household food production, complemented by household buffers (food stocks, capital and assets). Food price, in relation to income, determines the food purchasing power. Indicators are presented in Table 5.

Household income is useful if used as a head count indicator: the percentage of the population having an income above a poverty threshold (e.g. as set by the World Bank in

2008 at $1.25 per person per day). This is different from the average income of a population. However, if the majority of a population has an income below the poverty threshold, average income is an acceptable indicator. Income thresholds need to reflect food purchasing power and should ideally be deflated for staple food prices. Some monitor household expenditure, often easier to monitor than total household income. Household income is best assessed by asking household expenditure.

Household food production is a useful indicator only where consumption relies largely on that production. If no, or little, staple food is bought, then thresholds for food production can be established (e.g. 180 kg /p/y). As with the above-mentioned indicators, the ideal indicator is the percentage of the population producing a quantity of food above a threshold. If the majority produces insufficient food, then average production is an acceptable indicator. It is possible to add up different crops as kg cereal equivalent, or as total crop value. Total crop value is accepted as a food production indicator, but not as an income indicator because production costs are not included. Instead of monitoring all crops, it is acceptable to monitor the main staple crop.

Table 5 Proxy impact indicators: ideal, acceptable and rejected indicators for household income or food production

nr	Aspect*	Ideal indicators	Accepted for review	Rejected for review (examples)
7	Household income, purchasing power (20)	• % living above / below poverty threshold (6)	• Average annual income ($/p/y; $/hh/y) (9) • Average annual farm income, assuming that non-farm income does not change (8)	• Income from one commodity, neglecting other income • Crop value, neglecting production costs
8	Household food production (9)	• % hh producing sufficient food (threshold) (1)	• Staple food production (cereal equivalent kg/p/y) (5) • Production value ($/hh/y) (6) • Production of main staple (kg/p/y) (3)	• Production of one crop, not the staple crop
9	Food price (4)	• Trends in food price (% increase/ decrease /yr) (3) • Food price relative to wages (kg/day) (1)	• Food price ($/kg)	
10	Household buffer (4)	• Buffer food stock, above a minimum stock (kg/p) • Buffer capital or assets, above a minimum capital ($/p)	• Food buffer (kg/p) • Capital ($/p) (4)	• Assets that do not serve to bridge a period of food shortage (housing, farm equipment, land)

**Number of selected case studies using the indicator in brackets*

Some evaluations assess a change in only part of the household income or food production, without verifying the overall household situation. Income or production from one activity may have increased at the expense of another activity. It is best to assess overall household income or food production but if only part of the income or production is assessed, then it could be strongly argued that this was not at the expense of other income or production.

Food prices, in relation to wages or other price indices, are influenced by the production costs and the efficiency of the farming, but also by competitive supply from elsewhere. While higher food prices may seem better for net producers and worse for net consumers, the majority of small, vulnerable farmers are on the edge between net production and net consumption and do not benefit from high prices (Naylor and Falcon, 2010). Whereas increases in average income or average production may hide persistent food insecurity among the most vulnerable people, a reduction in food prices relative to wages or other price indices can be assumed to benefit the most vulnerable people.
Household buffers, in the form of capital, food stock, or other assets that can be exchanged for food, help households to bridge a lean season or a crop failure. Household buffers are best expressed in amount per household member. No evaluations considered a threshold value for household buffers above which one can consider a household food secure.

In conclusion: of the 38 selected case studies, 28 cases presented proxy impact indicators. Of those 28, twenty cases presented household income, nine cases presented food production, four cases presented food prices, and four cases presented household buffers. Of the 28 cases with proxy indicators, nine cases utilised an ideal head count indicator – the percentage of the population below a poverty threshold.

Outcome indicators for specific interventions

Indicators at the outcome level are very specific for each intervention. A brief overview of indicators used is presented in Table 6. Case studies were not rejected on the basis of outcome indicators, as long as there were also indicators at proxy impact or impact level.

Table 6	Outcome indicators: ideal and other accepted indicators for production, value chain, market regulations and land tenure security		
nr	**Aspect***	**Ideal indicators**	**Accepted for review**
11	Production	• Yield (kg/ha; % increase) x adoption (ha) (11) • Value yield ($/ha; % increase) x adoption (3) • National avg. yield (t/ha; % increase) (1) • National production (t; % increase) (4) • Production costs ($/kg; % decrease) (1)	• Yield (4) • Adoption (2) • Value yield ($/ha) (1)
12	Value chain	• On farm added value ($/kg; $/hh) (consider also additional costs) • Off-farm added value ($/kg) (consider also additional costs)	(most value chain projects use crop value or household income as indicators)
13	Market regulation	• Price difference producers (rural) / consumers (urban) ($; %) • Price difference between countries (2)	• Participation private sector (1) • Farmer use of inputs (1) • National stocks (t) (1) • Import and export (t/y) (1) • Synchronisation rural-urban price fluctuations (market integration) (1) • Export volume (t; $) (1)
14	Land security	• Number of farmers with certificate (4) • Area certified (2) • Number of farmers renting in land (1) • Number of farmers renting out land (1) • Investment in land (1) • Number of farmers with access credit (2)	• Farm ownership smallholders (1) • Share cropping smallholders (1) • Farmers feel land secure (1) • Land inheritance daughters (1)

**Number of selected case studies using the indicator in brackets*

For the outcome 'production volume', there was often need for different indicators in combination to usefully reflect progress in food security. For example, the impact on yield (kg/ha) of an improved practice or improved variety combined with the adoption rate (% land area) under that improved practice or variety. This combination is also used in the CGIAR meta-evaluations (Raitzer, 2003; Maredia and Raitzer, 2006) of the impact of research on food production. One of the two indicators alone - yield increase or adoption rate - does not mean much in terms of impact.

In conclusion, 31 of the 38 case studies presenting outcome indicators also presented (proxy) impact indicators. In such cases, incomplete outcome indicators (e.g. yield alone, or adoption alone) were still accepted, thus making the link between intervention and impact more plausible. However, case studies presenting incomplete outcome indicators, without (proxy) impact indicators, were rejected. Seven case studies relied solely on outcome indicators.

Effect on vulnerable people

Food security will only be improved if the direct or indirect beneficiaries of an intervention were food insecure. Of the 38 case studies, seventeen present or discuss specifically the effects on vulnerable people: poorer households, smaller farms, women, landless, or people from lower castes. This serves as an indication of the effectiveness in reaching the more food insecure people. In other case studies, the effect on vulnerable people was not specifically presented. In some situations it can be assumed that the majority of beneficiaries were food insecure, but in other situations it should be questioned whether the intervention reached the most food insecure people.

The list of 38 selected case studies, with information on the indicators used at impact, proxy impact and outcome level is presented in Annex 4.

4.2 The quality of the evaluations in attributing effects to intervention

Changes found by evaluations should be attributed to the intervention by a convincing counterfactual analysis, and by making a comparison with what would have happened if the intervention had not taken place. This is ideally done by comparing targeted and non-targeted households, villages or even countries, or by more complex models based on multivariate analyses of a population in which individuals participated to various degrees in the intervention. Models are often used to evaluate country-level interventions.

The purpose of this systematic review is to draw conclusions about what effects interventions had on food security, by combining information of different evaluations. Reported effects need to be attributed to the intervention, and should not reflect the overall development effect to which an intervention may have contributed. For this review a counterfactual analysis was therefore a requirement. The majority of evaluations of food security interventions have not done this, most likely because donor organisations simply did not require it.

Initially the review accepted case studies that either made a comparison between baseline and impact survey (without a control group), or made a comparison between a group of beneficiaries and a group of non-beneficiaries as a control group (without baseline data). However, many evaluations without a control group, turned out to be unconvincing in their counterfactual analyses. Food security indicators are influenced by many external factors, so one cannot simply assume that nothing would change in the absence of an intervention.

This is illustrated by those evaluations that made both comparisons. Out of the 38 selected case studies, nineteen case studies made a 'with-without' and a 'before-after' intervention comparison. Out of those nineteen, twelve case studies presented so-called 'double difference' results. All twelve cases showed that the trends for the control group were not negligible and of a similar magnitude to the difference between beneficiaries and non-beneficiaries. In seven cases, the control group situation worsened, while in five cases it improved. So, without a control group, effects would either have been underestimated (seven cases) or overestimated (five cases).

For this review, the ideal evaluations made both comparisons: 'with-without' plus 'before-after' intervention. In the absence of baseline data, a 'with-without' comparison can be strengthened by matching techniques. 'With-without' comparisons need to consider possible spill-over effects that reduce the difference, or possible effects of self-selection by beneficiaries, often increasing the differences. Acknowledging that participants and non-participants may have been different before the intervention (e.g. in availability of land, equipment, or labour), such differences can be used as covariates in the analyses. Without such matching techniques, a simple 'with-without' comparison becomes risky but was still accepted in three cases. A separate group of evaluations made use of modelling and multivariate analyses. They often analysed country-wide effects, did not make a clear 'with-without' comparison, but were able to attribute part of the overall change to interventions and other factors. Some of these model analyses were accepted in this review while others were rejected because of clear shortcomings in the model and underlying assumptions. A simple comparison of baseline with end-of- project survey, without any plausible attribution to the intervention, was always rejected. Table 7 gives an overview of the counterfactual analyses of the selected case studies.

Table 7 Counterfactual analyses of selected case studies

Quality of counterfactual	Cases	Type of analyses
Ideal	12	'Before-after' + 'with-without' comparisons
Good	12	(No baseline) 'with-without' comparison + matching techniques
Acceptable	3	(No baseline) 'with-without' comparison (no matching techniques)
Acceptable model	11	Trend, multivariate analyses, plausible attribution
Total	**38**	

In conclusion, the majority of food security evaluations could not present a convincing counterfactual analysis and could therefore not attribute the observed changes in food security to the intervention. Simple comparison between a baseline and end of project situation is insufficient because one cannot assume that food security would not change in the absence of an intervention.

5

Outcome and impact of different pathways to food security

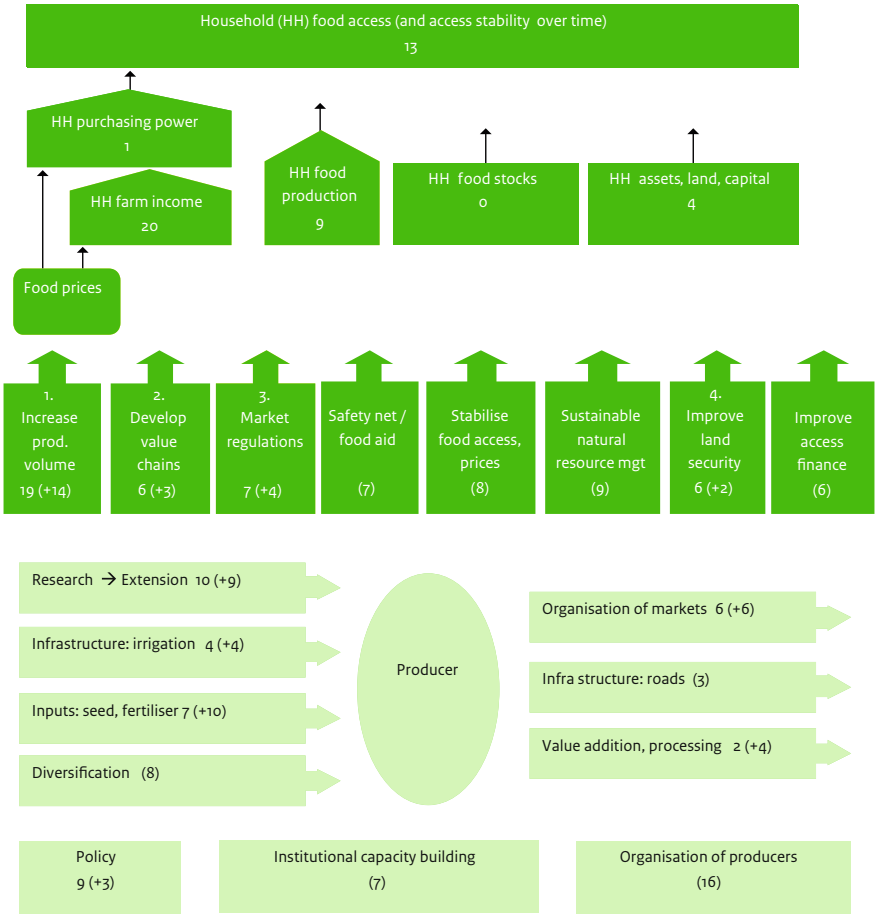
5.1 Overview of pathways and strategies

Of the 38 selected case studies, nineteen had 'increasing production volume' as the main pathway, six had 'developing value chains' as the main pathway, seven had 'reforming market regulations' as the main pathway, and six had 'improve land tenure security' as the main pathway. In most case studies, the main pathway was combined with other pathways, including those not in the primary focus of this review: safety nets, stabilisation of food access and prices, natural resource management, and access to finance.

For each case study, one main strategy was identified. Most frequently mentioned as the main strategy was research and extension (ten cases), followed by policy (nine), inputs (seven), output markets (six), irrigation (four), and value addition (two). In most cases, the main strategy was combined with other strategies. Details about combinations are presented in the results subsections per pathway. Figure 9 presents an overview of the frequency with which the ten strategies and the eight pathways were used to achieve food security. It also presents the frequency with which food security indicators were reported.

This overview only gives a first impression of the most frequently used pathways and strategies, with the obvious bias that the review selected case studies which had production, value chains, markets or land security as the main pathway. It seems that strategies focused less on expensive 'hardware' such as irrigation, roads or processing. Most interventions focused on research, extension and inputs, followed by 'software' such as organisation of producers, policy, organisation of output markets, and institutional capacity building as main strategy. A better view on what combinations were used and what effect they had is presented in the results subsections per pathway.

Figure 9 *Strategies and impact pathways used in 38 case studies*



Legend: ten strategies were used (at the bottom), to achieve intermediate 'outcome' following the eight impact pathways (in the middle). The impact pathways contributed to the proxy-impact indicators: food prices, household income, food production, food stocks and assets, which contribute to the final impact, household food security, at the top. Numbers show the frequency with which the strategy or pathway was used as main strategy or main pathway, while numbers in brackets are the frequency with which they were used as additional strategy or additional pathway.

5.2 Interventions increasing production

5.2.1 Case studies and review of interventions increasing production

The combinations of pathways and strategies are presented in Table 8. This table also summarises the outcome (food production or developed markets), proxy impact (household food production or income), and impact (household food security).

Table 8 Combinations of pathways and strategies, and the outcome, proxy-impact and impact for the selected case studies with increasing production volume as main pathway

Main path	Additional paths	Main strategy	Additional strategies	outcome*	proxy	impact	Ref
Production		Research extension	Inputs	+	+	+	1
		Research extension	Inputs	+			2
		Research extension	Irrigation Inputs	+	+		3
	Food quality Environment	Research extension	Inputs	+	+		4
		Research extension	Inputs	+	0		5
	Environment	Research extension	Institutional capacity Organisation producers	+	0		6
		Research extension	Inputs (vaccine) Organisation producers Institutional capacity	+			7
	Environment	Research extension	Organisation producers	+	0	0	8
	Environment Safety net	Research extension		+	+		9
Production /Prod. costs	Environment	Research extension	Inputs: equipment	+	+		10
Production	Value chain	Irrigation	Organisation producers Extension Roads Diversification	+	+		11
	Environment Credit Water, hygiene	Irrigation	Research extension		+	+	12

Main path	Additional paths	Main strategy	Additional strategies	outcome*	proxy	impact	Ref
	Safety net Credit Water	Irrigation	Institutional capacity Organisation producers	+		+	13
	Value chain	Irrigation		+	0		14
Production		Inputs	Organisation producers	+		+	15
		Inputs	Research extension Organisation producers	+	+		16
	Safety net	Inputs		+	+		17
	Safety net	Inputs		+	+		18
	Safety net	Inputs		0			19

** + positive effect; o: no effect; empty: effects were not assessed.*

Three main strategies were used to increase production volume: research and extension, irrigation and organisation of inputs. Summaries of the case studies are presented in Annex 4.

For each strategy, first the results for the selected case studies are presented, followed by a summary of a few other review studies.

Research and extension as main strategy for increasing production volume

Research has developed new agricultural technologies such as new high-yielding crop varieties or better pest control. Extension forms the interface between research and farmers. Out of seven selected cases, six show a positive outcome on crop production, and three show a positive proxy impact at the household level, and one shows a positive impact on household food security.

Combating Stem and Leaf Rust of Wheat: Historical Perspective, Impacts, and Lessons Learned.	Dubin and Brennan, 2009	World	ref 1
Pathways: → Production	Strategies: → Research extension + Inputs	Impact Proxy impact Outcome Vulnerable	+ + +

Since 1965, the International Research Institute on Maize and Wheat (CIMMYT), together with other international and national research institutes and universities around the world, has made continuous efforts to breed resistance against stem and leaf rust in wheat, as part of the larger breeding programme for high-yielding varieties. The free exchange of germplasm and information among researchers were of key importance for this continuing effort to breed resistance against new rust strains. Dubin and Brennan (2009) have estimated the

benefits in terms of avoided crop losses for the 60 to 120 million farm households growing wheat in developing countries. From their review of various studies they concluded that about 5% of the wheat production in developing countries is saved by rust resistance, which has reduced the wheat price worldwide by about 15%. By extrapolation they estimate that this has contributed to an additional calorie consumption of 4% and a reduction of child malnourishment by 2% in developing countries. The impact on vulnerable households was not assessed.

Economics of biological control of cassava mealybug in Africa	Zeddies et al. 2001	Africa	ref 2
Pathways: → Production	Strategies: → Research extension + Inputs	Impact Proxy impact Outcome Vulnerable	 +

Cassava mealy bug, first observed in 1970, can drastically reduce cassava yields. Yield losses can be up to 80% in the first year, diminishing to 40% in savanna and highlands, and 20% in low humid areas three years after infestation when native predators reduce the mealy bug population. The International Institute for Tropical Agriculture (IITA), in collaboration with national governments in Africa, have introduced a parasitic wasp in 150 sites in twenty African countries. The introduced parasitic wasp was more successful than domestic predators and reduced cassava crop losses to about 3%. Zeddies et al. (2001), using trends in national production and research data on infestation and crop losses, calculated that avoided cassava loss on the 9 million ha under cassava in Africa was about 2.1 million tonnes of dried cassava, or about 10% of the African cassava production. The impact on vulnerable households was not assessed.

Rice Research, Technological Progress, and Impacts on the Poor: The Bangladesh Case	Hossain 2003	Bangladesh	ref 3
Pathways: → Production	Strategies: → Research xtension + Irrigation + Inputs	Impact Proxy impact Outcome	 + +

In Bangladesh, the combination of research and extension of new rice varieties with irrigation, facilitated by liberalisation of the import of cheap Chinese irrigation pumps, increased food production spectacularly. The combination, accompanied by increased fertiliser and pesticide use, more than doubled the national rice production between 1965 and 2007, outweighing population growth in the same period, and benefiting over ten million farm households directly. Hossain et al. (2003) estimated that irrigation contributed for 38% of the production increase. The production increase in Bangladesh was entirely due to yield increase – the cultivated area remained stable. More efficient use of land and labour increased labour productivity. The number of man-days spent per ha declined from 142 to 110 days per ha for traditional rice varieties, and from 206 days to 133 days per ha for modern rice varieties. Although costs per ha for modern varieties and irrigation were higher, this was compensated by the higher yields, resulting in a net reduction of production costs from

$140 per ton in 1987 to $81 per ton rice in 2000. Reduced food prices relative to agricultural wages and other price indices had a key impact on food security. Wages relative to food price increased from 2.7 kg/day in 1987 to 5.0 kg/day in 2000. Lower food prices may, however, have discouraged farmers who gradually came to rely less on rice production for their income and more on their non-farm income. On the other hand, low food prices improved the food security of large numbers of consumers, including former farmers who found other employment outside the agricultural sector. Vulnerable households benefited from more, and year-round, employment and better tenancy arrangements.

The Mungbean Transformation. Diversifying Crops, Defeating Malnutrition	Shanmugasundaram	Asia	ref 4
Pathways: → Production + Food quality + Environment	Strategies: → Research extension + Inputs	Impact Proxy impact Outcome Vulnerable	 + + +

Although mungbean is not a staple crop, it can play an important role in the rice-wheat crop rotation and contributes directly and indirectly to food security. The World Vegetable Centre (AVRCD) has bred shorter maturing varieties that fit in the rice-wheat rotation, replacing the traditional short fallow period in the rice-wheat rotation. Shanmugasundaram et al. (2009) estimated that 1.5 million farmers in Asia grow improved mungbean varieties. Not only does this add directly to the total food production by an estimated 600kg mungbean per household, it also improves the soil, adding 30kg nitrogen/ha, and increases indirectly the subsequent rice yield by an estimated 900 kg per household (assuming an average of 2 ha rice-wheat-mungbean rotation per household). The additional farm income was estimated at $100 per household per year. Although it is not a staple crop, mungbean is a cheap vegetable protein source accessible to poorer people. Its high iron and vitamin A content are especially important for women suffering from anaemia.

The Philippine hybrid rice program: a case for redesign and scaling down	David 2006	Philippines	ref 5
Pathways: → Production	Strategies: → Research extension + Inputs	Impact Proxy impact Outcome Vulnerable	 o + -

Not all research and extension of new varieties paid off. David reviewed the hybrid rice programme in the Philippines (2006). The Philippine government invested heavily ($190m) in the multiplication of hybrid rice and in incentives for adopting farmers. (Note: hybrid rice is common in China, but not in other Asian countries where 'inbred' modern rice varieties are more common). However, the benefits of hybrid rice were still unproven in the Philippines, and only showed a positive net income gain in three out of fifteen provinces. Moreover, the national seed production and incentives for farmers were ineffective and inefficient: after a 5-year programme only 5% of the area was under hybrid rice. Much of the programme expenses benefited people other than rice farmers. More positive results in

hybrid rice from China are presented below under other reviews. The relatively high seed costs and the higher farm management requirements for hybrid rice make it less appropriate for poorer farmers.

Implementation completion and results report – Kenya agricultural productivity project	World Bank 2009	Kenya	ref 6
Pathways: → Production + Environment	Strategies: → Research extension + Institutional capacity + Organisation producers	Impact Proxy impact Outcome Vulnerable	 o +

One case study of a World Bank project aiming at the reform of national research and extension service in Kenya involving a large institutional capacity building effort, showed small effects on the adoption of improved practices. The use of fertiliser increased by 4%, hybrid seed by 7%, and mulching by 3% between 2004 and 2008 but there was no effect on agricultural production or household food production (World-Bank, 2009). The impact on vulnerable households was not assessed.

The Global Effort to Eradicate Rinderpest	Roeder and Rich, 2009	Worldwide	ref 7
Pathways: → Production	Strategies: → Research extension + Inputs (vaccine) + Organisation producers + Institutional capacity	Impact Proxy impact Outcome Vulnerable	 + +

The eradication of rinderpest is a very different case. A series of national, regional and worldwide vaccination campaigns between 1960 and 2005 is described by Roeder and Rich (2009). Initially the efforts were less successful due to the lack of action in rinderpest reservoirs in East and West Africa, the lack of surveillance, and the lack of international response after the first campaign when rinderpest was still observed. Later campaigns were better coordinated (by the FAO) and more effective using targeted vaccinations in buffer zones which were based on epidemiologic studies. The accreditation of rinderpest-free countries in stages (provisional freedom, freedom of disease, freedom of infection) resulted in more targeted vaccination campaigns. There have been no recent rinderpest outbreaks and many countries are rinderpest free. The benefits of one of the programmes, the Pan African Rinderpest Eradication Campaign (PARC) operating in ten countries from 1986-1998, were estimated. The programme has avoided losses of (cumulative) 126,000 t beef, 39,000 t milk, 14,000 t manure, and 86,000 ha animal traction. The national economic value of the benefits were calculated using social accounting matrices for each of these countries, but no household level proxy impact or impact on food security were assessed. The impact is particularly important for the many poor among livestock keepers.

Improved Fallows in Kenya: History, Farmer Practice, and Impacts	Place 2003-2004	Kenya	ref 8
Pathways: → Production + Environment	Strategies: → Research extension + Organisation producers	Impact Proxy impact Outcome Vulnerable	o o + =

Agroforestry practices, combing trees or shrubs with annual crops or livestock, do not have increased production as their single objective but also aim to ensure environmental sustainability of production and to provide additional benefits from the tree component, e.g. wood, fodder, fruit, etc. Part of the agroforestry research aimed specifically at increasing annual crop yields by combining crops with leguminous, nitrogen fixing trees and shrubs that would fertilise the annual crop. One of these practices tested and promoted by the World Agroforestry Centre (ICRAF) in Kenya is improved fallow, where maize is grown in a rotational short-term fallow with the shrubs *Tephrosia vogelii* and *Sesbania sesban*. Between 1997 and 2001, ICRAF promoted this in Kenya, where about 15,000 households adopted this rotation on very small plots (Place et al., 2004). On average, 0.04 ha out of the 0.6 ha per household under maize, was under improved fallow. Although the maize yield in trial plots was higher, due to the small plots, the impact on farmer income was negligible ($2 per household per year). There was no impact on food security: adopters and non-adopters faced the same decline in food security. Nevertheless, households were still voluntarily planting improved fallow. Poor and women-headed households adopted the practice as readily as male-headed households.

Impact of Soil Conservation on Crop Production in the Northern Ethiopian Highlands	Kassie 2007		ref 9
Pathways: → Production + Environment + Safety net	Strategies: → Research extension	Impact Proxy impact Outcome Vulnerable	 + +

Soil and water conservation measures reduce land degradation and avoid declining crop yields. Most research makes simple comparisons of fields with and without soil and water conservation in the same (few) years, rather than monitoring over a longer period. In Ethiopia, stone bunds were promoted in two areas - Amhara with 1980 mm annual rainfall and Tigray with 650 mm annual rainfall. In the wet Amhara area, there was no effect on crop yields. In the dry Tigray area, stone bunds increased production by $59 per ha. The average household had 1.06 ha land and 37% of the plots had soil and water conservation measures, which meant an average impact on household production value of $23 per year (Kassie et al., 2007). This excludes possible costs for installation and maintenance of soil and water conservation measures.

Reij et al. reviewed the impact of soil and water conservation on the northern part of the Central Plateau in Burkina Faso. Although various large-scale soil and water conservation projects, which had started in the 1960s had been phased out by 2000, farmers continue to

use soil and water conservation measures. These are often traditional measures that were gradually improved, such as *zaï* or individual planting holes in a crusted, degraded field into which a little organic material was added. By concentrating runoff water and nutrients in planting holes, degraded fields still produced a crop. Gradually, previously abandoned degraded fields were rehabilitated and became productive again. Other measures include lines of stones, grass or shrubs that keep water and top soil in the field. An estimated 200,000 ha has been conserved or rehabilitated in Burkina Faso. There was an increase in tree cover, documented by aerial photographs, and women mentioned the higher water tables in water wells (Reij and Thiombiano, 2003; Reij et al., 2009).

Review of the role of research in the Green Revolution

Evenson and Gollin (2003) assessed the impact of international agricultural research on food security. Annual growth rates in crop production, crop area and crop yield are summarised in Table 9 which also distinguishes the role modern varieties (MV) and other inputs (including fertiliser, pesticide and irrigation) played in yield improvement. Results are summarised for all developing countries and for sub-Saharan Africa (SSA). Interestingly, the contribution of MV to yield growth was higher in the late Green Revolution (1981-2000) than in the early Green Revolution (1961-1980). In the period 1981-2000, MVs accounted for 40% of the production increase and 50% of the yield increase in developing countries. IRRI and CIMMYT had access to genetic resources from developed countries which was a key factor in the success in MVs. The collaboration between international and national research which enabled the national centres to carry out location specific breeding was also a key factor.

In SSA, the impact of breeding seemed to lag behind. Production growth has mainly been achieved by area expansion. The contribution of MVs in SSA was negligible before 1980, increased after 1980, but was still lower compared to continents. The modest yield increase in SSA was entirely due to MV, with negligible contributions from fertiliser or other input use. The limited success of MVs in SSA is due to the crops grown (tropical maize and root crops) for which less breeding work has been done than for rice and wheat, and the diverse agro-ecological zones for which it is more difficult to breed suitable MVs. However, recent advances in breeding of rice, maize, cassava and other crops in Africa are promising. Impact is greatest in favourable areas with irrigation, abundant rainfall or with good water control. In less favourable areas, impact is much lower, in spite of the efforts by ICRISAT and ICARDA focused on these marginal areas. Not only is breeding more difficult in these areas but also the subsequent adoption is much more constrained.

Table 9 Annual growth rates of food production, area, yield and yield components, by region and by period		
	1961-1980	1980-2000
All developing countries		
Production	3.20%	2.19%
Area	0.68%	0.39%
Yield	2.50%	1.81%
MVs contribution to yield	0.52%	0.86%
Other inputs per ha	1.98%	0.95%
Sub-Saharan Africa		
Production	1.70%	3.19%
Area	0.52%	2.82%
Yield	1.17%	0.36%
MVs contribution to yield	0.10%	0.47%
Other inputs per ha	1.07%	-0.11%

Source: Evenson and Gollin, 2003

Evenson and Gollin ran counterfactual simulations, using an international multimarket model developed by IFPRI, of what would have happened without internationally-funded research between 1961 and 2000. They assumed that the national research would have increased their efforts to some degree. In the absence of international research, crop yields in the developing countries would have been 8.1-8.9% lower in 1999. Some farmers would have partly compensated this by expanding their crop area, so crop production would have been 6.5-7.3% lower. Crop prices (in all countries) would have been 18-21% higher, which undermines food security for poor consumers. Per capita calorie consumption in developing countries would have been 4.5-5.0% lower, resulting in an increase of child malnutrition by 2.0-2.2%.

In his review of the Green Revolution in South Asia, Hazell (2009) underlines the impressive production increase of 3.5% per year between 1967 and 1982. Of this, 3.1% is attributed to yield increase and only 0.4% to area expansion. Total public investment in agriculture by the twelve Asian governments increased from 34 billion in 1972 to 88 billion in 1990, but decreased as percentage of total government expenditure from 15% to 10% over the same period. The area under irrigation increased from 25% in 1970 to 33% in 1995. Fertiliser doses increased from 24 kg/ha in 1970 to 171 kg/ha in 1995. The cereal area under modern varieties increased from 40% in 1980 to 80% in 2000. As a result, yield and production doubled between 1970 and 1995 and outweighed population growth. This has resulted in an increase of calorie consumption by 24% over the same period. Poverty was reduced from 59% of the population in 1970 to 30% in 1995. However, due to population growth, the absolute number of poor is more persistent and dropped modestly from 1.1 billion 1975 to 0.8 billion in 1995 in Southeast Asia. Low food prices, which benefited the poor net consumers, were a key factor in improved food security. However, low prices were not so good for farmers

whose farm income remained low, but this was compensated by non-farm income that played an increasingly important role in farm households.

Review of disease resistant groundnuts

The importance of reducing crop losses is confirmed by a study of viral rosette disease resistance in groundnuts in Uganda (Kassie et al., 2011). Disease resistant groundnut varieties, yielding 873 kg/ha compared to 649kg/ha for traditional varieties, were introduced between 1999 and 2002 in a joint effort of international and national research, and extension services. A survey in 2006 found that adopters of the improved varieties (corrected for other differences by propensity score matching) increased groundnut production and household income by US$130-$245, which reduced the percentage households living below the poverty line by 7-9%. Although the majority (59%) of households used improved varieties, limited access was still a constraint in areas remote from information sources and major market centres.

Review of hybrid rice in China

Hybrid rice, with its estimated 31% higher productivity than inbred rice, has contributed to the worldwide rice production, rice prices, and rice consumption (Durand-Morat et al., 2011). Hybrid rice has been adopted on a large scale in China, where it occupied 63% of the rice area in 2008. Adoption in other countries (the Philippines, see case study above) is still low, partly because of higher seed costs, higher fertiliser requirements and the precise land management needed. By using a general equilibrium model (RICEFLOW), Durand-Morat et al. simulated what the production, price and consumption would have been without hybrid rice, for the year 2008 (Durand-Morat et al., 2011). The largest effects have been in China, where production would have been 9.3% lower, prices would have been 14.4% higher, and consumption would have been 9.4% lower (a reduction of 14 kg rice per capita per year) without hybrid rice. Worldwide, production would have been 2.3% lower and consumption would have been 2.4% lower.

Research and extension as a strategy to reduce production costs

The impact of production increases on food security in many Asian countries is also explained by the continuous reduction of food production costs, relative to wages or other price indices. This is shown in the above-mentioned cases studies of modern rice varieties and irrigation in Bangladesh (Hossain et al., 2003; Hossain, 2009) and the worldwide breeding programme for disease resistance in wheat (Dubin and Brennan, 2009). There are also interventions that specifically reduced production costs without necessarily increasing crop yields, such as those involving reduced tillage and integrated pest management.

Zero Tillage in the Rice–Wheat Systems of the Indo-Gangetic Plains: A Review of Impacts and Sustainability Implications.	Erenstein 2009	India Pakistan	ref 10
Pathways: → Production (+ Reduce production costs) + Environment	Strategies: → Research extension + Inputs: equipment	Impact Proxy impact Outcome Vulnerable	 + +

Reduced tillage and zero tillage, which were initially mainly promoted as a way to reduce soil degradation and to avoid declining crop yields, have become very popular by reducing production costs and increasing income, rather than by increasing crop yields. In favourable areas in India, zero tilled wheat grown in the dry season, in rotation with conventionally tilled rice in the rainy season, increased financial gains from higher wheat yields by $25/ha and saved $45/ha tillage costs, resulting in an income gain of $70/ha. In a less favourable area in Pakistan, reduced tillage wheat yielded $20/ha less, but reduced tillage costs by $40/ha, still resulting in an income gain of $20/ha. The reduced production costs have contributed to lower food prices in India and Pakistan. Women are not involved in tillage, but appreciate the time saved (Erenstein, 2009). Impact on vulnerable people was not assessed.

Review of reduced production costs

In integrated pest management (IPM), farmers only apply pesticides when they observe pest infestation above certain thresholds, instead of applying these inputs at fixed intervals. A review of 25 impact evaluations of IPM (promoted through Farmer Field Schools), of which there were 21 in Asia, shows that in twelve cases a substantial reduction in pesticide use of 60-80% was observed (Berg, 2004). IPM thus saves costs for farmers. In five cases, an increased production of about 20% was reported, in three cases profit or income had increased and in one case there was evidence that farmers' health had significantly improved due to IPM.

Irrigation as main strategy for increasing production volume

Irrigation makes it possible to increase the cropping intensity - to grow a second or even a third crop in one year, and to reduce the susceptibility to drought. It increases agricultural production and stabilises food availability within the year and over the years.

Out of four selected cases, three show a positive outcome on production, one shows a positive proxy impact at household level, and two show a positive impact on household food security. Contrary to the research and extension case studies, the irrigation case studies have made more effort to assess the impact on household food security.

An Impact Evaluation of India's Second and Third Andhra Pradesh Irrigation Projects. A Case of Poverty Reduction with Low Economic Returns	World Bank IEG 2008	India	ref 11
Pathways: → Production + Value chain	Strategies: → Irrigation + Organisation producers + Extension + Roads + Diversification	Impact Proxy impact Outcome Vulnerable	 + + =

A large-scale irrigation project in India constructed and rehabilitated at total of 390,000 ha for 212,000 households. Farmers were organised into water use associations to improve management of the water fees, water distribution and maintenance. Although construction was delayed, costs were overrun, and the associations have not yet managed to assure equal water distribution, payment and maintenance, the World Bank evaluation showed that production had increased by 50% (combined effect of yield increase and more crops per year), net-farm income had increased by 61%, and total household income had increased by 20-30%. In terms of absolute income, more vulnerable people had benefited less; in terms of relative income, vulnerable people had benefited equally. The indirect effects, of additional employment created by irrigation, was estimated being 25% of the direct effects, and had benefited low-paid women especially (World-Bank, 2008a).

Evaluation finale. Projet de développement rural de Tombouctou (PDRT)	Coulibaly et al 2003	Mali	ref 12
Pathways: → Production + Environment + Credit + Water, hygiene	Strategies: → Irrigation + Research extension	Impact Proxy impact Outcome Vulnerable	+ +

Evaluation finale. Projet de renforcement organisationnel credit et aménagement a Macina (ROCAM)	Ngampana et al 2004	Mali	ref 13
Pathways: → Production + Safety net + Credit + Water	Strategies: → Irrigation + Institutional capacity + Organisation producers	Impact Proxy impact Outcome Vulnerable	+ +

Two cases evaluated two similar projects implemented by CARE in Mali (Coulibaly et al., 2003; Ngampana et al., 2004). Both projects had irrigation as their main strategy, targeting relatively few farmers (4,000-8,000 households). In spite of weaknesses in the technical design of the irrigation schemes – both performed poorly in dry years, the combination of irrigation and access to credit had improved food security access and stability over the year. Credit for women correlated even stronger with improved cereal production than participation in irrigation schemes. The combination of credit and irrigation had the best results, even though credit for women was not intended for cereal production. Food security of beneficiaries was a bit better than that of non-beneficiaries, but trends were negative for both groups. The credit schemes specifically targeted women, but the impact on women and other vulnerable groups was not assessed.

Irrigation, agricultural performance and poverty reduction in China	Huang et al 2006	China	ref 14
Pathways: → Production + Value chain	Strategies: → Irrigation	Impact Proxy impact Outcome Vulnerable	 o + =

A study of irrigation in China showed mixed results (Huang et al., 2006). Surface water irrigation and groundwater irrigation increased crop production value on average by 79%. However, considering also the additional costs for farmers, surface water irrigation was profitable for only 62% and groundwater irrigation for only 52% of the farm households. This excludes the costs the Chinese government made for the irrigation schemes. Although the income effect on farmers seems disappointing, the indirect effect of better food availability and lower food prices on the food security of consumers, which is not mentioned in this study, is likely to have been positive and substantial. Poor farmers benefited less in terms of absolute income, but their relative income increase is higher than for wealthier farmers, because poorer farmers rely more on agricultural income.

Review of irrigation

According to the FAO, in 2000, 20% of all arable land in developing countries was irrigated, producing 40% of all crops and 60% of all cereal crops in developing countries. Differences between continents are large, reflecting differences in irrigation potential and in the drive for intensification. In South Asia, the percentage of cultivated land under irrigation increased from 28% in 1980 to 39% in 2000, harnessing 53% of the water resources. In Africa, the percentage of cultivated land under irrigation increased only slightly from 5% in 1980 to 6% in 2000 (13 million ha), harnessing only 2% of the water resources (FAO, 2004). A study of the potential area in Africa, for which investment in irrigation was profitable, identified an area of 16 million ha for large-scale dam-based irrigation plus an area of 7 million ha for small-scale irrigation. The profitability of small-scale irrigation was larger, with an average IRR of 28%, than the profitability of large-scale dam-based irrigation, with an average IRR of 7%. If only irrigation investment with an IRR of 12% or more is considered, then a potential of 2 million ha under large-scale irrigation and 4 million ha under small scale irrigation is found, totalling 6 million ha under new irrigation in Africa, on top of the existing 13 million ha currently equipped for irrigation (You et al., 2010).

The World Bank reviewed their water management in agriculture projects between 1994 and 2004 (World-Bank, 2006). The World Bank invested $5.6 billion in water management in agriculture, which included the installation or rehabilitation of about 14 million ha under irrigation, benefiting about twelve million households. The World Bank shifted its emphasis from installing new irrigation schemes to the rehabilitation of existing irrigation schemes. This seems to be justified. An updated map of irrigation areas showed that of the 279 million ha worldwide under irrigation equipment only 49 million ha were actually irrigated in 2000. The remainder is not irrigated due to lack of water, absent farmers, land degradation, damage to irrigation structures, or organisational problems (Siebert et al., 2006). The average costs in the World Bank projects were $6,600/ha new construction and $2,900/ha for rehabilitation of existing irrigation schemes.

The World Bank is fairly critical about the sustainability of their irrigation projects, although this improved over time. An earlier evaluation by the World Bank in 2002 found only 20% of the irrigation projects completed in the 1990s scored at least to have a 'likely sustainability', while the recent review in 1996 shows that of the projects completed between 2000 and 2004 this percentage had increased to 70%. The main constraints on sustainability were the organisation and cost recovery of operation and maintenance. Too much was expected from farmers organised in water use associations, while capacity building of higher level institutions received too little emphasis. Other constraints were the negligence of extension, inputs and credit for farmers, the lack of a policy clarifying roles and responsibilities of different institutions, and the lack of policy securing and enforcing water rights. The most successful projects combined good attention to community operation and management and physical modernisation of water distribution networks.

Poor households benefit directly from the increased production and income. They also benefit indirectly from increased demand for agricultural labour and higher wages, from growth in rural and urban non-farm economy, and from reduced food prices. The economic benefits of an irrigated area are the sum of direct benefits in agriculture plus the indirect benefits in the non-farm economy through growth linkages. Growth linkages are larger in intensive agriculture in Asia, compared to extensive agriculture in Africa. The World Bank review found an average economic rate of return of 22%, which is good. The main challenge for the future is to improve water use efficiency (World-Bank, 2006).

An infrastructure programme in Ethiopia, which involved the construction of irrigation and roads and the organisation of beneficiaries, improved food access by 30%, an increase of about 700 kcal / adult / day (Abebaw et al., 2010). In spite of a good quality assessment of the overall project impact on food security, the study presented too little information about the intermediate outcome or proxy-impact levels to follow the causal link between interventions and impact. Small families and families with more land were found to benefit more, which implies that more vulnerable households would have benefited less.

Inputs as main strategy for increasing production volume

The most important inputs are improved seed, fertiliser and pesticides. These inputs increase production and reduce crop losses, especially when used in combination. Out of four selected cases, three show a positive outcome on production, two show a positive proxy-impact at household level, and one shows a positive impact on household food security.

Rapid gains in food security from new maize varieties for complex hillside environments through farmer participation	Tiwari et al 2010	Nepal	ref 15
Pathways: → Production	Strategies: → Inputs + Organisation producers	Impact Proxy impact Outcome Vulnerable	 + +

The participatory seed selection and multiplication in Nepal increased crop yields using new varieties of various crops by about 45% and improved the stability in household food access, increasing the period with sufficient food from 6.7 to 8.3 months per year. A special feature of this project was that it reached poor and woman-headed households and lower caste households much better than the regular extension services did. The impact on these groups was the same as for better-off farmers (Tiwari et al., 2010).

Economic Impact on Food Security of Varietal Tolerance to Cassava Brown Streak Disease in Coastal Mozambique	Tiwari et al 2010	Nepal	ref 16
Pathways: → Production	Strategies: → Inputs + Research and extesion + Organisation producers	Impact Proxy impact Outcome Vulnerable	 + +

Cassava Brown Streak Disease damages cassava roots, reduces the edible part and thus the value of the harvest. A tolerant variety was quickly identified that yielded 18-32% more than susceptible varieties. NGOs, in collaboration with a national and international research network SARRNET, set up a successful multiplication and distribution scheme for farmers in coastal Mozambique. In 2006, an estimated 100,000 farmers planted tolerant cassava, on about 15% of the total cassava area which has avoided a crop loss worth $3.2m (cumulative 2003-2006), or $32 per household (McSween et al., 2006). The impact on vulnerable people was not assessed.

The Malawi agricultural input subsidy programme: 2005/06 to 2008/09	Dorward and Chriwa 2011	Malawi	ref 17
Pathways: → Production + Safety net	Strategies: → Inputs	Impact Proxy impact Outcome Vulnerable	 + + +

Against the earlier trends of reducing fertiliser subsidies as part of the structural adjustment programmes in the 1980s and 1990s, the Malawi government decided in 2004 to subsidise fertiliser on a large scale to increase maize production. Poor farm households were targeted through a voucher system. Subsidy varied from 64% in 2005/06 to 91% in 2008/09, when international fertiliser prices peaked. The programme was effective. Between 54% (2006/07) and 65% (2008/09) of the 2.5 million farm households received subsidised fertiliser. On average about 160,000 t fertiliser was distributed. An estimated 71% of the fertiliser would not have been used in the absence of this programme; 29% of the subsidised fertiliser replaced fertiliser that otherwise would have been bought at the normal price. Doward and Chirwa (2011) calculated the additional maize production, taking into account the 'crowding out' of commercial fertiliser and an average maize-fertiliser response of 15 (kg maize / kg N). They arrive at much lower figures than the official government figures, but still find an increase in maize production of about 650,000 tonnes per year (averaged 2005-2009). This corresponds to an increase of 500 kg per household or about 50%. Although poor farmers

were well targeted, women-headed households were initially poorly targeted by the voucher scheme. Poverty declined from 52% in 2005 to 40% in 2009. In a follow-up evaluation by Chirwa et al. in 2011 (Dorward, pers. com.), they found some economy-wide effects. General and food inflation declined during the period of the fertiliser subsidy programme between 2005 and 2010. Rises in daily wages matched or exceeded the rise of food prices between 2005 and 2009. The quantity of maize earned per day work increased by 47% between January 2009 and January 2010. This has a positive effect on the most vulnerable households, who are net consumers of maize and often depend on labour wages for their income. The fertiliser subsidy has contributed to this, even though its contribution was not quantified. The high costs pose a problem for sustainability and in 2011 the Malawi government decided to reduce its fertiliser purchases to 140,000 t, less than in 2010, due to fiscal and foreign exchange problems not related to the subsidy programme (Dorward, pers. com.).

Zimbabwe's Agricultural Recovery Programme in the 1990s: An evaluation using household survey data	Munro 2003	Zimbabwe	ref 18
Pathways: → Production + Safety net	Strategies: → Inputs	Impact Proxy impact Outcome Vulnerable	 + + =

During the 1990s, the Government of Zimbabwe implemented the Agricultural Recovery Programme to help smallholder farmers recover from repeated severe droughts. The programme aimed to provide drought-affected smallholders with crop packs (free seeds and fertiliser) and mechanised tillage services. Munro (2003) evaluated the impact of this programme. The tillage was unsuccessful because of its very low coverage: less than 5% of the farmers were served. The crop packs were successful: over 80% of the farmers were reached (800,000 farm households). The crop packs increased the crop area by 20%. Crop yields did not increase, so the household food production increased by 20%, which is about 200 kg maize per household per year. Although poor households were specifically targeted, in the end poor farmers and other farmers benefited equally. The impact on vulnerable households was not assessed.

Other review of fertiliser subsidies

The success of the fertiliser subsidy programmes in Malawi and Zimbabwe is partly due to the large coverage (65% of rural households in Malawi, 80% in Zimbabwe) including many vulnerable households. In contrast, an evaluation of the Fertiliser Support Programme in Zambia found that only 11% of the farm households benefited from this subsidy in 2006/07, and that recipient households were generally wealthier, male-headed households. Two of the three different methods of correcting for differences between beneficiaries and non-beneficiaries found a significant impact on maize productivity, gross crop income, and net crop income (fertiliser costs deducted) (Chiwele et al., 2010).

Assessing the effectiveness of a technical assistance program: The case of maize seed relief to vulnerable households in Zimbabwe	Langyintuo 2009	Zimbabwe	ref 19
Pathways: → Production + Safety net	Strategies: → Inputs	Impact Proxy impact Outcome Vulnerable	 + o =

To assist vulnerable rural households improve their food security, the British Department for International Development implemented a seed relief program from 2003/2004 to 2005/2006 that emphasised recycling of maize open pollinated varieties (OPVs). The idea behind this was that using OPVs farmers would not have to buy new hybrid seed every year, while OPVs give better maize yields than local varieties or recycled hybrid seed. Langyintuo and Setimela (2009) assessed the effectiveness of the programme. Choice of varieties was guided by ecological adaptability of available commercial seeds and less by preferences of beneficiaries. Insufficient information was given to the beneficiaries about the OPVs including how to recognise the seed and how to select and recycle the seed. Results were disappointing: only 12% of the beneficiaries who received the OPV seed recycled and replanted the OPV the following year. The impact on production and food security was not assessed. Poor and women-headed households were specifically targeted.

Other review: the impact of food prices on food security

The impact of food prices on food security is not specific for the pathway aimed at increasing production but is also valid for the pathway reforming market regulations and other pathways. Nevertheless, we present here some review on this matter, which will come back in the overall conclusions.

First of all, to understand the impact of household income or food prices on food security, household income and food prices need to be considered jointly. If only one indicator is to be presented, one can deflate trends in food prices using trends in daily wages (rather than deflating using consumer price indices), or one can present trends in wages by expressing this in kg staple food earned per day labour (Dorward, 2011) .

Naylor and Falcon (2010) analysed the effect of food price volatility on the poor. They studied the expenses on food, and income from farming, agricultural wages, and other income, using data from the World Bank Living Standards Measurement Study. People were classified in different categories of poverty. Table 10 presents the averages of four countries: Ghana (1998), Guatemala (2000), Malawi (2004) and Uganda (2000).

Table 10 Share of household expenses spent on food and share of different household income sources, for households in different poverty categories					
		Expenses	Income source (% of total income)		
	% Rural	Food (%)	Farming	Ag. wage	Other
Extremely poor (<$1.25/p/day)	90%	62%	45%	23%	32%
Poor ($1.25-$2.50/p/day)	85%	60%	39%	18%	43%
Near-poor ($2.50-$4.00/0/day)	68%	57%	30%	16%	54%

Sources: Naylor and Falcon, 2010. WB Living Standards Measurement Studies. Averaged over Ghana 1998, Guatemala 2000, Malawi 2004, Uganda 2000.

Table 10 first of all shows that the vast majority of the extremely poor (90%) in these four countries are rural. Secondly, farm income of the extremely poor is insufficient for their food expenses; additional income from agricultural wages or other income is needed to cover food expenses on food. The majority of extremely poor are net consumers: they buy a little more food than the amount of own production that they sell, if they sell at all. Surprisingly, there are many net producers (who sell more food than they buy), who are poor or extremely poor, who do not really have a surplus, sell some food because of their need for cash, and are calorie deficient. In other words: net producers do not necessarily have enough food to eat. Extremely poor net consumers suffer from price rises. Extremely poor net producers do not gain much from price rises, because the quantity sold is very small. A small minority of better off farmers are the net producers who do benefit from higher food prices. An additional problem for poor and extremely poor rural households are fluctuations in prices, partly due to poor market linkages. After harvest, food finds easily its way from rural households, at low prices. Later in the season and during food shortages, food does not that easily find its way back to the rural areas, and often at much higher prices.

Food prices are the link between poverty and food insecurity. Reductions in poverty do not automatically imply an improvement in food security. First of all it depends on whether a poverty threshold reflects food prices. The situation in India in 2005 is an illustrative example. Following the simple MDG poverty threshold of 1$ per person per day, 35% of the Indian population was below this poverty line in 2004/05. The Indian government uses thresholds considering the differences in updated food prices and difference in food requirements in rural (2400 kcal/p/d) and urban areas (2100 kcal/p/d). Using these price-based poverty thresholds, 28% of the rural population and 26% of the urban population were poor in 2005. However, this does not imply that people meeting this price-updated threshold really eat sufficient calories. Using average consumption expenditure to meet the calorie norm, Panda and Ganesh-Kumar calculated that there are divergent trends between price-updated poverty and calorie-based poverty. While price-updated poverty declined from 55% to 34% between 1973 and 1994, calorie-based poverty increased from 55% to 66% over the same period. The main reason is that the proportion of income spent on other expenses than food has increased over time, also for poorer households. As a result, the calorie intake by the poorer population (bottom 30%) stagnated at 1650 kcal/p/day between 1970 and 2000, well below the norm (Panda and Ganesh-Kumar, 2009).

5.2.2 Conclusions about interventions increasing production

Research-developed modern crop varieties were the basis for improved food security

Four case studies evaluated research interventions on genetic crop improvement: worldwide wheat breeding, rice breeding in Bangladesh, mungbean breeding in Asia and hybrid rice breeding in the Philippines. Except for hybrid rice in the Philippines where the results were affected by poor implementation modalities by the government, the studies showed significant positive impact on food security by improved crop varieties, jointly bred by international and national agricultural research institutes and universities. This benefited large groups of producers by increasing production and household income, and consumers by increasing employment and wages and by increasing food availability at low prices (Hossain et al., 2003; Dubin and Brennan, 2009; Shanmugasundaram et al., 2009).

In addition to the case studies, the elaborate reviews of the Green Revolution (Evenson and Gollin, 2003; Hazell 2009), confirm the positive results of genetic crop improvement found in the selected case studies. In Asia, the total crop production increase between 1960 and 2000 outweighed population growth. Increased food availability combined with low food prices have contributed in Asia to improved food security and reduced poverty. The large share of production increase in Asia has resulted from yield increases, as there was little room for production area expansion. It is estimated that about half of the yield increase in Asia has resulted from modern varieties; the other half can be attributed to the intensified use of other inputs. However, it is difficult to disentangle the effects of modern varieties, irrigation, increased use of fertiliser and pesticides, and the extent to which these were conditioned by extension services, credit, market regulations, and land tenure security. In Asia, poorer households benefited, both directly because poor farmers also had access to modern varieties along with accompanying irrigation and inputs, and indirectly because poor non-farming households benefited from increased farm and non-farm employment and from low food prices. In Africa, the impact of modern varieties has been much lower, because breeding efforts started later, the agro-ecological environment is more diverse, and farmers had less access to irrigation, inputs, markets and credit that would optimise the benefits of modern varieties. Adoption of modern varieties in Africa, which are expensive and therefore not always profitable for poor farmers, is still low and had reached only 23% of the cultivated area in 1999 (Maredia and Raitzer, 2006). In contrast, the review on hybrid rice which is much grown in China is much more positive than the case study of hybrid rice in the Philippines (Durand-Morat et al., 2011). The implementation modalities of the hybrid rice research and extension programme in the Philippines affected the results more than the agronomic potential of hybrid rice.

International collaboration and free germplasm exchange were key aspects for success

Five case studies mention the importance of collaboration between international research institutes and national research institutes, the free exchange of germplasm and information, and the location-specific breeding by national research institutes, paid by public funding. These conditions ensured that modern varieties also became available to poorer farmers, especially in Asia. This collaboration was not only important for the success of new crop varieties mentioned above, but also for the control of pests and diseases in cassava and the eradication of rinderpest (Zeddies et al., 2001; Roeder and Rich, 2009).

In addition to the case studies, other reviews of the Green Revolution confirm the importance of collaboration between international and national research institutes (Evenson and Gollin, 2003; Hazell, 2009).

Research on avoiding production losses had large effects, especially in Africa

Four case studies show the importance of reducing production losses by breeding disease-resistant wheat worldwide (Dubin and Brennan, 2009), multiplication and distribution of cassava with tolerance for brown streak disease in Mozambique (McSween et al., 2006), introducing a biological control agent against cassava mealy bug in Africa (Zeddies et al., 2001), and the eradication of rinderpest worldwide (Roeder and Rich, 2009). The latter two cases benefited poor farmers because there was no additional production costs involved while the rinderpest control benefited livestock keepers, including less well-off households.

In addition to the case studies, other reviews confirm the importance of reducing production losses, notably in Africa, as shown in a meta-evaluation of costs and benefits of agricultural research (Maredia and Raitzer, 2006), and a review on disease-resistant groundnuts in Uganda (Kassie et al., 2011).

Agroforestry and soil and water conservation so far lacked sufficient evidence about effects and costs

Three selected case studies evaluated the impact of environmentally sustainable agriculture: agroforestry in Kenya, soil and water conservation in Ethiopia, and reduced tillage in India and Pakistan, with mixed results. The effects of the agroforestry practice combining maize with leguminous shrubs as an improved fallow in Kenya had negligible impact on household income, due to the tiny plots under this practice (Place et al., 2004). The effects of stone bunds on production in Ethiopia were encouraging in the dry area of Tigray, but had no effect in the wet area of Amhara, which questions the appropriateness of extension messages (Kassie et al., 2007). Both case studies did not present the costs and labour required for installation and maintenance. These costs could explain the relatively low adoption of several labour-demanding agroforestry and soil and water conservation measures. The results of reduced tillage in India and Pakistan was positive, not always by increasing production but by reducing production costs, which made this practice attractive to farmers (Erenstein, 2009).

In addition to the case studies, not much evidence of the impact of natural resource management (NRM) on food security was found in other reviews. An independent review of the CGIAR system confirmed the impact of a few NRM research projects, of which the results were easily scaled up (biological pest control, reduced tillage). However, the review explained the lack of quantified impact of most other NRM research by the location specific results that have limited spill-over opportunities and are difficult to scale up (McAllister et al., 2008). On the other hand, a review of simple soil and water conservation measures in West Africa shows that large-scale adoption does take place, but its effect on food security is still to be studied more thoroughly (Reij and Thiombiano, 2003; Reij et al., 2009). Note that quantifying impact of long-term investment in NRM is more difficult than quantifying impact of improved varieties of annual crops.

Farmer participation in seed selection increases its acceptability, especially in diverse agro-ecological settings

Two case studies show the importance of considering farmers' opinion when introducing new crop varieties. Participatory maize seed selection and multiplication in Nepal had a positive impact on food security, partly because beneficiaries appreciated the new varieties. In addition, this scheme reached poorer, women-headed households and lower castes much better than the regular extension service (Tiwari et al., 2010). In contrast, the free distribution of open pollinated maize seed in Zimbabwe failed: very few farmers re-used the seed because they did not appreciate the variety (Langyintuo and Setimela, 2009). It is not that easy for research and extension to become more responsive to farmers. One case study investigated the reform of the national research and extension service in Kenya. The changes in farmer adoption of recommended practices were small and there was no impact on production yet (World-Bank, 2009).

In addition to the case studies, other reviews of the genetic crop improvement during the Green Revolution did not specifically mention participatory breeding, yet it resulted in large-scale adoption of improved rice and wheat varieties in Asia (Evenson and Gollin, 2003; Hazell, 2009). Probably non-participatory breeding works for large, homogeneous agro-ecological zones under optimal conditions (irrigation, inputs) but participatory breeding efforts are needed for the highly diverse agro-ecological zones under suboptimal conditions.

Irrigation has been effective in increasing food production and employment in Asia, but operation and maintenance of large-scale schemes requires more emphasis

Two case studies show the important role irrigation has played in Bangladesh and India, not only in increasing production but also in stabilising food access over the years and during seasonal shortage periods. The large-scale irrigation schemes in India, even though they were criticised for cost overruns and delays, have been effective in increasing food production and farmer income. The absolute income increase has been lower for poorer farmers, but their relative income increase was equal or higher than that of wealthier farmers (World-Bank, 2008a). The individually-owned shallow tube well pumps in Bangladesh are an alternative that did not require high government or donor funding (Hossain, 2009). A third case study raised questions about the profitability of surface and groundwater irrigation for farmers in China (Huang et al., 2006).

In addition to the case studies, another review on irrigation projects between 1994 and 2004 by the World Bank confirmed the direct benefits for producers and the indirect benefits for wage labourers. However, it raised questions about the institutional and financial sustainability. The study concluded that the most successful irrigation projects combined the physical improvement of water delivery systems with sufficient attention to community operation and management, good water and maintenance costs recovery, building capacity in institutions - including those above the water use association level, and accompanying support to extension, input and credit. In addition, policy is needed that clarifies the roles of different institutions, and secures and enforces water rights. Farmers are encouraged to increase investment once irrigation reduces the risk of low fertiliser response or crop failure (World-Bank, 2006).

There is a large, untapped irrigation potential in Africa

The two case studies of rural development projects with an irrigation component in Africa show the synergy between irrigation, credit, extension, and organisation of farmers and women's groups. However, the small scale of these projects and the apparently poor design of the irrigation schemes – functioning poorly in dry years – limited their impact (Coulibaly et al., 2003; Ngampana et al., 2004).

In addition to the case studies, other reviews confirm that Africa has a large untapped irrigation potential. The percentage of cultivated land under irrigation in Africa stagnated between 5% in 1980 and 6% (13 million ha) in 2000. Although the irrigation potential in Africa is much lower than in Asia, there is scope for expansion as currently only 18% of the potential is used (FAO, 2004). A study of the profitability of investments in large-scale dam-based irrigation and small-scale irrigation identified an area of 6 million ha in Africa for which the investments had an IRR of 12% or more (You et al., 2010).

Progress in food production in sub-Saharan Africa lags behind because of its agro-ecological diversity, high transaction costs and risks, weak preconditions, and limited scale of interventions; lowering input prices had a significant effect on production.

The case study results of production increases in Africa, other than those on successfully reduced production losses discussed earlier (Zeddies et al., 2001; McSween et al., 2006; Roeder and Rich, 2009), are meagre. Six case studies show no results to modest results. Reform of research and extension services in Kenya (World-Bank, 2009), distribution of open pollinated maize seed in Zimbabwe (Langyintuo and Setimela, 2009), and the agroforestry project in Kenya (Place et al., 2004), did not substantially increase production. The soil and water conservation project in Ethiopia (Kassie et al., 2007) and two integrated rural development projects in Mali (Coulibaly et al., 2003; Ngampana et al., 2004) have had modest effects on food production, but for small numbers of beneficiaries. The two case studies that showed substantial production increases for large numbers of farmers are the Farm Input Subsidy Programme in Malawi (Dorward and Chirwa, 2011) and Zimbabwe's Agricultural Recovery Programme (Munro, 2003). They were successful because they reached the majority of farmers, including the most vulnerable people, and substantially increased the use of hybrid seed and fertiliser.

In addition to the case studies, other reviews confirm that in sub-Saharan Africa production increase has been less than in Asia and has mainly resulted from area expansion, rather than intensification and higher yields (Evenson and Gollin, 2003). The adoption and impact of modern crop varieties is still limited (Maredia and Raitzer, 2006). Breeding of African crops started later and was more complex because of the diverse agro-ecological areas, compared to the more homogenous irrigated areas in Asia. The irrigation potential and the area currently under irrigation in Africa are smaller than in Asia (FAO 2004; You et al., 2010). Unreliable weather poses a risk to investments in seed and inputs (Evenson and Gollin, 2003). Access to extension and credit was reduced after governments cut budgets for these agricultural services. Other reviews also confirm that high input prices are a major constraint. The low usage of fertilisers on food crops is explained by the unfavourable fertiliser/yield ratios and their respective prices (Diagne and Zeller, 2010; Matsumoto and Yamano, 2009).[5]

[5] See also section 5.4: Reforming market regulation.

Increasing labour productivity and reducing the cost price of food are crucial but have received little attention in interventions

Two case studies show the effect that modern varieties and reduced tillage have had on increasing labour productivity. In Bangladesh, more efficient use of land and labour reduced the number of days spent per ha by 23% for traditional varieties and by 35% for modern varieties, between 1965 and 2000. Although both irrigation and modern varieties require more labour and costs per ha, the higher crop yields largely compensate for this resulting in a reduction of the average cost price of rice by 42% (Hossain et al., 2003). Reduced tillage of wheat, intercropped with conventionally tilled rice, increased wheat yields in some cases in India but reduced wheat yields in other cases in Pakistan. However, because reduced tillage required substantially less labour and tillage costs per ha, the net benefit of reduced tillage compared to conventional tillage was between $20 and $70 per ha. This reduced the cost price per ton of wheat (Erenstein, 2009).

In addition to the case studies, various other reviews report on the effect of production increase on food prices (Evenson and Gollin, 2003; Hazell, 2009), implicitly pointing to an increase in labour productivity, but few reviews report explicitly on the effects on labour productivity. One review looked into a number of integrated pest management projects and found more evidence of reducing costs of pesticides than evidence of increased yields. The net effect is a reduction in labour and costs per ha, while yields remained similar, thus reducing the cost price of food (Berg, 2004).

The success of improved food security in many Asian countries is explained by the continuous increase in production coupled with the reduction of production costs, resulting in low food prices relative to wages or other price indices

Two case studies described interventions that not only successfully increased production but also contributed to low food prices. The worldwide breeding of wheat resistance to stem and leaf rust is estimated to have reduced wheat prices by 15% (Dubin and Brennan, 2009). In Bangladesh, the modern rice varieties (in combination with irrigation) reduced rice production costs. In local currency, food prices increased by 3.1% per year while labour wages increased by 5.6% per year. Wages expressed in kg rice per day increased from 2.7 to 5.0 between 1987 and 2000, which was good for agricultural labourers. For farm households, income from rice declined in absolute terms, but the time made available by increased labour productivity was used to increase non-farm income (Hossain et al., 2003).

In addition to the case studies, other reviews confirm the indirect effect of increased production, through low food prices, on consumers' food security. A counterfactual analysis estimated that the modern varieties developed with internationally funded research (1961-2000) have reduced food prices by 18-21%, which particularly benefited poor consumers (Evenson and Gollin, 2003). However, low food prices in Asia were not so good for farm households, who saw their farm income decrease, but often managed to compensate this by increasing non-farm income (Hazell, 2009).

The majority of food insecure households are better off with low and stable food prices

Although not found in the case studies, other reviews analysed the relationship between food prices and poor households in Uganda, Ghana, Malawi and India. It shows that the majority of (extremely) poor households are net consumers and suffer from higher food prices. In addition, poor market linkages and other causes resulting in price fluctuations aggravate their food insecurity situation: they sell at low prices and have to buy at high prices (Naylor and Falcon, 2010). A reduction of poverty, expressed as the percentage of people living on less than $1 per day, can be negated in terms of food security by increased food prices. However, even when price-updated poverty indicators are used, food security improvement may lag behind. In India, in spite of a reduction of price-updated poverty between 1973 and 1994, calorie-based poverty increased over the same period due to an increased share of non-food expenditure (Panda and Ganesh-Kumar, 2009).

5.3 Interventions developing value chains

5.3.1 Case studies and review of value chain development

Interventions aimed at developing value chains can be grouped according to the market they serve. Jaffee et al. (2011) make a useful differentiation into six markets with different market requirements from informal domestic markets that do not require specific quality standards to high-end export markets that require third party certification (Table 11).

Table 11 Spectrum of regulatory and market requirements in agri-food systems

Level	Market		Requirements	Quality assessment
1	Developing countries	Traditional retail	Visual characteristics	Visual inspection
2		Local supermarkets	Quality grades, Consistent supply	Visual inspection
3		High-end supermarkets	Internal quality, Consistent supply Food safety	1st and 2nd party inspections / testing
4	Industrialised countries	Local stores	Basic standards, Consistent supply Hygiene, food safety, Basic record keeping	1st, 2nd, and 3rd party conformity assessment.
5		Discount supermarkets	Specific process standards, Consistent supply Hygiene, food safety Detailed record keeping	1st, 2nd, and 3rd party conformity assessment
6		High-end supermarkets	Specific process standards in integrated supply chain , Consistent supply Detailed record keeping	1st, 2nd, and 3rd party conformity assessment

Source: Jaffee et al. 2011

The six selected case studies in this review are organised according to their main implementation strategy: the organisation of output markets, or the value addition through certification. A distinction is made between domestic and export markets. The 6-level classification used by Jaffee et al. (Table 11) for each case study is indicated in Table 12 under 'main strategy'.

The four case studies on organising output markets, one for the domestic market and three for the export markets, all showed a positive impact on household income and food security. Of the two case studies on value addition through certification, one showed a positive effect on household income, while the other showed a positive effect on household asset accumulation.

Table 12 Case studies on value chain development

Main path	Additional path	Main strategy	Additional strategies	outcome*	proxy	impact	ref
Value chain		Output market (domestic: level 3)	Inputs Diversification Org producers	+	+	+	20
	Production Environment	Output market (export: level 4)	Extension Diversification Org producers Processing	+	+	+	21
	Production Environment	Output market (export: level 4)	Extension Diversification Org producers Institutional capacity	+	+	+	22
	Credit	Output markets (export: level 5)	Diversification Processing Extension Org producers		+/0	+/0	23
	Production Environment	Value addition (export: level 6)	Outputs market Processing	+	+		24
	Credit	Value addition (export: level 6)	Org producers	+	0/+		25

Output markets in developing countries as main strategy to increase production value

Final evaluation of the 'Dairy Development Food For Peace Development Assistance Program for Vulnerable Populations in Zambia'	Swanson 2009	Zambia	ref 20
Pathways: → Value chain	Strategies: → Output markets + Inputs + Diversification + Org producers	Impact Proxy impact Outcome Vulnerable	+ + + -

In Zambia, the organisation of 2700 dairy farmers around nineteen newly installed milk collection centres proved to be a successful formula to link smallholder farmers to a high-value dairy sector. Although it served a domestic market, and was classified as market requirement level 3, dairy is a capital intensive sector with high quality and food safety requirements. The programme provided improved breed milking cows, through a distribution scheme, to 1000 households, including vulnerable households and households who had never had cattle before. Areas were selected based on the presence of commercial dairy farmers, allowing logistical efficiency and information exchange between experienced and new dairy farmers. The market demand was growing and prices were expected to remain good. Weak points were the lack of business skills of some of the cooperatives and the dependence of cooling tanks on unreliable electricity. Income for project beneficiaries was $370 per household per year above non-beneficiary dairy farmers, and assets (cows, equipment) were substantially higher. Stability in food access increased from 7.5 months to 9.2 months per year for beneficiaries, against 8.2 months per year for non-beneficiaries. Although vulnerable and women-headed households were specifically targeted, women's participation and income remained lower than men's participation and income (Swanson, 2009).

Review of domestic markets

The lower participation level of poor farmers with small landholdings in milk cooperatives was also found in Ethiopia (Francesconi, 2009). Cooperatives with joint marketing activities increased member farmers' milk commercialisation, but the poorest farmers were less likely to be members of these marketing cooperatives. In contrast, other cooperatives, without collective marketing activities, that function more as negotiation partners for government or NGOs, were more open to poorer farmers but had no impact on milk commercialisation.

Jaffee et al. (2011) in their overview of eleven domestic and export value chains in Africa, show that there is great potential to upgrade smallholder farmers to serve higher market segments in the domestic or regional markets. There are many more smallholders involved in the domestic and regional market than in export markets supplying industrialised countries. One example is the sunflower value chain in Uganda. Private sector, public research and extension, and donors jointly invested in improved seed, logistics, and oil presses: over 200,000 farm households benefited. Another example is the Kenyan horticultural sector, where 500,000 smallholders produced for the domestic market,

against only 11,500 smallholders who produced for the export market. In contrast, many employed labourers are involved in horticulture export, as will be shown further on.

Output markets in industrialised countries as main strategy to increase production value

Final project evaluation Viable Initiatives in the Development of Agriculture. Phase I (1996-2001); Phase II (2001-2006)	Langworthy 2001, 2006	Mozambique	ref 21, 22
Pathways: → Value chain + Production + Environment	Strategies: → Output markets + Extension + Diversification + Org producers + Processing + Institutional capacity	Impact Proxy impact Outcome Vulnerable	+ + +

Two succeeding projects in Mozambique, implemented by CARE, aimed at improving farmer income by organising the export of sesame, groundnut, sunflower, and paprika, combined with efforts to increase production in an environmentally sustainable way. Although they serve the export market, and are classified as level 4 market requirements, the quality and food safety requirements are obviously not as demanding as, for example, for milk in the domestic market. In the first phase, targeting 65,000 households, processing of sunflower oil was also included. In the second phase, targeting 41,000 households, capacity building for local government institutions was also included. Export increased in a spectacular way, due to good collaboration with private traders and exporters. The flexibility to switch between crops and exporters was important, because markets that are promising in one year may fail the next year (paprika had a niche market with only one buyer, while several buyers were interested in sesame). More flexibility was needed in organisational set up, as farmer associations were not always performing better than individual farmers linked to traders. Export crop yields and production increased and export value increased even more. Farmer income remained stable in phase 1 (against declining income of non-beneficiaries) and increased in phase 2. Household food production increased by 20% and household assets doubled. Food access stability improved: the food shortage period declined from four months per year in 1996 to 2.2 months in 2002 and to 1.5 months per year in 2006. Individual women participated less, but women in groups participated more. Poor households participated equally. In the second phase, women adopted improved child nutrition practices (Langworthy et al., 2001; Langworthy, 2006). The impact on vulnerable people was not assessed.

Non-traditional Crops, Traditional Constraints: Long-Term Welfare Impacts of Export Crop Adoption among Guatemalan Smallholders	Carletto 2009	Guatemala	ref 23
Pathways: → Value chain + Credit	Strategies: → Output markets + Diversification + Processing + Extension + Org producers	Impact Proxy impact Outcome Vulnerable	+/0 +/0

In Guatemala, benefits of the export of snow peas into the US market depended strongly on the flexibility to step in and step out of this very volatile market. Guatemala increased the export of non-traditional exports from US$146 million in 1992 to $262 million in 2001. A cooperative, *Cuatro Pinos*, with, at its peak, 1600 members, organised the export. Smaller and poorer farmers also participated, which made this an example of pro-poor non-traditional export. An evaluation using panel survey data from 1985 to 2005 compared farmers that stepped in and/or stepped out of this value chain at various times. Farmers who stepped in during the boom (1980s) and stepped out when prices sharply declined (by more than 70% in the 1990s) were best off: they increased their income during the boom (+20%) which they invested in other productive activities. In contrast, farmers who continued to produce snow pea in spite of prices which were too low, were worse off than farmers who had never produced snow pea. Moreover, inappropriate chemical use caused land degradation and rejection by some customers. The farmer cooperative lacked good price information, had weak financial and project management, and considered diversification into alternative export crops rather late (Carletto et al., 2009).

Review of export markets

The review of African value chains by Jaffee et al. (2011) shows that the export of high value products may benefit labourers more than smallholders. For example, the Kenyan horticulture export is supplied by only 11,500 smallholder farmers and 500,000 labourers employed by large horticulture export companies (early 2000s).

Adding value by certification for export to industrialised countries as the main strategy for increasing production value

There are a number of certification schemes that could potentially add value. Jaffee et al. (2011) provide a good review of various donor efforts to support smallholder farmers with compliance to standards that would either be required or would facilitate export to industrialised countries. Donors have invested an estimated $350-$450 million over ten years on technical assistance, training, certification costs, small equipment, etc. to support compliance by African smallholders with regulatory and market agri-food standards. This is about 5% of the total donor support to African agriculture ($997m in 2001). The motivation for donors was to prevent smallholder farmers being excluded by high import requirements, and to create possibilities to add more value and increase smallholder farmer income instead.

An important aspect is the number of smallholder producers who benefited from participating in a certification scheme. Table 13 shows an overview of the number of producers certified in GlobalGAP (for fresh fruit and vegetables), Fairtrade and organic (with as main products coffee, banana, cocoa, tea).

Table 13 Number of farmers producing certified products for export markets

Standard	Worldwide	Developing countries	Africa
GlobalGAP (2007)	97,000		2,871
Organic (2009)	1,808,000	1,526,000	511,000
Fairtrade (2008)		977,000	589,000

These figures explain why several donors have been disappointed about the impact of their efforts to build the capacity for smallholder certification in GlobalGAP in Africa (Jaffee et al., 2011). The number of organic and Fairtrade certified producers in Africa is important, over half a million each, but this still remains only a modest percentage of all producers, and is limited to export crops. However, both organic and Fairtrade demand and supply are steadily growing. About 2% of all coffee farmers are certified Fairtrade; coffee being the most important Fairtrade product in 2008 (FLO, 2010).

Organic faming

Worldwide, there are about 1.8 million certified organic producers, of which about 0.5 million are in Africa. Uganda hosts a large share: about 200,000 organic producers.[6]

The Economics of Smallholder Organic Contract Farming in Tropical Africa	Bolwig 2008	Uganda	ref 24
Pathways: → Value chain + Production + Environment	Strategies: → Value addition + Output markets + Processing	Impact Proxy impact Outcome Vulnerable	+ +

The Swedish donor SIDA supported the programme Export Promotion of Organic Products from Africa (EPOPA) from 1996 to 2008. Under this umbrella 34 projects were implemented involving about 110,000 farmers in Uganda and Tanzania. Support consisted of market studies, organising and training of farmers and field staff who were employed by an experienced exporter, setting up an internal control system, and facilitating (and initially paying for) organic group certification (EPOPA, 2008). The evaluation of one of these projects, with 3,870 Arabica coffee farmers in Uganda, shows that organic certified coffee farmers earned 75% more from coffee than non-certified coffee farmers. The difference in total household income was more modest, 12% or $95 per household per year, partly because of competition between coffee and other farm and non-farm activities. The portion of total income derived from coffee is 40% for certified farmers and only 15% for non-certified farmers. Strong points were the linkage of farmers to an experienced commercial exporter

6 FiBL and IFOAM statistics (2009) on www.organic-world.net

rather than supporting inexperienced farmers to export themselves, ensuring sufficient volume, group certification and support for certification costs, and the combination with efforts to improve coffee quality through better processing. Coffee export continues without donor support. It is not clear to what extent the most vulnerable households participate in coffee export (Bolwig et al., 2009).

Fairtrade

For export crops, not only the world market price but also the market organisation influences the profitability for producers. The role of multinationals in determining world and domestic market prices is increasing. For example, in coffee, 90% of the trade is dominated by three main exporters. The proportion of total value in the coffee chain paid to producers declined from 40% in 1990 ($12 / $30 billion) to 16% in 2002 ($8/$50 billion) (Thomas, 2006). The low share of farmers in the value chain has been one of the reasons for the Fairtrade initiatives.

Fairtrade has a number of potential benefits for farmers: the direct income effects through a price that does not drop below a certain minimum price set by Fairtrade Labelling Organisation (FLO), a more guaranteed market through long-term relationships between buyer and farmer organisation, better possibilities for credit and a Fairtrade premium that is used for community development thus benefiting community members not producing Fairtrade.

Measuring the impact of Fairtrade on development	Ruben 2009	Peru, Costa Rica	ref 25
Pathways: → Value chain + Credit	Strategies: → Value addition + Org producers	Impact Proxy impact Outcome Vulnerable	0/+ + -

An evaluation assessed the impact of Fairtrade in coffee and banana cooperatives in Peru and Costa Rica. In four out of six cases, there was no significant difference in total household income, while one case showed 38% higher income and one case showed 22% lower income. The difference between the fair trade price and the conventional price was small during the study in 2006/2007 because of the generally high prices for conventional coffee and bananas. The low income for Fairtrade farmers is due to the competition between the Fairtrade crop and other farm and non-farm activities, the additional costs for inputs and (hired) labour, and the limited Fairtrade market - only part of the produce is sold as Fairtrade. The benefits of the Fairtrade premium, used for community development, were not considered in this study. The Fairtrade impact study, which included also some organic certified farmers, found a systematic higher household income among organic certified farmers. An indirect effect is that the stable prices, guaranteed market, and easier access to credit, encourage farmers' longer-term investments in farm, house and education. Fairtrade seems to have reinforced men's roles in household and cooperative decision making around cash crops; in one case women's income had even declined (Ruben et al., 2009). It is not clear to what extent the most food insecure people participated.

Although worldwide Fairtrade supply and demand are steadily growing, not all supply can be sold as Fairtrade. Of all Fairtrade coffee produced, 62% was actually sold as Fairtrade in 2008; the remainder was sold as conventional, often at lower prices. So although the average price of Fairtrade coffee was 28% higher than conventional coffee, the average coffee price that Fairtrade cooperatives received was 17% higher than what non-Fairtrade cooperatives received (FLO, 2010). Because of the operational costs of the cooperative, not all of this will be passed on to their member producers.

In addition to the direct income effects for certified Fairtrade producers, communities that host Fairtrade farmer cooperatives benefit from the Fairtrade premium. The Fairtrade cooperative decides on the type of community investment, e.g. a school, a health centre, drinking water supply, etc. The total sum of Fairtrade premiums for community development was €46 million in 2008. For the 850,000 Fairtrade smallholder producers and 127,000 Fairtrade labourers, this meant an average Fairtrade premium of €47 per producer.

Review of certification for export markets

Jaffee et al. (2011) found that in four of the six reviewed export value chains in Africa, there were examples where donor-support focused first on certification and gave too little or too late emphasis on other requirements, such as a minimum quality, minimum volume, price, and consistency in supply. Some value chains, including honey and groundnuts, failed because the domestic prices were at least as high as export prices while domestic market requirements were much lower.

5.3.2 Conclusions about value chain development

Most value chain development projects have successfully increased farmer income

Of the six case studies, four showed improved farmer income (Langworthy et al., 2001; Langworthy, 2006; Bolwig et al., 2009; Swanson, 2009) , of which three also found improvement in food security. Two case studies showed no clear effect on income: one case showed positive results only for farmers who stepped in and out at the right moment in a volatile market (Carletto et al., 2009), while another case showed no direct income effects, but showed indirect effects of credit and stable markets on investment and asset accumulation (Ruben et al., 2009). Three case studies showed how specialisation in a cash crop competed with other farm income (Bolwig et al., 2009), non-farm income (Carletto et al., 2009) or both (Ruben et al., 2009).

In addition to the case studies, other reviews often present the effects of value chains on cash crop prices or cash crop value for a household, but not the impact on total household income (Jaffee et al., 2011; FLO, 2010; EPOPA, 2008). For evaluating the impact on household income, one should consider also the effects of additional production costs and competition with other farm and non-farm activities. A focus on income from cash crops overestimates the total household income effects of value chains. The review by Jaffee et al., (2011) distinguishes value chains producing for the local market (in developing countries) and for the export market in industrialised countries. In addition, it distinguishes different market

requirement levels, from low requirements for simple bulk goods such as sunflower or coffee, to higher requirement levels for perishable products such as milk or vegetables. This turns out to be a useful classification for understanding the potential number of beneficiaries of a value chain intervention.

The low-requirements domestic and export market benefits large numbers of smallholders in Africa

Two case studies of successive value chain projects in Mozambique show that upgrading farmers to produce basic bulk crops for export markets was relatively simple, and successfully increased income and improved food security for a substantial number of farmers. It required organising farmers into groups, training in farm practices, and linking up with buyers and exporters (Langworthy et al., 2001; Langworthy, 2006).

In addition to the case studies, one other review confirms that large numbers of farmers benefit from value chains of bulk products, including those for the domestic market. For example, in a sunflower value chain in Uganda, private sector, public research and extension, and donors jointly invested in improved seed, logistics, and oil presses (Jaffee et al., 2011).

The high-requirements domestic dairy market requires high investment and benefits small numbers of farmers in Africa

One case study shows that upgrading smallholder dairy farmers from selling raw milk to the local market to selling to milk processors for domestic supermarkets required large investments including improved breeds of milk cows, milk collection centres with cooling equipment, and an advanced quality management system to ensure food safety. The income of the assisted dairy farmers can be greatly improved but, because of the high costs, the number of assisted farmers was limited (Swanson, 2009).

In addition to the case studies, other review confirms the small proportion of smallholder dairy farmers producing for milk processors in Zambia, Kenya and Uganda. The vast majority produces for the informal unprocessed milk market. The bottlenecks for milk processors are low production and low milk quality from smallholder dairy farmers (Jaffee, et al, 2011).

The medium-requirements certified export markets benefit substantial numbers of farmers in Africa

Two case studies show the impact of certified organic and certified Fairtrade export on household income. The direct income effects of Fairtrade coffee and bananas were negligible in 2006/07, when conventional prices were high. However, the indirect effects were positive: assured market and access to credit encouraged Fairtrade farmers to invest more in farming, housing and education (Ruben et al., 2009). The income effects of organic certification were positive (Bolwig et al., 2009; Ruben et al., 2009).

In addition to the case studies, other reviews point to the substantial numbers of farmers linked to the Fairtrade or organic market. There are about one million Fairtrade producers of which 0.5 million were in Africa in 2008 (FLO, 2010). There are about 1.5 million organic

producers in developing countries, of which 0.5 million in Africa in 2009.[7] In terms of percentages, the number of farmers is small, but the Fairtrade and organic market shares are steadily growing. One other review is more positive about the direct and indirect effects of Fairtrade. The direct effect was that Fairtrade cooperatives received higher coffee prices than other cooperatives. The indirect effect was that a substantial Fairtrade premium was paid which benefited the whole community. Because the Fairtrade premium was not paid out to Fairtrade members, this premium was not considered in the case study (FLO, 2010).

The high-requirements horticulture export market benefit few smallholder farmers in Africa

No case studies of African horticulture for high-requirement export markets were included in this review. Another review by Jaffee et al. shows that African smallholder farmers play only a minor role in the export of horticultural produce. For example in Kenya, many smallholder farmers produce horticultural produce for the domestic market, while only a few smallholders produce for the export market. However, many people are employed by large export farms. Donor efforts to certify smallholder farmers under the GlobalGAP scheme, a standard for fresh fruit and vegetables for European supermarkets, have benefited very few smallholders in Africa.

Involvement of experienced private sector increases the success of value chain development

Three case studies show how successful value chain development projects in Africa combined temporary donor funding with private sector investment - the private sector being an experienced commercial company rather than a farmer association with little commercial experience (Langworthy et al., 2001; Langworthy, 2006; Bolwig et al., 2009).

In addition to the case studies, the reviews of a number of organic value chains in Africa (EPOPA, 2008) and other value chains in Africa (Jaffee et al., 2011) confirm that the involvement of experienced private exporters or existing leading firms was one of the success factors, while bottom-up approaches with inexperienced farmer organisations often failed. Not only did private sector involvement ensure a more critical look at commercial viability – using a demand-led rather than a supply-led approach - it also increased the chances of continuation after donor support stopped.

The risks of volatile export markets demand a flexible approach

Two case studies show the importance of being able to adapt to changing export markets. In Mozambique, farmers successfully shifted from one export product to another, when suddenly the exporter was no longer interested or prices were no longer profitable. In contrast, in one less successful programme in Guatemala, a farmer association had difficulty reacting to lower prices or to complaints from buyers about product quality, eventually resulting in a financial loss.

In addition to the case studies, one review points to a different type of flexibility: complying with more than one certification standard. Certified organic smallholder farmers in developing countries often use an 'internal control system' (ICS) that allows using one

7 FiBL and IFOAM statistics: www.organic-world.net

certificate for a group of producers. When such an ICS is in place, many of the requirements for other certification schemes are already met, which allows groups of smallholders and exporters to add more certifications and respond to changing market preferences (Jaffee et al., 2011).

Priorities in meeting market requirements: certification as the last step

The case study on organic coffee mentions that in addition to organic certification, meeting other market requirements was also important, especially quality, price, minimum volume, and consistency in supply (Bolwig et al., 2009).

In addition to the case studies, the other reviews of African organic value chains (EPOPA, 2008) and other value chains (Jaffee, et al., 2011) confirm this view, and suggest priorities in market requirements that should be met. First, a good cost price analysis should be done, then sufficient volume should be produced, a minimum quality and a consistent supply over the years should be assured, and then later further quality improvements can be made. Certification is often the last value to be added when other requirements have been met.

The most vulnerable people do not necessarily benefit from value chain development

Of the six case studies, four mention that vulnerable people, poor households or women, were specifically targeted. However, even where more vulnerable people participated in the value chain, none of the case studies showed a specific positive effect on vulnerable people. On the contrary, in the dairy sector in Zambia, women participated and earned less than men. Fairtrade reinforced the dominant role of men in cash crops, in the household and in the community, and in one Fairtrade cooperative women's income had decreased.

In addition to the case studies, one other review confirms the lower participation of poorer households in those dairy cooperatives that jointly sold milk and increased the income of its members (Francesconi, 2009). Other reviews do not specifically analyse or mention the participation of the most vulnerable people in value chains and it should be questioned whether they participate and benefit as much as the slightly wealthier farmers.

No indirect effects through lower food prices on food security

The case studies and the other reviews gave no indication of an indirect effect of value chains on food prices that could benefit households not involved in the value chains.

5.4 Interventions reforming market regulation

5.4.1 Case studies and review of reforming market regulation

For the pathway 'reforming market regulations', it was more difficult to find case studies that had a clear 'with-without' comparison, because interventions are often applied to a whole country. Only six case studies qualified. Therefore, more other review articles were added in this Chapter: one meta-evaluation by FAO and eleven other studies.

Six of the 22 selected case studies had market development as their main development pathway, always combined with other, additional pathways. The main strategies were policy (three), organisation of output markets (two) or organisation of input markets (one) and always combined with other, additional strategies (see Table 14).

Table 14 Pathways and strategies in selected case studies, with outcome and impact

Main path	Additional paths	Main strategy	Additional strategies	outcome	proxy	impact	Ref
Market regulation	Production Safety net Stable access, prices	Policy	Infrastructure: irrigation Output markets Infrastructure: roads	+	+	+	26
	Stable access, prices Production Land security	Policy	Research and extension Output markets Diversification	+			27
	Safety net Stable access, prices	Policy	Output markets		0		28
	Value chain Reduce costs Production Stable prices Credit	Output markets	Policy Institutional capacity Research and extension Organisation of producers Organisation of inputs	+	+	+/0	29
	Stable access, prices	Output markets	Organisation of inputs Policy	0	+/-		30
	Production	Input markets	Research and extension Institutional capacity	0			31
	Production /production costs	Input markets	Irrigation Policy	+	+		32

Policy as the main strategy for market development

Policy strategies in all cases included trade reform, in most cases reducing government interference and facilitating private domestic and international trade. Out of three cases, two show a positive outcome, of which one also shows a positive proxy-impact and impact. In Bangladesh, this had improved the recovery after food shortfalls caused by floods, in Vietnam, this has resulted in well integrated and competitive markets, facilitating subsequent export, but in Nepal the facilitated international trade had little impact in the still inaccessible, remote and food insecure areas.

Public policy, food markets and household coping strategies in Bangladesh: Lessons from the 1998 floods	Del Ninno et al 2003	Bangladesh	ref 26
Pathways: → Market regulations + Production + Safety net + Stabilised access and prices	Strategies: → Policy: trade reform + Infrastructure: irrigation + Infrastructure: roads + Organisation of output markets	Impact Proxy impact Outcome Vulnerable	+ + + +

More efficient markets can mitigate localised food production shortfalls. An interesting case study is the trade reform in Bangladesh that started in the early 1990s. Bangladesh recovered much better from the floods in 1998, but also from the floods in 1988 (before the trade reform), than from the floods in 1974 that resulted in the famine of 1975. The main difference between the flood of 1974 and those in 1988 and 1998 is that food prices in 1974/75 increased by 58%, making food unaffordable to many poor households, while prices in 1988 and in 1998 went up by only 7% and 12% respectively. The main cause for the high price rise in 1974/75 was not the food shortfall, which was smaller than after the later floods, but the speculation by food traders, who knew that the public food stocks were very small, that the government was unable to buy more food because it had too little foreign currency, and that aid from the US would come in late. Private import was not allowed. In 1988, private import was not yet allowed either, but the government had a much larger food stock and a larger reserve of foreign currency, there was more irrigated winter crop reducing the period of food shortage, and internal markets were functioning better. Since the early 1990s, private import was allowed and temporarily encouraged by the government by eliminating the 2.5% import tariff during food shortage periods. Meanwhile, the area under irrigation further increased, roads were improved, and the food market functioned well. After the floods in 1998, although the government food stocks were smaller than in 1988, the rapid private import reduced price rises to Indian import parity levels. The government complemented imports and distributed a smaller amount as direct transfers to the poorest and flood affected households. Although market development was not the only factor contributing to the quick recovery in 1998, it was certainly a very efficient measure in mitigating the effects of the localised food shortages. Simulations indicate that in the absence of private import after the 1998 floods, food prices would have increased by 30% instead of 12%, so the policy effect was a reduction of food prices by 18%. Calorie intake by the rural poor in the absence of private import would have been 4-8% lower than the already low 1638 kcal per person per day. The avoidance of high food prices benefited the poorer households in particular (Del Ninno et al., 2003).

Rice market integration in the Mekong River Delta: The transition to market rules in the domestic food market in Vietnam	Lutz et al 2006	Vietnam	ref 27
Pathways: → Market regulations + Stable access, prices + Production + Land security	Strategies: → Policy: trade reform + Research and extension + Organisation output markets + Diversification	Impact Proxy impact Outcome Vulnerable	 +

One study examined rice market integration in Vietnam. After the food deficit in 1980, the government followed a step-by-step reform of the agricultural sector, similar to the reform that China started in 1978. Before 1981, farmers were paid as collective farm labourers irrespective of what they produced, and had little incentive to produce more. In 1981, farmers were contracted to sell a set quota to the collective, but could sell the surplus to private traders, a major incentive. In 1988, households were given greater land security through long-term leases, and were free to grow what they wanted and to sell to whom they wanted. The role of cooperatives was limited to irrigation support and technical advice. In 1989 domestic trade was further liberalised, and in 1996 the first private export took place. The study concludes that the domestic rice market is well integrated and highly competitive involving many private traders. Interestingly, the government still secures the supply of the North (Hanoi) with cheap rice by subsidised transport through state-owned enterprises, still determines export prices and dominates export markets. The impact of domestic trade reform alone was not evaluated, but together with the other pathways in Vietnam's agricultural development, it contributed to the production increase, from a deficit of 27% in 1980 to a surplus of 40% in 1999 (Lutz et al., 2006). The impact on vulnerable people was not assessed.

Trade liberalization and food security in Nepal	Pyakuryal et al 2009	Nepal	ref 28
Pathways: → Market regulations + Safety net + Stable access and prices	Strategies: → Policy: trade reform + Organisation output markets	Impact Proxy impact Outcome Vulnerable	 0 -

The impact of reducing cross border trade may be limited if domestic markets are not well developed. This comes out clearly in the inaccessible mountains of Nepal, where food prices are 2-3 times higher than in the valleys, and where poverty has increased over the last decades, against the national decline in poverty. A study simulated the elimination of the already low applied import tariffs (14.5%) combined with a uniform consumption tax to maintain government revenue of Nepal. The effect would be small because export and import of food is less than 1% of the national production. The reform would transfer resources from agriculture to services, reduce agricultural prices by 4%, and reduce agricultural wages. This trade reform would slightly reduce poverty for those in the easily accessible valleys (*Terai*), but would slightly increase poverty for those in the remote hills and mountains. Because the population in the hills and mountains relies more on agriculture and is poorer than the population in the valleys, investment in roads to develop the domestic market would contribute more to food security than reducing import tariffs (Pyakuryal et al., 2010).

Review: meta-evaluation of trade reform for market development and food security

FAO did a meta-evaluation of the impact of trade reform on food security using fifteen case study countries (Thomas, 2006). The study analysed trends between 1980 and 2001 on trade policy, prices, production of food crops and export crops, agricultural trade, and food security. The trade reform consisted of several actions, which can be grouped as follows:

1. Liberalised exchange rate, and liberalised foreign exchange.
2. Reduced barriers for import and export
3. Loosened government control on interest rates.
4. A fiscal policy: reducing the expansion of money supply to reduce inflation, and a balance between government revenue and expenditure. This often resulted in reduced government support to agriculture.

Some of the key trends in import tariffs, agricultural production, agricultural trade, and food security for the fifteen case study countries are summarised in Table 15.

Table 15 Trends in agricultural import tariffs, crop production, agricultural trade, and food security of fifteen case study countries

	Per capita GNI		Ag. import tariff [1]		Crop production		Agric. trade [2]		Malnourished	
	($)	Change since	Avg	Change since	Crop prod change	Cereal yield change	Food import change	Ag. export change	Avg (%)	Change since
	2001	1990	00-03	1990	80-01	80-01	78-99	78-99	99-01	1990
Malawi	160	-	16%	-	98%	-5%	515%	165%	33%	-16%
Uganda	250	-	13%	-	107%	6%	268%	10%	19%	-4%
Tanzania	270	+	20%	-	32%	40%	174%	45%	43%	8%
Ghana	290	-	20%	0	173%	47%	142%	14%	12%	-23%
Nigeria	300	+	53%	+	200%	-17%	90%	-9%	8%	-5%
Kenya	350	-	23%	-	65%	18%	409%	115%	37%	-7%
India	460	+	42%	-	79%	83%	46%	208%	21%	-4%
Senegal	490	-	15%		58%	21%	89%	-28%	24%	1%
Cameroon	570	-	24%	0	62%	101%	123%	27%	27%	-6%
Guyana	860	+	23%	0	36%	33%	38%	76%	14%	-7%
China	900	+	19%	-	133%	59%	(N.A.)	308%	11%	-6%
Morocco	1190	+	52%	+	69%	10%	171%	115%	7%	1%
Guatemala	1700	+	11%	-	54%	16%	369%	127%	25%	9%
Peru	1970	+	17%	-	115%	68%	153%	137%	11%	-29%
Chile	4600	+	7%	-	90%	132%	67%	1185%	4%	-4%

Source: Thomas, 2006

1) Applied average MFN (most favoured nations) tariffs on agricultural products

2) Trade: comparing period 1995-2002 with 1970-1984

All countries reformed their fiscal policy, their foreign exchange policy, and their import policy. All countries that had a marketing board reduced its influence. Most countries reduced import tariffs, some maintained the same tariffs, and only Nigeria and Morocco increased import tariffs.

Following the reduction in import tariffs, domestic food prices followed more closely the world market prices, which declined between 1980 and 2000. However, this effect was often compensated by the devaluation of the local currency. The exchange rate and other policies had a larger effect on domestic food prices than trends in world market food prices. Reduction of input subsidies made fertiliser use less profitable.

Crop production increased in all countries between 1980 and 2000, but the increase was insufficient compared to population growth in Tanzania, Senegal, Guyana, and Guatemala. Lower food prices reduced incentives to invest in food production, except in India, where farmers managed to increase production to compensate for the lower food prices. In other cases, the incentive of higher crop prices was offset by increased input costs (e.g. fertiliser) or by reduced access to credit. Most structural adjustment programmes have reduced access to credit and increased its costs.

In most African countries, the increase in food import was larger than the increase in agricultural export. The ratio of food import to agricultural export has worsened for all African countries plus Guatemala and Peru, remained the same for Guyana, and had improved for China, India and Chile (1970-2002). In the period 1995-2002, the situation was worst for Senegal which imported food worth more than three times their total agricultural export.

Farmer income from export crops increased in all countries. In contrast, farmer income from liberalised food crops decreased in all countries, except in Chile. Farmer income from food crops that were still protected increased in Cameroon, Nigeria, Morocco, China, India, Chile, Guyana and Peru.

Malnutrition has declined in most countries, also in Africa, between 1990 and 2001. There are strong correlations between national food availability (production plus import plus food aid) and the reduction in malnutrition. In Tanzania, Senegal and Guatemala the decline in per capita food production contributed to an increase in malnutrition. The strategic national food reserves in Kenya and Tanzania has not prevented food insecurity.

Generally, female headed households are still poorer, more vulnerable, and have lower food access. For example in Cameroon, male-headed households made more progress than female headed households between 1996 and 2001, probably due to men's focus on more profitable export crops.

In spite of the efforts analysing quantitative relationships in the FAO meta-analysis, it is hard to draw general conclusions on what trade reform worked best in what situation, because of the complexity of many other, often country-specific, factors affecting agricultural production and food security.

Review: open borders and substitution of crops reduce price fluctuations and the need for food aid

Reduced import and export barriers and the involvement of private sector import can mitigate localised food shortfalls, and can reduce the need for expensive food aid. This is shown by a World Bank study (2008b) and by Dorosh et al. (2009). The World Bank study simulated complete closure of borders. If Zambian borders were closed, a maize production increase of 30% would result in a maize price decrease of 50%. If free export to the DRC would be allowed, the price reduction would only be 26%. If Malawian borders were closed, a maize production decline of 30% would result in 100% higher maize prices. If import of 10% of the national maize consumption would be allowed, maize price rise would be 50%. Dorosh et al. showed how the government interventions in Zambia have been counterproductive. Private imports were not allowed when there was a food shortage in 2005, and exports were not allowed when there was a bumper harvest in 2006, both of which accentuated national price volatility.

Drought tolerant staple crops such as cassava, millet and sorghum, can mitigate the decline in maize production due to droughts. The simulation by the World Bank for Northern Zambia, where both maize and cassava is grown, showed that open borders to DRC and consumer substitution of maize by cassava resulted in a total calorie intake reduction of only 2% following a maize production decline of 30%.

Aid organisations have often overestimated the need for food aid, ignoring the role private traders and substitute food can play. Dorosh et al. (2009). shows that in northern Zambia, open borders allowing private import of maize, and consumer substitution of maize by cassava, could accommodate roughly two-thirds of the maize production shortfall in case of low production, thus reducing the need for government interventions and food aid.

Review: the relation between trade liberalisation, national GDP and poverty

Even if trade liberalisation does increase the national GDP, this does not mean that poverty will be reduced. Panda and Ganesh-Kumar (2009) simulated the further reduction of the already low import tariffs of India, comparing the baseline scenario with the 2003/2004 import tariff with two policy scenarios: unilateral trade liberalisation, and multilateral trade liberalisation. Both scenarios had negligible (positive) impact on the GDP. However, the simulation model showed a 0.45% reduction of real income for poor rural households, resulting in a slight reduction of food security for the lower income groups (the bottom 30% of the population), while the middle and higher income groups slightly improved their food security situation.

Review: trade reform - removing export support in developed countries

Rusastra et al. (2008) estimated what the effect would be of the removal of export support on soya (USA), sugar (EU) and milk (EU, Canada) on food security in Indonesia. Withdrawing export support would not change soya prices much, because since 2002, the US no longer gives support for soya export to Indonesia and much is produced by Argentina and Brazil without export support. Withdrawal of export support would increase world market sugar prices by 5%, and would increase milk prices substantially, by an unknown percentage. The direct impact of this trade reform on food security would be negligible, because of the

limited effect on prices, and because food insecure people in Indonesia spend little on soya (3% of total household expenditure), sugar (3%) and milk (1%). Soya, sugar and milk account for only 7% of the total calorie intake of food insecure people. However the indirect effect through better employment in agriculture and the food industry is expected to be positive, especially for the sugar consuming food industry.

Review: democracy results in more favourable policies for the majority of farmers

In many African countries, policies are not favourable to farmers, in spite of famers forming the majority in most countries. A study by Bates and Block (2009), comparing twenty countries in sub-Saharan Africa, shows that agricultural policies in Africa are more favourable to farmers when the country is more democratic. Agricultural taxation is lower in countries with electoral party competition. They further found that redistributive taxation of cash crops is common if the cash crop is widely grown, or if the cash crop is only grown in a specific area and the president does not originate from that cash crop area. The effects of different policies on food security were not discussed.

Organising output markets as main strategy for market development

Organising output markets here refers to a reform of the pre-existing market organisation. In the 1960s and 1970s, many governments controlled the output markets to various degrees: from setting prices and exporting cash crops through marketing boards to controlling domestic trade and transport of food crops. Out of two cases, one shows a positive outcome and proxy impact, and an unclear impact on food security, while the other only assessed the outcome which was nil.

The organisation of output markets as strategy was applied very differently. In Burkina Faso, a careful re-organisation of the cotton market, as part of a complex reform of the formerly state-controlled cotton sector, tripled cotton production, while the abrupt elimination of support for food crops combined with reduced import tariffs in Gambia and Ivory Coast, to reduce local food production by a half.

Institutional Reform in the Burkinabè Cotton Sector and its Impacts on Incomes and Food Security 1996–2006	Kaminski et al 2009	Burkina Faso	ref 29
Pathways: → Market regulations + Value chain + Production (+ Reducing production costs) + Stable prices + Credit	Strategies: → Organisation output markets + Policy (sector reform) + Institutional capacity building + Research and extension + Organisation of producers + Organisation of inputs	Impact Proxy impact Outcome Vulnerable	+/0 + +

An interesting case is the thorough analysis of the cotton sector reform in Burkina Faso between 1996 and 2006. It is a very complex intervention in which several donors, national government, and farmer organisations, with different interests and convictions, negotiated a set of pathways and strategies. Its main pathway was to develop a more efficient market,

which also reduced production costs, realised better cotton prices for farmers, and motivated farmers to increase cotton production. The strategy was certainly not a full liberalisation, but a gradually transfer of some of the parastatal responsibilities to new institutions and farmer organisations, and to private ginneries, input and credit suppliers. This process was accompanied by intensive capacity-building of the new institutions and a careful sequencing of the gradual reform. Central to the strategy was a new price setting system that was better adapted to world market prices but still prevented the large fluctuations that farmers find hard to handle. Although cotton yields declined slightly (-5%), the number of farmers growing cotton increased (+80%), and the area under cotton increased even more (+380%). Cotton production per worker increased by 140%. National production increased by 360% and export earnings increased by 245% between 1996 and 2006. A counterfactual analysis attributed an income increase of $69 per household per year to the cotton reform. The study extrapolated the real household income gains into an assumed reduction of food insecurity by 5% of the total cotton growing population. However, this study also presents (correctly) results from provincial food security and malnutrition surveys, which showed no positive trend in the cotton growing provinces in Burkina Faso. Very likely, the income gains from the increased area under cotton are partly undone by reduced food production and increased food prices (Kaminski et al., 2009). The impact on vulnerable people was not assessed.

Neoliberal policy, rural livelihoods, and urban food security in West Africa: A comparative study of The Gambia, Côte d'Ivoire, and Mali	Moseley	West Africa	ref 30
Pathways: → Market regulations + Stable access and prices	Strategies: → (abandoning of) Org. outputs + (abandoning of) Org. inputs + Policy: trade reform	Impact Proxy impact Outcome Vulnerable	 +/- 0 +/-

A comparison of trade liberalisation and reduced government involvement in agriculture in Gambia, Ivory Coast and Mali, shows that this initially resulted in lower food prices, but this also discouraged domestic food production. In Gambia, the elimination of fertiliser subsidy reduced the applied fertiliser doses from 20 to 3kg/ha. Rice production fell from 50% to 10% of consumption. In Ivory Coast, the shift from food to export crop production reduced food production from 70% to 40% of consumption. In contrast, in Mali, where rice is a less important food crop, rice production remained high (80% of consumption) due to continued donor support in the irrigated rice schemes. Mali remained self sufficient in food. The dependency on cheap rice imports caused high food price peaks in Gambia and Ivory Coast of over 100% in 2007/08, compromising local food security. In Mali, rice prices also increased, but the abundance of other staple food (sorghum, millet, maize - partly because cotton farmers grew less cotton and more sorghum in 2007), and the relatively good road network resulted in only limited rises in food prices. This study does not mention the advantages of export crop earnings in Ivory Coast or possible alternative use of government budget saved from reduced agricultural support in Gambia. Nevertheless, it can be concluded that simply abandoning support to agriculture and relying on cheap food import, without investing in a sector that provides alternative income to rural households,

makes the food security situation very fragile. Poorer consumers initially benefited most from cheap imported rice, but also suffered most when food prices suddenly doubled (Moseley et al., 2010).

Review: reform from government marketing board to private markets passing a period of mistrust

The cotton reform from one parastatal marketing board to several private ginner-outgrower schemes in Zambia between 1994 and 2002 shows three distinct phases: a stable outgrower introduction phase up to 1998, a outgrower failure phase from 1999 to 2000, and the outgrower success phase from 2000 to 2002. First, outgrower schemes were formed, geographically separated, that provided inputs and credits just as the former parastatal did. Then, new private traders came in, buying cotton from farmers who had contracts (and had received inputs) from other established ginners. Credit recovery became problematic and the relation between farmers and ginners deteriorated. Combined with the decline in cotton prices, the percentage farmers growing cotton halved from 11.0% in 1998 to 5.4% in 2000. From 2000 onwards, six companies worked on improving the outgrower schemes and rebuilt relationships with farmers, resulting in the increase in the percentage farmers growing cotton back to 11.6% in 2002 (Brambilla and Porto, 2006).

Review: domestic market development – policy and infrastructure

Domestic market development takes time. Rashid studied market integration in Uganda in 1999-2001, about ten years after Uganda dismantled its parastatals that controlled domestic food trade. The results show that most markets were well integrated in 1999/2001, while they were not in 1993/94. The remote markets in the north of Uganda were still not integrated. Market integration functioned in two directions: changes in consumption in Kampala and changes in the two main production areas determined prices (Rashid, 2004).

Better roads encourage market-oriented agricultural production. A study by Mogues et al. (2007) explained household income in different provinces in Ethiopia as a function of public investments in roads, education, agricultural research and extension, and health. The study concluded that the highest household income returns are found in investment in roads, but the effects varied across regions: better returns were found in areas with better roads already developed than in less developed areas. Returns on investment in agriculture and education were smaller, but the effects varied less across regions. The best returns on agricultural investment were found in regions with a larger city that serves as market. From these results it could be concluded that a minimum level of development (road density, market access) is needed before investment pays off.

Organising input markets as strategy for market development

Inputs include seed, often multiplied in national seed centres or companies, and fertiliser and pesticides, which are often imported. The import and domestic trade can be done by state controlled organisations, private sector, or a combination. One case study in Ethiopia showed the failed attempt to involve the private sector in the import of fertiliser, the production of seed, and the distribution of fertiliser and seed to farmers. Another case study showed the successful import of cheap irrigation pumps in Bangladesh after private trade restrictions were removed.

Project performance assessment report Ethiopia: Seed Systems Development Project; National Fertiliser Sector Project	World Bank 2007	Ethiopia	ref 31
Pathways: → Market regulations + Increasing production	Strategies: → Organisation of inputs + Research and extension + Institutional capacity building	Impact Proxy impact Outcome Vulnerable	 0

The evaluation of the Seed Systems Development Project and the National Fertiliser Sector Project from 1995 to 2002 showed the mismatch between the donor policy of involving the private sector to deliver better services (seed and fertiliser) to farmers, and the Ethiopian government which was apparently not ready to allow more private sector involvement. The money given to the government to support the fertiliser project was used to continue subsidised government imports. Meanwhile, the government enforced discriminating policies for the private sector. While the private sector played a modest role in fertiliser import and a large role in fertiliser retail at the start of the project, by the end of the project the private sector had abandoned the fertiliser trade all together. Fertiliser imports and use did not increase. The decentralisation of government seed multiplication was a success, but the involvement of the private sector and farmers in the subsequent second stage seed multiplication and distribution failed. By the end of the project, 90% of the improved seed was still produced by government Ethiopian Seed Enterprise, reaching only 30% of the farmers (World-Bank, 2007). The impact on vulnerable people was not assessed.

Shallow tube wells, boro rice, and their impact on food security in Bangladesh	Hossain 2009	Bangladesh	ref 32
Pathways: → Market regulations + Production/prod. costs	Strategies: → Input market (equipment) + Policy	Impact Proxy impact Outcome Vulnerable	 + +

Market liberalisation in Bangladesh in 1989 allowed the private import of Chinese tube well irrigation pumps, reducing the price to farmers from $670 to $220 per pump. The total irrigated area increased from 30% in 1988 to 70% in 2007. Only 22% of the farmers own pumps but they serve another 50% (neighbouring) farmers. The 1.3 million shallow tube well pumps serve 80% of the irrigated area in Bangladesh. Irrigated summer rice is more intensive than rain fed rice, requires more labour and inputs, but this is offset by much higher yields. The production costs (in $/ton) of irrigated rice was 17-22% lower than rain fed rice. The net effect was a national production increase that kept pace with population growth, and a steady reduction of food prices (-1% per year in the 1980s and 1990s) that reduced poverty slightly. However, irrigation in Bangladesh has a negative environmental impact because of the higher use of pesticides and water pollution. Since 1996, Bangladesh overexploits its groundwater for irrigation (Hossain, 2009). The impact on vulnerable people was not assessed.

Review: farmer response to changes in crop and fertiliser prices

More favourable food crop prices do not automatically result in higher food production. Nyairo et al. (2010) calculated the elasticity of the farmer production response to higher maize prices in Kenya and Zambia, using historical data from 1963 to 2003. Although trade reform was meant to motivate farmers to respond to changes in prices, the producer response was very weak in both countries. Farmers in Kenya increased the area under maize but did not intensify their maize production. Farmers in Zambia did not increase production at all. The increased maize prices were still too low to make fertiliser use profitable. In Zambia the response was even weaker after the reform (starting in the 1980s) than before the reform. Interestingly, in Kenya, farmers who grew maize and tea as a cash crop, responded positively to higher tea prices by investing part of their cash crop income in food production.

A study by Matsumoto and Yamano (2009) showed that the relatively high fertiliser doses applied to maize in Kenya (18 kg N/ha) and the very low fertiliser doses applied to maize in Uganda (1kg/ha) were explained by the nitrogen-maize price ratios and the maize response to nitrogen. Price ratios were more favourable in Kenya (13 in 2004 and 16 in 2006) than in Uganda (22 in 2003 and 34 in 2007), mainly due to the 60% lower maize prices in Uganda. Kenyan farmers adjusted their fertiliser doses to changes in the nitrogen-maize price ratio. Apparently, farmers in both countries apply the economic optimum doses. This means that non-market approaches, such as credit or extension, will have limited effect if relative fertiliser-crop price ratio remains higher than the maize response to nitrogen.

The unfavourable fertiliser-maize price ratio in Malawi between1993 and 1996 was the cause of the negative impact of credit on food security. Farmers who used credit for unprofitable fertiliser use, further aggravated by droughts, were worse off than farmers who had not taken this credit. Fertiliser use on tobacco was profitable in that same period, due to high tobacco prices (Diagne and Zeller, 2001).

5.4.2 Conclusions about reforming market regulation

Reduced trade barriers increased farmer income from cash crops

One case study shows how cotton farmers benefited from reduced trade barriers. The reform of the cotton sector in Burkina Faso reduced the role of the government cotton marketing board and reduced costs between the farm gate and export which in turn resulted in higher farm gate prices that reflected better the world market prices. The net effect of the cotton reform was calculated to be $69 per cotton growing household per year.

In addition to the case studies, a review of trade reform by the FAO confirms the positive effects that reduced trade barriers have had on farm income from export crops. Women benefited relatively less, as they are less involved in cash crops than men (Thomas, 2006). One review estimated that reduced support to sugar in industrialised countries would increase income opportunities in the sugar consuming food industry in Indonesia (Rusastra et al., 2008). Agricultural policies are more favourable in countries with a democratic government through lower taxation and in countries where the president originates from the cash-crop area (Bates and Block, 2009).

Reduced trade barriers combined with reduced government support discouraged domestic food production

Two case studies show the negative effect of reduced trade barriers in combination with reduced government support to the agricultural sector. In West Africa, cheap imports initially reduced food prices. Abandoned subsidies increased input prices. This combination discouraged domestic food production especially in Gambia and Ivory Coast (Moseley et al., 2010). In Nepal, a simulation of further reduction of trade barriers showed that in the remote mountains crop prices and agricultural wages would decline (Pyakuryal, et al., 2009).

In addition to the case studies, the FAO review on market reform confirms the negative effects of reduced trade barriers on domestic food production when there was no support for local producers. In all African countries, the ratio of food import to agricultural export worsened in the 1980s and 1990s (Thomas, 2006). A simulation model for India confirmed that further trade liberalisation would increase the national GDP but decrease income of the rural poor (Panda and Ganesh-Kumar, 2009).

Gradual and multi-stakeholder reform of government control on commodity markets gave better results

Two case studies show that better results were observed when market reform and transfer of roles from government to new institutions, producer organisations and markets, was carefully planned and paced, for example with rice in Vietnam (Lutz et al., 2006), and negotiated with the various stakeholders, for example with cotton in Burkina Faso (Kaminski et al., 2009). In both cases, production and farm income increased spectacularly while new institutions and the private sector gradually played more important roles. Less positive results were observed when trade was liberalised and agricultural support was abandoned abruptly without any accompanying measures, as was the case with rice in Gambia and Ivory Coast (Moseley et al., 2010).

In addition to the case studies, other reviews confirm this. The cotton reform of the parastatal marketing board in Zambia, which was less carefully planned, passed through a difficult period of mistrust between producers and private ginners and reduced cotton production (Brambilla and Porto, 2006). The FAO review concludes that some reform aspects have a short-term negative effect on farmers (e.g. removal of subsidies or import trade barriers), while a possible redirection of government investment (e.g. in research and extension or roads) takes longer to have a positive effect. The private sector does not immediately have the capacity and the confidence to take over roles previously played by the government (Thomas, 2006).

Domestic market development is important before international trade reform

One case study shows how the domestic market was developed first before opening up to international markets. In Vietnam (and also in China, as will be seen in the next section on land tenure), the domestic market developed after government restrictions on private trade were gradually abandoned between 1980 and 2000, well before the government dared to reduce its influence on export volumes and prices (Lutz et al., 2006). One other case study concludes that in Nepal, improvement of the domestic markets by better roads will have more impact on food security than further reduction of international trade barriers, especially for the poorer rural households in the remote areas.

In addition to the case studies, other reviews confirm the importance of policy and infrastructure for domestic markets. In Uganda it took about ten years after the government abandoned its control on domestic food trade before most markets were well integrated (Rashid, 2004). In Ethiopia, government investments in roads encouraged market-oriented agriculture and increased income, while government investment in agriculture gave best returns in areas with access to markets through the presence of roads (Mogues et al., 2007). Market integration reduces prices for consumers and encourages producers to react to changes in demand.

Reform of input markets is needed to reduce production costs

One case study shows how the revised trade policy in Bangladesh allowed the import of cheap Chinese shallow tube well irrigation pumps, reducing the price from $670 to $220 per pump. This encouraged farmers to increase overall production, benefiting from reduced production costs while keeping food prices for consumers low. One negative effect was the overexploitation of groundwater (Hossain, 2009). Another case shows the failed attempt of the World Bank to involve the private sector in seed and fertiliser supply in Ethiopia, due to the government hesitating to give up their control (World Bank, 2007). Two case studies mentioned earlier (under 'Interventions increasing production'), show how the re-installation of government subsidies on seeds and fertiliser in Malawi and Zimbabwe increased their use and food production (Munro, 2003; Dorward and Chirwa, 2011).

In addition to the case studies, other reviews confirm unfavourable fertiliser/crop price ratios as a constraint. The FAO review shows how the abandonment of government support to domestic food production increased prices of inputs and reduced its use (Thomas, 2006). In Kenya and Zambia, higher maize prices did not encourage higher fertiliser use, because its use was still not profitable (Nyairo et al., 2010). The low fertiliser doses applied on maize in East Africa actually reflect the unfavourable fertiliser/maize price ratio, which are strongly affected by the high transaction costs, for example for transport between the coast and landlocked countries (Matsumoto and Yamano, 2009). This should have been a warning against some credit schemes for unprofitable fertiliser use, for example in Malawi in the mid-1990s which caused further deterioration of the financial and food security situation of farmers (Diagne and Zeller, 2011).

Abandoning support to agriculture and relying on cheap food imports, without investing in a sector that provides alternative income to rural households, made the food security situation very fragile in Africa

One case study in West Africa shows how reducing trade barriers for food import combined with abandoning support to the domestic agricultural sector drastically reduced domestic food production. Food prices initially declined through cheap imports and later followed the volatile world market food prices, especially in Gambia and Ivory Coast. The price fluctuations were less in Mali where the domestic sector was still supported, resulting in greater food self-sufficiency (Moseley et al., 2010).

In addition to the case studies, other review confirms this. The FAO review shows how the reduction of trade barriers on import competing crops may have resulted in lower food prices in the short run, although this effect was often compensated by the devaluation of

the local currency. Meanwhile, structural adjustment resulted in increased fertiliser prices and reduced access to credit. This, in turn, resulted in declining food production and reduced rural economic growth in several African countries (Thomas, 2006). In contrast, in several Asian countries, farmers managed to increase production sufficiently to compensate for declining food prices. The idea behind liberalising import is that countries will make better use of their comparative advantage. The question is whether each country has sufficient comparative advantage, and whether additional measures are needed, and taken, during a transition period to enable farmers to draw benefit from these advantages.

Acute food shortage is best mitigated with open borders and private import

One case study shows how open borders for private food import made Bangladesh recover much better after the floods in 1998 than after the floods in 1974, when private import was not allowed. Not only did private import increase food availability, it also much reduced the rise in food prices, which was a major problem for poor households in 1975. Note that the government adapts the import tariffs from 2.5% normally to 0% when acute food shortages are foreseen (Del Ninno et al., 2003).

In addition to the case studies, other reviews confirm the positive effect of open borders and private trade on food prices by simulating the effects of different levels of trade barriers in Central and East Africa. Open borders reduce food price rises in case of shortage which is good for consumers, and reduce the price fall in case of a bumper harvest which is good for producers (Dorosh et al., 2009; World Bank 2008b).

Acute food shortage can be mitigated by government imports but this distorts markets

The case study on the recovery of Bangladesh after the floods of 1974, 1988 and 1998 shows that Bangladesh recovered well after the floods in 1988 when private import was not yet allowed, thanks to a large government food stock and enough foreign exchange to allow government food imports (Del Ninno et al., 2003). The study does not discuss the costs for the government in both years, so we cannot conclude that a government food stock and government import (1988) was better than allowing private food import (1998).

In addition to the case studies, other reviews, based on experiences in Africa, are not so positive about governments controlling food stocks and food imports. The FAO review points out that the strategic national food reserves in Kenya and Tanzania did not prevent a worsening of the food security situation in the 1990s (Thomas, 2006). The interventions by the Zambian government have been counter-productive. Private import was not allowed during the food shortage in 2005 while private export was not allowed after the bumper harvest in 2006, both accentuating food price volatility. The unpredictable government measures frustrated the private sector (Dorosh et al., 2009).

Acute food shortage and price rises are mitigated by substitution with other staples

The case study of the effects of trade reform on food prices in West Africa shows that food prices were less volatile in Mali, partly because consumers were able to substitute one staple food (rice or maize) for another staple food (cassava, millet, sorghum) (Moseley, et al., 2010).

In addition to the case studies, other reviews confirm the mitigating effect of food substitution. Drought tolerant crops as cassava, sorghum and millet, mitigate maize production shortfalls due to drought in Central and East Africa, especially when combined with open borders (World Bank, 2008b; Dorosh, et al., 2009).

5.5 Interventions improving land tenure security

5.5.1 Case studies and review of improving land tenure security

The rationale for increasing land tenure security is that if farmers have less fear for having to leave the land they cultivate, they will be encouraged to invest in land, thus increasing production. If farmers have a formal land certificate, they may get access to credit using their land as collateral. If land certificates enable a land rental or land sales market, this could result in a transfer of land to those who make most productive use of it (Deininger, 2008). There is a distinction between land use certificates, where land belongs to the state and certificate holders cannot sell land, and full land ownership titles, allowing title holders to sell land.

Table 16 Pathways and strategies in selected case studies, with outcome and impact

Main path	Additional paths	Main strategy	Additional strategies	outcome	proxy	impact	ref
Land tenure	Stable food prices Markets Production/ Prod.costs	Policy	Output markets Diversification	+	+	+	33
	Stable food prices Markets Production	Policy	Outputs markets Organisation producers Organisation inputs Diversification	+	+	+	34
		Policy	Organisation producers Capacity building	+			35
Main path	**Additional paths**	**Main strategy**	**Additional strategies**	**outcome**	**proxy**	**impact**	**ref**
		Policy	Capacity building	+	+		36
	Production Credit	Policy	Organisation producers Infra (irrig., road, water) Output markets Processing	+	0		37
		Policy		+			38

The six selected case studies are all very different situations (Table 16). The first is the issuance of land use certificates (without ownership) in the context of the agricultural and economic reform in China and Vietnam, which also included more market conform food pricing by the government, gradual liberalisation of food trade, and measures to increase production volume and reduce production costs. The second is the formalisation of customary land rights by land use certificates (without ownership) in Ethiopia, organising farmers and building local institutions. The third is land titling (ownership) of previously untitled land in Peru, building capacity of the cadastral services. The fourth is land redistribution (ownership) from large to small farms in the Philippines, accompanied by measures to increase smallholder productivity. Finally, one case study shows the impact of the amended inheritance law on land inheritance by women in India.

Land use certification in an agrarian and economic reform

Crossing the River while Feeling the Rocks: Incremental Land Reform and Its Impact on Rural Welfare in China	Bruce 2009	China	ref 33
Pathways: → Land tenure security + Stable food prices + Market regulations + Production /prod costs	Strategies: → Policy + Output markets + Diversification	Impact Proxy impact Outcome Vulnerable	+ + + +

Land Tenure Policy Reforms: De-collectivization and the Doi Moi System in Vietnam	Kirk 2009	Vietnam	ref 34
Pathways: → Land tenure security + Stable food prices + Market regulations + Production	Strategies: → Policy + Output markets + Organisation producers + Organisations inputs + Diversification	Impact Proxy impact Outcome Vulnerable	+ + + +

Land tenure policy reforms in China and Vietnam were part of a larger economic reform from a communist planned economy to a market-oriented economy. In both countries, the governments understood that the collective farms and the artificially low food prices set by the government provided insufficient incentive to labourers to work effectively and efficiently. This had resulted in a national food deficit before the reform in 1978 in China and in 1981 in Vietnam. In both countries, there was a gradual reform starting with issuing land use certificates to rural households, initially with the obligation to produce and sell a quota of food to the cooperatives, and later with more freedom in the choice what to grow and whom to sell to. Farm households obtained land use certificates on long-term leases but did not obtain full ownership land titles. Tenure security increased gradually, from one-year contracts initially to lease agreements of 30 years for arable land and 70 years for tree crops in 1999. In China, rental, sale and mortgage of land were prohibited. In Vietnam, the sale of land was prohibited, but an illegal land market did develop. The government

tried to limit this to avoid landlessness. Since1996, land use rights can be traded and foreign investors can acquire land use rights.

The increases in production were spectacular. In China, during the so-called household responsibility system reform between 1978 and 1984, national grain production increased from 305 to 407 million tonnes. Increases in efficiency increased labour productivity and reduced production costs and food prices. Agricultural production on household farms was more labour efficient than on old collective farms: the number of man-days spent per ha was reduced by 22% for rice, by 48% for corn, and by 53% for wheat. As a result, per capita grain consumption increased from 195 to 250 kg per year, and household income increased by 15% per year between 1978 and 1984. The efficiency gains in agriculture made labour available for the rural industry sector that absorbed about one third of the rural labour force by 1996. Poverty declined from 53% in 1981 to 8% in 2001. Three different counterfactual analyses attributed between 32% and 56% of the production increase between 1978 and 1984 to an increase of total factor productivity, due to the increased household land tenure security; the remaining 46-68% of the production increase was due to increased irrigation and inputs (Bruce and Li, 2009).

Vietnam followed a similar path to China but experienced problems with inflation and discouraged producers in the mid-1980s. In the mid-1980s, farmers were not sure about the quota to be delivered and the crop prices they would receive. The quota system was abolished in 1991. Per capita annual food production increased from 260 kg in 1976-1980, to 293 kg in 1981-1984, then declined to 281kg in 1987, and then further increased to 420kg in 2001 and 470 kg in 2007. Poverty declined from 58% in 1993 to 29% in 2002 and 16% in 2006. In Vietnam, increased land tenure security allowed farm households to rent in or rent out land, has encouraged farm investments such as planting coffee, but has not yet facilitated access to credit (Kirk and Tuan, 2009).

Initially, land distribution in China had put women at a disadvantage: when they divorced or became widowed and returned to their home village: they no longer had access to land. Later, women's land use rights were more secure when women moved to their husband's village, thus allowing them to come back. Both in China and in Vietnam, the farmer society may still be egalitarian, but there is a growing wealth gap between the rural and urban population. Landless people in Vietnam are those who have left agriculture and have often found more profitable employment or business.

One of the success factors was that the Chinese government first allowed bottom-up experimentation in some provinces which was carefully evaluated before adjusting national legislation.

Formalising customary land use rights in land use certificates and land ownership titles

Impacts of Land Certification on Tenure Security, Investment, and Land Markets: evidence from Ethiopia	Deininger 2008	Ethiopia	ref 35
Pathways: → Land tenure security	Strategies: → Policy + Organisation beneficiaries + Capacity building local govt.	Impact Proxy impact Outcome Vulnerable	 + +

In Africa, there is increased interest in land registration. Since the 1990s, most African countries have passed legislation to strengthen customary land rights, improve female land ownership, and decentralise land administration. This has become more urgent because of the increasing pressure on land from domestic and foreign investors. Clear property rights (at individual or community level) and transparent land administration are necessary to avoid social conflicts (Deininger et al., 2008).

Farmers in Ethiopia felt insecure about their access to land, due to politically motivated land redistribution, e.g. in Amhara in 1997. A simple method of land use certification (without full ownership) successfully increased land tenure security. The certification method, involving a participatory and decentralised village land use administration committee, proved to be effective and cheap. The $20 million project, the largest land certification programme in Africa, issued twenty million plot certificates to six million households between 2003 and 2008, which means a certification cost of only $1 per plot. The evaluation shows that farmers, and especially women, now have less fear of losing land, have fewer land conflicts with other farmers, and invest more in soil and water conservation. Women and men were both mentioned on the certificate, so women had less fear of having to return land back to their husband's family when their husband died.

Impact of the Peruvian rural titling program (PETT) over rural households	Torero and Field	Peru	ref 36
Pathways: → Land tenure security	Strategies: → Policy + Capacity building cadastre	Impact Proxy impact Outcome Vulnerable	 + +

The Peruvian special rural land titling programme (PETT) is considered one of the successful titling examples in Latin America. Between 1993 and 2000, the Peruvian government registered 1.1 million parcels for about 350,000 households. Most of the parcels were previously in cooperative ownership and were distributed without title to members in the 1980s. Some parcels had some sort of , less complete, land title. The new ownership titles allowed the holders to sell land. An evaluation shows that title holders were encouraged to invest in land: fencing, higher fertiliser use (+4kg chemical and + 6 kg organic fertiliser per plot) and labour investments (+3 hours per month), resulting in a higher production (+$921

per year) and higher household expenditure (+$274 per year).In addition, households assets increased due to the higher value of titled land (average +$2148 for 6.5ha land). However, when the evaluation analysed the results for the three zones, coast, mountains and jungle, separately, these effects were no longer significant. There was no effect on the utilisation of credit, probably due to the small land holding (average 6.5 ha) (Torero and Field, 2005).

Two follow-up evaluations of the PETT programme were carried out by Fort (2008) and by Zegarra et al. (2008), using a survey in 2004 as baseline and a survey in 2006 as final survey. Both evaluations found no impact of land titling on access to credit, but found different effects on land value, farmer investments and farmer income. The evaluation by Fort (2008) confirmed that titling increased the value of land by 34% (about $1050 per household). Farmers with formal PETT land ownership titles were 5% more likely to make land investments (infrastructure and land improvements) than farmers without formal land titles. However, the evaluation by Zegarra et al. (2008) found no significant impact on land value or on most other indicators when considering the whole sample of households. However, for specific subgroups some significant effects were found. Farmers with a higher probability of being rejected for a loan in 2004, who obtained a land title between 2004 and 2006, increased their income (income per ha, non-farm income, total income: +$2940/hh/y) and increased investments in permanent crops, but reduced investment in soil conservation. This was not the result of increased access to credit, but most likely the result of increased tenure security. Both Fort and Zegarra et al. found stronger effects in areas with a higher land title density. Fort found higher investments and higher land value. Zegarra et al. found a higher number of parcels being rented out. This confirms that the strategy of massive titling is appropriate for reducing transaction costs in a land rental market.

Review: the effect of titling on access for smallholders

Where large land owners have land titles are smallholders do not, titling improved smallholder land security, for example in Honduras and West Bengal, India. In contrast, titling of communal land led to transfer of land to big estates, as happened in Malawi, Kenya and South Africa. Poorer people can benefit from property rights if initial income and power are not very unequally distributed. In four sub-Saharan African countries, neither titled tenure nor land transfer rights affected farm productivity (Eastwood et al., 2010).

Review: the effect of unclear land use rights on vulnerable households

Unclear property rights can result in the exclusion of the most vulnerable households from access to natural resources, especially during a food crisis. A case study in the Kafue Flats in Zambia, during the southern African food crisis in 2002/03, showed how households with lower land tenure security lost access to land and natural resources, had reduced livelihood options, and became disproportionally food insecure. Differences between villages were based on ethnicity and the history of immigration: pastoralists were better off than arable farmers, while original Batwa fishermen were worst off. Ineffective monitoring of and enforcement of property rights and sustainable natural resource management by the state, incentives to privatise land, and customary institutions that favour the politically powerful and kinship-based relations, all resulted in a worsening situation of the most vulnerable people during the crisis. Formerly respected usufruct rights were no longer respected. For

example, commercial fishing competed and reduced fish yields by traditional fishermen (Batwa) and women. Earlier efforts to formalise customary land use rights into 99-year leasehold titles in 1995 failed: only two powerful leaders had their land registered, because others faced barriers of costs, complicated procedures and the lack of the required consent of local authorities (Merten and Haller, 2008).

Review: the effect of land markets on land access for small farmers

A distinction is made between land rental markets and land sales markets.
In China, parts of Pakistan, Ethiopia and Uganda, the land rental market has improved access for poorer households (Carter, 2003). Transferable land use rights have resulted in a more efficient re-distribution, increased access to landless, and a better use of the land, in part of Latin America, India and China (Eastwood et al., 2010). However, in other (more commercial) parts of Pakistan, in Mexico, the land rental market reduced access for smaller farmers that had no access to credit. In Nicaragua, the rental market facilitated rentals between family and friends. In Honduras, smaller farms do rent in small areas of land from larger farms, limited by the access to capital. Small farmers can easier benefit from rental markets than from sales markets (Carter, 2003).

The land sale market in Guatemala resulted in a transfer of land from large, extensive farms to smaller, labour intensive farms producing high value crops for the non-traditional export market. In Chile, more than half of the small farmers, who had received land in the land redistribution in 1966, sold their land to larger specialised export companies between 1970 and 1991. In Paraguay, the export boom resulted in a similar transfer of land from small to large export farms during the 1970s and 1980s (Carter, 2003). Whether small farmers can benefit from land markets depend on their access to capital and on the capability to set up a profitable, competitive business.

Land redistribution from large to small farmers

Impact of access to land on food security and poverty: the case of Philippine agrarian reform	Guardian 2003	Philippines	ref 37
Pathways: → Land tenure security + Production + Credit	Strategies: → Policy + Organisation producers + Infra (irrigation, road, water) + Output markets + Processing	Impact Proxy impact Outcome Vulnerable	 0/+ + +

The Philippines have a history of land tenure inequality with a few very large farms and many smallholders who work on a share cropping basis. During the 1990s there was political will to redistribute land to farming households. Between 1988 and 2002, under a large-scale land reform and additional support programme 5.8 million ha were bought and redistributed to three million households, which cost $3.6 billion. Additional services in selected villages (credit, extension, irrigation, roads, drinking water, processing equipment) for 0.8 million of these households cost an additional $2 billion. Landownership among

cultivators increased from 2% in 1990 to 23% in 2000. Share cropping declined from 67% to 3% over the same period. However, there is only a minor effect on rural poverty, which declined from 48% in 1990 to 45% in 2000 for households that had received land, while the poverty level of household that did not receive land rose slightly from 55% to 56%. Among the smaller group of beneficiaries that received land plus intensive additional support, real income levels increased by 12% between 1990 and 2000 (Guardian, 2003).

In addition to the case study, a review by Cox et al. (2003) confirms that additional support to smallholder farmers is needed, and that securing land rights in itself rarely improved access to credit.

Inheritance law and land access for women

Inheritance Law Reform and Women's Access to Capital: Evidence from India's Hindu Succession Act	Deininger et al 2010	India	ref 38
Pathways: → Land tenure security	Strategies: → Policy	Impact Proxy impact Outcome Vulnerable	 + +

The rationale for improving women's access to land and other assets is that this is important for their bargaining power, livelihood opportunities and intra-household allocation of resources towards consumption and investments. Women's ability to inherit land or other property is restricted in many societies. Legal change to improve women's inheritance rights could reduce gender discrimination and improve women's socio-economic position. This in turn could affect food security positively, as women tend to favour spending more on household food provisioning than men. In addition, improved access to assets for women also has been shown to result in later marriage and higher school attendance of girls (Deininger et al., 2010).

In many cases women have traditionally no secure access to land. In India, the government took several legal measures to improve land tenure security for women within the household and family. India's inheritance law reform of 1994 has indeed resulted in a higher inheritance of land by daughters. Daughters whose fathers died after 1994 inherited 22% more land than daughters whose father died before 1994. Nevertheless, daughters still inherit less land than sons. The law reform also resulted in an increase in girls' education by about 0.3 year in elementary school. Finally, daughters whose fathers died after 1994 marry half a year later than daughters whose fathers died before 1994. More education and later marriage are indications of the improved social-economic status of women (Deininger et al., 2010).

Review: land access for women

Rao (2006) finds that women's improved access to land in India coincided with a period in which agriculture was becoming less important for household income, from 96% in 1970 to 27% of household income in 1995. In that period men aspired to better paid opportunities

outside agriculture, leaving women on the land to take care of food production. While a right to land for women is a positive development, it appears also to be leading to an increase of work burdens without much change in terms of status or decision-making authority.

5.5.2 Conclusions about improving land tenure security

The hypotheses of the relationships between land tenure security and food security are described below. First of all, when farmers get the full benefit of what they produce, they will be more motivated than when they are wage labourers or share croppers. Secondly, when farmers have rights to cultivate land for a longer period of time, they will be encouraged to make long-term investments in its productivity and conservation. Thirdly, when farmers have formal ownership of land, they can use it as collateral to access credit. Finally, land tenure security formalised in land use certificates or land ownership titles allows a land rental market or a land sales market. This could facilitate the transfer of land to those who make best use of it.

Efforts to increase land tenure security have taken place in very different contexts. The formalisation of customary land use rights in Ethiopia is very different from the redistribution of land ownership from large to smaller farmers in the Philippines, which, in turn, is very different from the transition from collective to family farms in China and Vietnam.

Formalising land use rights reduces the fear of losing land, especially for vulnerable people

One case study of formalising customary land use rights in Ethiopia showed that farmers, especially women, now have less fear of losing land and have fewer conflicts with other farmers (Deininger, 2008). Another case study shows how the amendment of the inheritance law in India increased land inheritance by women (Deininger, 2010). There were no indications of how this affected productivity.

In addition to the case studies, other reviews partly confirm this finding. Customary land use rights in Zambia, which were not formalised, favoured the politically powerful, worsening the food security situation of the most vulnerable people during the food crisis in 2002/03 (Merten and Haller, 2008). However, titling of communal land also led to big estates, for example in Malawi, Kenya and South Africa. Poorer people could benefit from property rights if initial income and power were not very unequally distributed (Eastwood et al., 2010).

Formalising customary land rights encourages farmer investments

Three case studies show that formalising land rights encouraged land investments. The government programme in Ethiopia formalised customary land rights by issuing land use certificates, which encouraged farmers to invest more in soil and water conservation. The effect on production or food security was not assessed (Deininger, 2008). The government programme in Peru issued land ownership titles to farmers who had a less formal or no land title at all. Title holders invested more in farm inputs and labour, and increased production and income. Household assets increased due to the higher value of titled land. In Vietnam, the government issued land use certificates with long-term lease agreements which encouraged farmers to invest in irrigation or tree crops such as coffee. Production

and income increased (Kirk and Tuan, 2009).

In addition to the case studies, one review questions the impact of formalising customary land rights on investments. In four sub-Saharan African countries, neither titled tenure nor land transfer rights affected farm productivity (Eastwood et al., 2010).

More secure land rights did not improve access to credit

Three case studies mentioned the link with access to credit. In Ethiopia, no impact of land use rights – which could not be transferred anyway – on access to credit was expected (Deininger, 2008). In Vietnam, farmers with land use certificates, who were allowed to lease, inherit or mortgage them, had no better access to credit, even though an illegal land sales market emerged (c34). In Peru, where tradeable land ownership titles were issued, there was no evidence of increased access to credit, probably due to the small size of the farms (Torero and Field, 2005).

In addition to the case studies, one review confirms that access to credit was rarely improved by securing land rights (Cox et al., 2003).

Land redistribution improved access for smallholders

One case study on land redistribution in the Philippines shows how 5.8 million ha of land was bought from large land owners and redistributed to over three million smallholders. Land ownership among cultivators increased and share-cropping was almost abandoned between 1988 and 2002. Those new landowners who also received additional assistance (credit, extension, equipment) increased their income, but the effect on poverty was only minimal (Guardian, 2003).

In addition to the case studies, one review confirms that gradual, compensatory and consensual land reform resulted in a more equal redistribution over more and smaller farms, whereas forced land reform resulted in much more unequal redistribution (Eastwood et al., 2010).

A land rental market can increase land access to poor farmers

The case study in Vietnam shows that the gradual introduction of a land rental market in 1993, which started in a situation with a very egalitarian land distribution, resulted in a small reduction of rural households with land. Landless people were not the poorest, which is explained by the fact that people who can earn more outside agriculture are the first to rent out land to other farmers who stay behind. The effects on production or food security were not assessed.

In addition to the case studies, other reviews confirm the positive effects of a land rental market. Experiences in China, Pakistan, Ethiopia and Uganda show that the creation of a land rental market increased access to land for vulnerable people, especially when these poor households also had access to credit (Carter, 2003). This phenomenon was observed in cases of well-endowed land owners leaving agriculture and renting out their land to more dedicated farmers. Transferable land use rights, rather than ownership titles, has resulted in

a more efficient redistribution and better use of the land, and in increased access to the land by the landless in parts of Latin America, India and China (Eastwood, et al., 2010).

A land sales market does not guarantee access to poor farmers

The two case studies where farmers had full ownership titles, in Peru and the Philippines, did not report on the effects of a land sales market (Guardian, 2003; Torero and Field, 2005). One case study described the emerging, small illegal land sales market in Vietnam. The poorer households rent rather than buy land, while poor households are more likely to sell land after severe shocks. However, the effects of this small illegal land sales market on production and food security were not assessed (Kirk and Tuan, 2009).

In addition to the case studies, one review found the creation of a land sales market only facilitated the transfer of land to poor households with sufficient labour if they had sufficient capital. Smallholders in Guatemala were indeed able to purchase small parcels for labour intensive high-value export crops but smallholders in Chile and Paraguay were not as competitive and ended up selling their land to medium and large commercial farms growing traditional export crops (Carter, 2003).

The transition from collective to family farms, combined with market reform and other preconditions, increased production spectacularly in China and Vietnam

Two case studies show the impact of improved land tenure in combination with market reform. Land tenure policy reform in China and Vietnam was part of a larger economic reform from a communist planned economy to a market-oriented economy (Bruce and Li, 2009; Kirk and Tuan, 2009). In both countries, the governments understood that the collective farms provided insufficient incentive to labourers to work effectively and efficiently, which had resulted in a national food deficit before the reform in 1978 in China and in 1981 in Vietnam. In both countries, there was a gradual reform starting with issuing land use certificates to rural households, initially with the obligation to produce and sell a quota of food to the cooperatives, and later with more freedom in the choice of what to grow and to whom to sell. Farm households obtained land use certificates, but did not obtain full ownership land titles. This transition has had a tremendous impact on 160 million rural households in China and twelve million rural households in Vietnam. Food production and food security increased spectacularly. Efficiency gains maintained food prices low compared to wages, while the labour that was made available was absorbed into industry. Poverty declined in both countries. Note that in China and Vietnam, other conditions for increased agricultural production were met before the change in land tenure security started: irrigation, roads and electricity were in place, and improved crop varieties, fertiliser, other farm inputs and equipment were used. The case study in the Philippines confirms the synergy between land tenure and other agricultural support (Guardian, 2003).

In addition to the case studies, other reviews confirm the synergy between land tenure security and access to capital and other agricultural support such as credit, inputs, extension, and setting up value chains, and that land reform without additional support to poor smallholders has had disappointing results (Carter, 2003; Cox et al., 2003).

6

Costs and benefits

Only ten out of 38 selected case studies had information about project costs, number of beneficiaries and a positive impact or proxy impact that could be translated into monetary benefits. Although such a small number of case studies does not allow generalisation of the efficiency of different types of development aid, they still provide interesting insights into the huge variability in costs and benefits per benefiting household.

Table 18 presents the projects costs and benefits in US$ per benefiting household. First of all, it is useful to distinguish interventions that have non-recurring investment costs and have continuing benefits, e.g. the installation of an irrigation scheme, from interventions that have recurrent annual costs, e.g. subsidy on fertiliser. Although some studies also extrapolated benefits into the future and calculated internal rates of return using various assumptions, Table 18 presents only the simplified costs and benefits, based on the household benefits actually found during the evaluation.

A few notes of caution when reading this table:

- This simplified presentation of intervention costs and estimated benefits per household does not replace or even approach more thorough calculations of costs benefit analysis, NPV, IRR, or ERR, as has been presented in some of the selected case studies; they only serve as an illustration for the large variation between interventions in costs and benefits per beneficiary.
- This comparison should not be used to draw generalised conclusions about the efficiency of impact pathways. Costs and benefits are as much determined by the scale of the intervention and other implementation modalities, and are very specific to the example interventions.
- Indirect effects are not presented here, because only some of the case studies presented these, often using different assumptions. Indirect effects, for example through reduced food prices or increased employment and wages, are expected to be important for large-scale and national interventions.

Table 17 Costs and benefits per beneficiary for ten selected case studies

Project evaluation	Country	Cost per household		Benefits per household per year		Benefits: costs		Beneficiaries (households)	Reference
Impact biologic control cassava mealy bug (production)	Africa	$5	total in 34 years	$19	Avoided losses	+++	break even within one year	10,000,000	Zeddies 2001
Impact brown streak virus tolerant cassava (production)	Mozambique	$9	total in six years	$25	Avoided losses	+++	break even within one year	100,000	McSween 2006
Land titling (land tenure)	Peru	$210	in seven years	$274	Additional income	++	break even within one year	477,000	Torero 2005[8]
Impact organic certified coffee (value chain)	Uganda	$90	total in six years	$95	Additional income	++	break even in one year	3,870	Bolwig 2008
Impact export sesame, groundnuts (value chain)	Mozambique	$154	total in five years	$35	Additional income	+	break even in five years	65,000	Langworthy 2001
Impact irrgiation project (production)	India	$1,840	total in nineteen years	$225	Additional income	+	break even in eight years	212,000	WB 2006
Impact dairy development (value chain)	Zambia	$3,660	total in five years	$340	Additional income	-	break even in eleven years	2,732	Swanson 2009
Impact breeding rust resistance in wheat (prod.)	Worldwide	$2	per year	$13	Avoided losses	+++	break even within one year	90,000,000	Dubin 2009
Impact fertiliser subsidy (production)	Malawi	$82	per year	$122	Additional production	+	Maize cheaper than market and food aid	1,600,000	Dorward 2011
Drought recovery seed + fertiliser pack (production)	Zimbabwe	$37	per year	$20	Additional production	-	More expensive than market, cheaper than food aid	800,000	Munro, 2003

[8] Complemented with information from Fort (2008) and Zegarra et al. (2008)

The first thing that clearly comes up from this overview is the enormous variation in costs per beneficiary, varying from $2 per household benefiting from breeding disease resistant seed, to $3,660 per household benefiting from an improved breed milking cow and access to cooling equipment. Obviously, benefits per household very as well. The case studies are ranked by the number of years in which cumulative annual benefits outweigh the project costs.

Of the ten case study interventions, seven have temporary external costs and continuing benefits and three of these show benefits that outweigh the total investment within one year, partly due to the large number of beneficiaries. Two of the three most efficient projects dealt with reducing crop losses, while one improved land tenure security. Three value chain projects show benefits outweighing the investments in one, five and eleven years respectively. The difference is due to the low capital investments in traditional export crops and high capital investments in the dairy sector. One irrigation project combined large investment costs with a large number of beneficiaries. Farmer benefits will outweigh the investment in about eight years.

Three case study interventions have annual recurrent costs. The continuing maintenance breeding of rust resistance in wheat is still very efficient, because of the large number of benefiting wheat producers in developing countries. However, the free or subsidised fertiliser and seed schemes are costly when compared to local food prices, but are efficient when compared to the costs of food import or food aid during a national food shortage.

Not many evaluations present costs and benefits per household; much of the data presented above had to be sought in additional project documents. Yet such presentation of costs and benefits may guide future interventions aimed at maximising benefits of limited investments. Benchmarks for different types of interventions could be developed.

7

Sustainability and scaling up

Out of 38 selected case studies, 33 studies gave information on sustainability. Two aspects of sustainability are distinguished:

- whether benefits were expected to continue after the evaluation;
- whether there were environmental improvements or problems.

Interventions were classified according to the level on which they operated: village, provincial, national or regional, and whether there was any scaling up, or had been any scaling up. Details are provided in the project summary in Annex 4.

Continuation of benefits

In 23 cases, benefits were expected to continue because the new practices were profitable for farmers, trade was profitable, or the removal of barriers allowed continued agricultural development (China and Vietnam). In six cases, benefits had not yet been achieved, because of slow project progress, conflicting policies between government and donor, the lack of profitability, or the use on inappropriate crop varieties. In four cases, benefits would require continuous external funding for maintenance breeding of wheat, free or subsidised inputs in Zimbabwe and Malawi, or to compensate for the lack of cost recovery from water fees in India.

Environmental sustainability

Of the 38 case studies, fourteen cases provided information on environmental sustainability. Ten cases studies mentioned positive effects. Soil fertility was improved by compost, soil and water conservation, reduced burning and leguminous crops; fuel was saved by reduced tillage; soil and water conservation and tree planting were encouraged by improved land tenure security. Four case studies mentioned a negative effect on the environment. Irrigation in Bangladesh resulted in water pollution and an overexploitation of groundwater. Low levels of fertilisation in Burkina Faso resulted in soil mining. Non-traditional export by inexperienced farmers resulted in excessive use of chemicals and land degradation in Guatemala.

Scale and scaling up

Scaling up allows multiplication of pilot-scale successes, can justify relatively expensive pilot projects, and can improve the benefit-costs ratio.

Of the 38 case study interventions, eight interventions operated at the scale of several villages, three operated at district or provincial level, eighteen at national level, three at regional level, and two operated worldwide. In thirteen case studies there was mention of scaling up. None mentioned specifically that there was no scaling up. Some small-scale interventions were scaling up, while other, large-scale interventions were the result of scaling up in the past. Table 18 gives an overview of the scaling up of the thirteen case studies.

Table 18 Scaling up of interventions at village, district, national and regional level		
Scale	**Scaling up***	**Result of scaling up****
Villages	4	1
District / Province	2	
National	2	3
Regional	1	

** Interventions were scaling up during the evaluation*

*** Interventions were the result of scaling up of a preceding pilot phase*

Scaling up can happen spontaneously by producers or private sector, or actively supported by NGOs, research institutes or government. Successful scaling up often required other pre-conditions to be met, for example financial institutions encouraging farm investment or market regulation encouraging trade.

Spontaneous scaling up was often caused by the same factors as those affecting continuation of benefits: the practices were beneficial for farmers and required no or little investment such as the multiplication of appreciated crop varieties, profitable export, some agroforestry practices and reduced tillage.

An interesting comparison is the six-year participatory seed selection and multiplication project in Nepal, and the three-year seed distribution relief programme in Zimbabwe. The project in Nepal was successful in its scaling up and continuity because the new varieties were appreciated. In contrast in Zimbabwe, only 12% of the beneficiaries decided to reuse and plant the open pollinated maize varieties the following year because the new varieties were not appreciated and farmers had not received sufficient information and training on seed selection.

NGOs, research institutes and private sector have scaled up interventions that they considered successful in a preceding project such as support for agroforestry practices, setting up value chains (notably those involving organic and Fairtrade certification), and distribution of maize seed after droughts.

Small-scale projects targeting few villages often justify their approach by pointing at the possibility that successes could be multiplied at a larger scale, by the same or other NGOs, or government. The evaluations often mentioned that there was scaling up going on during the evaluation. One evaluation specifically mentioned that other NGOs were copying their value chain approach in Mozambique. However, little is known about scaling up beyond the project period and beyond project boundaries in terms of increasing numbers of beneficiaries.

Governments have scaled up policy measures after observing a test at regional level. Land reform in China was informally allowed in one area before policy was adjusted nationally. Ethiopia continues its decentralised participatory land use registration programme. In India, several states had amended the inheritance law before India amended its national

law. The Malawi government scaled up its fertiliser subsidy scheme after a trial phase.

There was one example where the evaluator concluded that the government programme for hybrid rice in the Philippines, which had not yet proved to be profitable, should be downscaled to a pilot programme first before continuation.

8

Conclusions overview

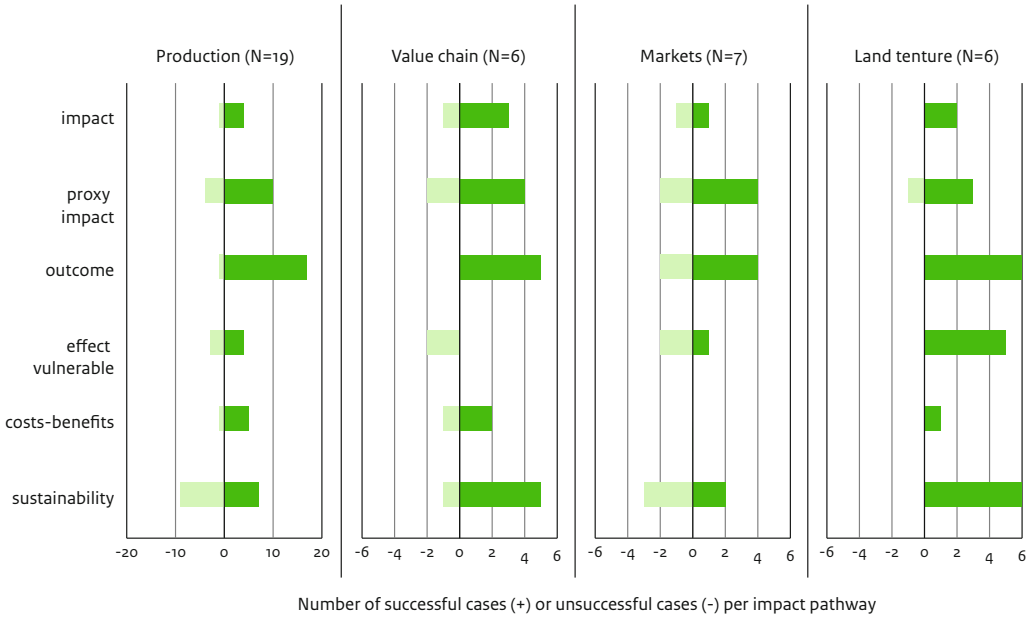
Qualified case studies

The selection criteria, especially the requirement for a convincing counterfactual analysis, limited the number of qualifying case studies to 38. Nineteen studies evaluated interventions increasing production, six studies evaluated value chain development, seven studies evaluated market regulation, and six studies evaluated interventions improving land tenure security. From the total of 38 studies, thirteen studies presented food security impact indicators, 28 presented proxy-impact indicators (household food production or income), while seven studies did not present proxy-impact or impact indicators and only presented outcome indicators. The low number of qualified case studies implies that caution is needed when drawing general conclusions. Instead of generalising conclusions about impact pathways, the success or failure presented in individual case studies needs to be understood in the specific context of each case study.

Score of the four pathways on the evaluation criteria

Figure 10 shows, in a simplified manner, the relative success of the four impact pathways (production, value chains, market reform, and land tenure security) on the basis of the six evaluation criteria. Note that the scale of each intervention does not appear in this presentation, except under 'benefits-costs', which takes the number of beneficiaries into account when compared with project costs. The score is based on the number of case studies that offer information on the specific criterion.

Figure 10 *Number of successful and unsuccessful cases of interventions in production, value chain, market reform, and land tenure security, on impact, impact on vulnerable households, proxy impact, outcome, efficiency and sustainability*



Negative scores mean the following: for impact, it was measured but negligible; for proxy impact, it was nil or even negative (lower income, increased food prices); for outcome, it was nil or negative; for effect on vulnerable groups, they did not benefit more than the average population; for efficiency, the project costs were not outweighed by benefits within ten years; and for sustainability, it was compromised by lack of continuation or environmental problems.

At first glance, land tenure interventions score best, followed by interventions increasing production and value chain development, while interventions in market regulation score least. Context-specific differences for each evaluation criterion are described below.

Outcome, proxy impact and impact

For each of the four impact pathways, examples of successful and unsuccessful interventions are given. These contrasts show that the success of the intervention is sometimes determined by the design of the intervention itself (proven technology), but is more often determined by the match with the specific local context (match with the preferences of beneficiaries, national policies, or other reforms parallel to the intervention).

Crop genetic improvement and irrigation have contributed most to food security

Most interventions aimed at increasing production have indeed increased food production (or reduced losses), and in general have had a positive effect on income and food security.

- The most successful interventions were large scale, commodity specific, and tackled a major constraint (improved plant material, disease control). In contrast, positive impact was also achieved by small-scale, area-specific integrated development projects (irrigation, new farm practices, and credit). The free, or subsidised, seed and fertiliser schemes in Zambia and Malawi were successful thanks to their large coverage of beneficiaries and successful inclusion of poor farmers. Other positive cases include soil and water conservation, reduced tillage and a large-scale irrigation project.
- The least successful case was the annual free distribution of an open pollinated maize variety that was not appreciated by farmers (Zimbabwe), followed by examples of interventions producing a modest outcome but negligible impact (reformed extension service in Kenya, small-scale agroforestry in Kenya, unproven hybrid rice in the Philippines, unprofitable irrigation in China).

In addition to the case studies, other reviews confirm the positive effects of crop genetic improvement and irrigation as the key ingredients of the Green Revolution, especially in Asia, and the positive effects of reducing crop losses in Africa (Evenson and Gollin, 2003; Hazell, 2009; Maredia and Raitzer, 2006). In Africa, the adoption of modern varieties is still low (Maredia and Raitzer, 2006), and much of the irrigation potential remains untapped (You et al., 2010). Less impact was found from research on natural resource management, partly because recommended practices are location specific (McAllister, 2008) and also because effects are often more difficult to quantify.

Value chains have the potential to increase income of substantial numbers of beneficiaries

Value chain development interventions have successfully created new linkages with the domestic, traditional export, or certified export markets.

The successful value chain development interventions all improved food security through improved income from a cash crop. Although the specialisation competed with food production or other activities, the net impact on food security was positive.

The least successful case was one in which farmers did not adapt to changes in prices and market requirements (snow pea in Guatemala), followed by one case (Fairtrade coffee and bananas) that had no direct income effects but still had positive indirect effects on household assets through improved credit and secure markets.

In addition to the case studies, other reviews confirm the effects of cash crop income, but often without considering the effect on total household income, not to mention food security. There is ample evidence of the large numbers of beneficiaries that benefited from domestic and export value chains of simple products in Africa. In contrast, the number of beneficiaries of value chains of perishable export products has been very limited (Jaffee et al., 2011; EPOPA, 2008; FLO, 2010).

Market regulation reform has had good effects during acute food shortages but has had negative long-term effects on food production in African countries that could not compete with cheap imports

Interventions reforming market regulations varied greatly in their success.

- The most successful market reform was in Bangladesh, where a government monopoly on food import was replaced by regulated private import, i.e., with import tariffs being adjusted when domestic production turned out to be insufficient. Two other examples successfully reformed a state monopoly. In Burkina Faso the cotton market has become a multi-stakeholder, semi-planned market, while in Vietnam the government verified national food availability before gradually liberalising the rice market.
- The least successful case of market reform was one where donor and government had conflicting objectives and policies (failed input privatisation Ethiopia), or where the removal of trade barriers coincided with the lack of support for domestic food production and domestic markets (reduced food self-sufficiency in West Africa and Nepal).

In addition to the case studies, other reviews confirm that open borders and private import mitigated the effects of sudden food production shortfalls (Dorosh et al., 2009; World Bank, 2008b). Reduced trade barriers have often improved income from cash crops. However, cheap food import combined with an abrupt abandonment of support to the agricultural sector, as has happened in many African countries during structural adjustment, discouraged food production and did not contribute to improved food security (Thomas, 2006; Moseley et al., 2010).

Improved land tenure has had positive impact when combined with market reform and other support to smallholder farmers

Interventions improving land tenure security all seem to have had positive effects, but have taken place in very different contexts.

- The most successful cases are the land reforms in China and Vietnam, which were part of the larger reform from state-planned to market economy. This reform as a whole has been very successful in improving food security. The formalisation of informal land rights by land use certificates in Ethiopia and land ownership titles in Peru has successfully encouraged farmer investments.
- A less successful case was the land redistribution in the Philippines. The redistribution, when combined with additional support, improved household income but the effect of this expensive programme on rural poverty remained limited.

In addition to the case studies, other reviews confirm that the best results are obtained when improved land tenure security is combined with other agricultural support including credit, extension and equipment, while acknowledging that improved land tenure alone was insufficient to improve access to credit (Carter, 2003; Cox et al., 2003). Land rental markets appear more positive for poor and smallholder farmers than land sales markets (Eastwood, et al., 2010; Carter, 2003). Titling customary land in situations with very unequal wealth and power relations may result in the exclusion of poor farmers (Eastwood et al., 2010). With the exception of the cases of China and Vietnam, no information was found about the effects of improving land tenure security on food security.

The indirect effects of interventions through lower food prices relative to wages are vital for improving food security

Some interventions, such as reduced trade barriers, may have aimed specifically at reducing food prices. Other interventions may have had low food prices, relative to wages, as an indirect effect. For example, increased productivity often also reduced food production costs. Increased demand for farm or non-farm labour often increased wages. Both examples improve the wages/food price ratio. Seven case studies presented information on effects on food prices and wages, and all seven showed a more favourable wages/food price ratio (Table 19). Note that all cases are nation-wide interventions where indirect effects on food prices relative to wages can be expected. In addition, all except one are cases in Asia, where food and labour markets generally work better than in Africa.

Positive effects on food security can be achieved by reducing food prices, by allowing private import during acute food shortage, or by reducing production costs using modern varieties and irrigation. Positive effects can also be achieved by increasing wages, which can be the result of more intensive agriculture, or by increased employment outside agriculture. Positive effects can even be achieved by higher food prices, as shown in China and Vietnam where the artificially low food prices set by the government discouraged production before the reform. It should be kept in mind that over the same period, increased productivity has reduced the rice in food price relative to wages in China and Vietnam.

In addition to the case studies, other reviews confirm the importance of the often indirect effect of interventions on food security through lower food prices. These indirect effects can only be expected from large-scale interventions (Evenson and Gollin, 2003; Dorward, 2011). For the majority of food insecure people who are net buyers, low food prices are better. Only a minority of larger farms which are net sellers substantially benefit from higher prices. Large fluctuations in food prices can be even worse. In badly functioning markets, often found in sub-Saharan Africa, many farmers sell food that is not even a surplus at low prices after harvest and buy more expensive food later on in the season (Naylor and Falcon, 2011). Smallholder farmers have difficulty in reacting to sudden changes in food prices.

Table 19 Effects of interventions on food prices and wages

Project evaluation	Country	Food price	Wages	Wage / food price	Comment	Reference
Land reform (and market reform)	China	+	++	+	Abandon artificial low food price	Bruce, 2009
Land reform (and market reform)	Vietnam	+	++	+	Abandon artificial low food price	Kirk, 2009
Effect private import after flood (Without private import) (With private import)	Bangladesh	- (++) (+)	= (-) (-)	+ (- -) (-)	Compared to no private import	Del Ninno, 2009
Farm input subsidy	Malawi	=	+	+	Increased wages	Dorward, 2011
Modern rice varieties and liberalised import irrigation pumps	Bangladesh	-	+	+		Hossain, 2003, 2009
Impact irrigation project	India	=	+	+	Increased wages	WB, 2006

Effects on vulnerable households

Improvements in food security need to be made for the most vulnerable people and the most food insecure households. These include households located in remote regions, the poorer and women-headed households, and women within the household. Interventions may specifically target more vulnerable people, may target the whole population including vulnerable people, but may also miss the most vulnerable households. As a result, vulnerable people may benefit substantially more, to a similar extent, or substantially less, than the average household in a population. For example, a vulnerable household included in a large-scale irrigation scheme that increases its income less in absolute terms but more

in relative terms than a better-off benefiting household is judged as 'benefiting to a similar extent'. A household benefiting less, or to a similar extent, resulted in a negative score in Figure 10.

Of the 38 qualified case studies, sixteen provided information about the targeting of vulnerable households and the impact on vulnerable or women-headed households. Although within a household some members may be more vulnerable than others, none of the selected studies presented intra-household differences in food security.

Vulnerable households benefited especially from large-scale interventions or interventions specifically targeting vulnerable people

Of the interventions aimed at increasing production:

- Vulnerable households benefited especially from the large-scale interventions that either targeted the whole farm population (improved rice varieties in Bangladesh, worldwide rinderpest eradication), or made specific efforts to target poor farmers (fertiliser subsidy in Malawi).
- Vulnerable households benefited to some extent, but not more than non-vulnerable households, from irrigation in India and participatory seed selection and propagation in Nepal, the latter making specific efforts to include lower castes and women-headed households.

In addition to the case studies, one other review on the Green Revolution confirmed that small farmers also benefited from modern varieties and irrigation (Evenson and Gollin, 2003).

Vulnerable people do not specifically benefit from value chain development

The two value chain development programmes that provide information on vulnerable people did not lead to specific benefits for these households. Although the dairy project tried to target vulnerable people, women–headed households participated less frequently and increased their income less than male-headed households. Fairtrade coffee and banana export did not try to target vulnerable people specifically and in fact reinforced the role men had in households and community decisions about cash crops.

In addition to the case studies, other reviews did not provide indications that vulnerable farmers benefited specifically from cash crop value chains. Poorer farmers often participate less in commercially-oriented dairy cooperatives (Francesconi, 2009). In spite of donor efforts to include smallholders in high market requirement export, their participation often failed. High-end export markets were mainly supplied by large farms, which created substantial employment for labourers (Jaffee et al., 2011).

Vulnerable consumers benefited from cheap food imports, but small, food-producing farmers in Africa suffered from the abrupt abandonment of government support to agriculture.

Of the market reform interventions:

- The liberalisation of food import in Bangladesh reduced price rises after domestic production shortfalls, particularly benefiting poor consumers. Meanwhile, during normal years, the modest import tariffs protected local farmers from cheap imports.

- The liberalisation of food imports in Nepal did not benefit the poorer households in the remote mountainous areas where the majority depend on farming and agricultural wages. In West Africa, liberalisation coincided with reduced government support to domestic farmers, resulting in a domestic production decline and reduced income for producers. Initially consumers benefited from cheap imports, but later suffered from high food prices.

In addition to the case studies, other reviews confirm that open borders in case of acute food shortage reduce food prices which benefit especially the more vulnerable people (Dorosh et al., 2009; World Bank, 2008b). Women-headed and other households that are less involved in cash crops benefit less from reduced trade barriers. These households, together with net consumers, become more vulnerable to fluctuating food prices (Thomas, 2006; Moseley, 2010).

Vulnerable households benefited from increased land tenure security, especially land use certificates, when combined with other agricultural support

All selected cases on land tenure interventions specifically benefited poor households who improved their land use rights (China, Vietnam, Ethiopia) or their land ownership (the Philippines, Peru).

In addition to the case studies, other reviews give a much more mixed picture. Land titling in customary land has also resulted in big estates in Malawi, Kenya and South Africa (Eastwood et al., 2010). Land rental markets indeed often favoured small and poor farmers, for example in China, Pakistan, Ethiopia and Uganda, parts of Latin America and India. In contrast, land sales markets disadvantaged small and poor farmers, for example in Chile and Paraguay (Carter, 2003; Eastwood et al., 2010)

Sustainability and scaling up

Out of 38 selected case studies, 33 studies provided information about sustainability and scaling up. Three aspects can be distinguished: whether benefits were expected to continue after the evaluation, whether there were environmental improvements or problems, and whether there were indications of scaling up in terms of increasing the numbers of beneficiaries.

Continuation of benefits

Interventions aimed at increasing production are expected to continue, except in cases constrained by the lack of a system for cost recovery

For most interventions, increasing production benefits were expected to continue. For other interventions, benefits were not expected to continue, for various reasons. First, the recurrent annual costs were high (fertiliser subsidy, breeding disease resistance, irrigation operation and maintenance costs) thus requiring a cost recovery mechanism. Secondly, some practices were not profitable (hybrid rice in the Philippines and an irrigation scheme in China). One other review confirms the problems with the financial and organisational sustainability of operations and maintenance in large-scale irrigation schemes (World Bank, 2006).

Value chains are expected to continue where actors were able to deal with risks and adapt to changing markets

The majority of value chain development evaluations expected that the profitable business would continue. Only one value chain intervention, snow pea in Guatemala, faced problems of farmers not being able to adjust to changing market demands. Other reviews confirm that the involvement of the private sector ensured the continuation of value chains (EPOPA, 2008; Jaffee et al., 2011).

Reformed market regulations have mixed benefits; expectations for continuation are unclear

The positive effects of market reform in Vietnam (liberalisation of the rice market) and Bangladesh (privatisation of import of food and irrigation pumps) were expected to remain. The continuation of the reformed cotton market in Burkina Faso, however, depended on new farmer institutions that were still weak. The privatisation of the input market in Ethiopia failed during the project period, but the government had become more receptive to privatisation after the project ended. Other reviews did not provide information about the sustainability of market reform.

Benefits of improved land tenure security can be compromised by land concentration and land grabbing

The benefits of all six land tenure security interventions were expected to continue. However, other reviews on this subject warn about a possible concentration of land ownership by larger farmers which has happened in some Latin American countries. In addition, there is growing fear of so-called 'land grabbing' by domestic and international investors (Liversage, 2010; Deininger et al., 2011)2011

Environmental effects

Increased production has direct and indirect positive environmental effects but has also resulted in overexploitation of ground water and water pollution

Interventions increasing production more often have a positive than a negative environmental impact. Soil fertility is maintained or improved by soil and water conservation (Ethiopia): the cultivation of leguminous crops (mungbean in Asia) or shrubs (improved fallow Kenya), mulching (Kenya), and reduced tillage (India, Pakistan), which also saves fuel. However, irrigation in Bangladesh has resulted in water pollution and in an overexploitation of groundwater. In addition to the case studies, one review points to the fact that increased productivity reduced pressure on uncultivated land, and thus reduced the rate of deforestation (Evenson and Gollin, 2003).

Value chains of certified organic or Fairtrade products claim environmental effects which are often not measured

Most value chain interventions promoted, or even required, farmers to adopt environmentally sound practices (export from Mozambique, organic and Fairtrade certification). One value chain for snow pea in Guatemala had problems with excessive use of chemicals and land degradation. In addition to the case studies, other reviews did not document the effects on the environment.

Market regulation reform contributed to overexploitation of irrigation water in Asia and did not resolve the problem of soil mining in Africa

Market reform led to increased irrigation in Bangladesh, resulting in water pollution and over-exploitation of groundwater. The cotton sector reform in Burkina Faso has not resolved the negative nutrient balances in the soil. In addition to the case studies, other review did not provide information on the effects on the environment.

Improved land tenure encourages soil and water conservation

Improved land tenure has encouraged farmer investment in soil and water conservation (Ethiopia and Vietnam) and in planting perennial crops (Vietnam). In addition to the case studies, other reviews did not provide information on the effects on the environment.

Scaling up

The impact pathways increasing production, developing value chains, and improving land tenure security, have examples of scaling up. Market reform is mostly a national intervention, but has been the result of scaling up in some cases.

Some interventions increasing production were spontaneously scaled up by farmers during the evaluation: new varieties (Nepal) or disease resistant varieties (Mozambique), and new practices (zero tillage in India and Pakistan, improved fallow in Kenya). Other interventions received continued support from the government (research and extension in Kenya, hybrid rice in the Philippines, relief seed in Zimbabwe).

Most value chain programmes were scaling up: export volumes for conventional, organic and Fairtrade products are steadily growing. Other reviews confirm the growing market share of tropical products in northern supermarkets and the growing share of organic and Fairtrade products (Jaffee et al., 2011; EPOPA, 2008; FLO, 2010).

There has been no indication of scaling up market regulation, which is mostly a national policy issue. However, there were positive examples of more gradual reform.

Interventions in land tenure security often started with a pilot phase (China) or were in the process of scaling up (Ethiopia). The Indian government amended the national inheritance law after several states had enforced such laws. Other reviews confirm the interest in improving land tenure security, both by issuing land use certificates and ownership titles, because of the growing pressure from domestic and international investors (Liversage, 2010; Deininger et al., 2011)2011

Costs and benefits

Only ten out of the 38 case studies provided sufficient information for a comparison of costs and benefits, of which six were interventions increasing production, three were value chain development interventions, and one was a land titling intervention.

Research on crop genetic improvement and reducing production losses provide the most convincing benefit-cost ratios for a large number of beneficiaries

The most efficient interventions increasing production were those that reduced production losses (biological control and disease resistant varieties in cassava, disease resistant wheat, and vaccination against rinderpest). Less efficient interventions were the expensive large irrigation scheme in India, and the free or subsidised fertiliser and seed schemes in Malawi and Zimbabwe with high recurrent costs. Other reviews confirm the high benefit-cost ratios of research on crop genetic improvement and on reducing crop losses (Raitzer, 2003; Maredia and Raitzer, 2006).

Value chain development interventions may have favourable benefit-cost ratios but the number of direct beneficiaries is more modest

The most efficient value chain development interventions were on traditional export crops and organic certified coffee, while the high capital investments for few beneficiaries in the dairy sector of Zambia were not that efficient. Other review confirms that the investments in high-end market value chains such as the GlobalGAP certification for fresh fruit and vegetables, gave very low returns considering the small number of beneficiaries (Jaffee et al., 2011).

Little is known about costs and benefits of land tenure security interventions

The land titling scheme in Peru was efficient: the costs of survey and registration were less than the higher value of titled land. Other reviews provided no information about costs and benefits.

Interventions combining different impact pathways

Synergy between different pathways, and interventions in situations where other pre-conditions are met, provided the largest successes

Very often the overall effect cannot be attributed to one of the four impact pathways alone because interventions combined several impact pathways. Ten of the 38 reviewed interventions worked through one impact pathway, fourteen interventions combined two impact pathways, six interventions combined three pathways, and seven interventions combined four or more pathways.

Table 20 presents the combinations of pathways in the selected case studies. A combination frequently found was market regulation with production. Although one cannot conclude that combinations work better than single pathway interventions, there are indeed several cases with a strong synergy between production, market reform and land tenure security.

Table 20	Combinations of impact pathways in the 38 reviewed interventions							
	Main pathway			Additional pathways				
	N*	single	mix	production	value chain	market	land	other
Production	19	7	12	x	1	0	0	10
Value chain	6	1	4	2	x	0	0	4
Markets	7	0	7	5	1	x	1	5
Land tenure	6	2	4	3	0	2	x	3

** Number of interventions*

Other reviews confirm the synergies between different interventions, notably between modern varieties, irrigation, credit and extension (Evenson and Gollin, 2003; Hazell, 2009), and between improving land tenure security and other agricultural support to smallholder farmers (Carter, 2003; Cox et al., 2003).

Food security impact in Africa

Although productivity gains have been modest in Africa, reduction in production losses has been successful. Africa still has unused potential for irrigation, but should address the high transaction costs, the unfavourable crop/input price ratios, and reinvest in agricultural support to smallholders.

This review does not conclude that interventions in Africa have been less successful in improving food security. From the 38 case study interventions, eighteen took place in Africa, fifteen in Asia, three in Latin America and two were worldwide. Of the eight case studies with benefits exceeding intervention costs within ten years (or with annual benefits exceeding annual recurrent cost), five were interventions in Africa. These interventions successfully reduced production losses, set up profitable value chains, and subsidised fertiliser. A sixth successful intervention is the worldwide eradication of rinderpest that particularly benefited many livestock farmers in Africa.

In addition to the case studies, other reviews on the costs and benefits confirm that research on genetic crop improvement had less impact in Africa, while research on reducing crop losses had substantial impact in Africa (Maredia and Raitzer, 2006). Africa still has a large untapped irrigation potential (You et al., 2010). A key constraint is the unfavourable crop-fertiliser price ratio in many Africa countries due to high transaction costs in land-locked countries (Diagne and Zeller, 2001; Matsumoto and Yamano, 2009).

The case studies show that unsuccessful interventions in Africa were characterised by the combination of market reform with reduced government support to the agricultural sector (West Africa), a conflict between donor and government policy (Ethiopia), and the introduction of a technology that was either not appreciated (open pollinated maize in Zimbabwe) or had negligible impact (reformed research and extension in Kenya; improved fallow in Kenya).

In addition to the case studies, one review confirms the negative effects on domestic food production in many African countries of reduced trade barriers combined with the strong reduction in support to the agricultural sector (Thomas, 2006).

In conclusion, it is true that the positive examples in Africa do not demonstrate the agricultural intensification seen in other continents combining irrigation, modern varieties and high doses of chemical inputs. This is in line with the general observation that the increase in food production in Africa over recent decades has been achieved mainly from expanding the area under cultivation and not yet by intensification.

Reach of the conclusions

A final note of caution about the reach of these conclusions is appropriate. From this systematic review one should not conclude that investing in one particular pathway will have the greatest likelihood of achieving an impact on food security - for two reasons. First, not all impact pathways to food security were included in this review, and some included pathways were underrepresented by the lack of evaluations that met our quality standards. Secondly, improvements in food security were often the result of synergies between different interventions and pre-conditions, e.g. production, markets and land security. Each area, country or region has its own unique set of constraints and opportunities. This review can give guidance for specific situations, through the 38 examples presented, but does not pretend to provide far-reaching, general recommendations.

9 Discussion

The World Development Report (WDR) of 2008 on 'Agriculture for Development' called for greater investment in agriculture in developing countries. The report warned that the sector must be placed at the centre of the development agenda if the goals of halving extreme poverty and hunger by 2015 are to be realised. While 75 percent of the world's poor live in rural areas in developing countries, a mere four per cent of official development assistance has been committed to agriculture. In sub-Saharan Africa, public spending on agriculture is also only four per cent of total government spending. For the poorest people, GDP growth originating in agriculture is about four times more effective in raising incomes than GDP growth originating outside the sector.

In its State of Food Insecurity in the World (2010), FAO observes that both the number and proportion of hungry people have declined in 2010 as the global economy recovers and food prices remain below their peak. Yet only one year later we must conclude that a new global economic recession is announcing itself and that food prices have peaked significantly in 2011. This volatility in global food prices and macro-economic conditions have great effects on the food security of the poor: with so many intervening factors poor people seem to have less secure access to food than ever. This applies even more to the 22 nations that are in astate of protracted crisis, where malnourishment is much higher (37%) than the average in other developing countries (13%). Here, people are subjected to multiple crises including weak governance, conflict and unfavourable climate. The current aid architecture needs to be modified in order to provide short-term solutions to the immediate effects of hunger and long-term interventions to address the underlying causes.

After a decade of global disinvestment, the WDR announced a renewed focus on food security. Since 2008 the Netherlands Ministry of Foreign Affairs, with support from the Ministry for Economic Affairs, Agriculture and Innovation are in the process of refocusing Netherlands aid on food security. Developing sustainable food value chains, improving access to food markets and private sector development are key issues in addressing this priority. More recently these issues have received major attention in the 'fast-track countries' where Netherlands' Embassies have developed new policy and multi-annual plans for development interventions.

About evaluating food security interventions

This systematic review explored major information sources of food security evaluations ranging from bilateral aid projects, multilateral programmes, projects executed by international non-governmental organisations and international research. The review limited its scope to four pathways to achieving food security: increasing production, developing value chains, reforming market regulation, and improving land tenure security. This study excluded food security measures related to food uptake and nutrition[9], as well as related interventions, such as creating national food stocks and enhancing household food buffers. The Campbell Collaboration methodology for systematic reviews was used. Based on this global inventory, 300+ potentially qualifying evaluations were identified. Yet, after

[9] The current food security discussion focuses more on the importance of food quality and the lack of micro nutrients as cause for malnutrition. However, monitoring micro-nutrient malnutrition is more difficult than monitoring energy-malnutrition, which is more commonly reported on in evaluations.

applying evaluation quality criteria, notably the condition for a counterfactual analysis (what would have happened in the absence of a project?), only 38 evaluations qualified for inclusion in this study.

This brings us to the conclusion that, over the past decades, food security interventions have been poorly evaluated. The collection of 38 qualifying evaluations shows a strong bias towards interventions aimed at raising agricultural production and productivity. This bias is partly due to the larger number of evaluations and relative ease of evaluating these interventions as compared to other pathways. Other interventions, such as improving food markets, value chains or policy, are represented in fewer qualifying evaluations. This review of food security evaluations therefore indicates that there is no strong evidence base for conclusions regarding the effectiveness of related interventions. In other words, from this review we cannot distinguish, in general terms, what works, what does not work, or which interventions work better than others.

We assume that the fact that so few of the evaluations qualify for this review is the result of both deliberate decisions by those commissioning evaluations and the lack of evaluation capacity. Measuring impact of food security interventions is extremely difficult, requiring complicated techniques and substantial human and capital resources.

Aid organisations are increasingly expected to demonstrate impact, but have lacked the proper tools and methods to do so in a systematic way. Quality criteria, such as those related to the Campbell protocol for systematic reviews, were not designed for development aid interventions, but for controlled experiments and treatments that also include a non-treatment population or placebo treatments. But development aid organisations do not operate in this rather scientific context and find moral dilemmas in their pathways for qualifying evaluations. Moreover, aid interventions do not take place in isolation from other interventions and influences and therefore require large sets of data and multi-variate analysis to be able to attribute causes to observed effects. Another difficulty in comparing the impact amongst food security projects is the diverse range of indicators used in the evaluations. The level of food security is understood as the percentage of the population for whom the minimum food requirements are met. Only three selected case studies monitored this, while nine case studies considered average food access for a population; all others used proxy indicators of different lower-level achievements contributing to food security.

Development aid organisations therefore seek less complicated, more participatory and qualitative evaluation methods. Though these can yield rich results in terms of insights and understanding of impacts and their plausible causalities, they may not be the appropriate method for attributing these effects to interventions. This limits the use of these evaluations for comparison with other evaluations because their methods differ too much and this limits the shared learning of evaluations.

About effective food security interventions

Macro-economic figures indicate declining poverty levels across most countries in sub-Saharan Africa. However, food security lags behind and has worsened in several of these countries over the last decade, as shown by FAO figures. Even in middle-income countries, growing inequalities within countries and rising food prices create a situation where a persistently poor group failed to benefit from national economic growth and is food insecure, in spite of improved national food availability.

Contemporary policy priorities in the domain of food security, emphasising interventions ranging from enhancing productivity to creating an enabling environment for private sector development, are not always rooted in evidence of their effectiveness in the recent past. This study presents some impacts that can be attributed to food security interventions, but these remain contextual while the evidence base is insufficient for their extrapolation. For example, there is scarce evidence from evaluations that confirm that private sector development or interventions in value chains have a positive impact on the food security of the most vulnerable households.

Positive effects of research on crop and livestock production can be attributed to interventions that optimise collaboration between international and national research centres. Free access and exchange of germplasm is important but this poses challenges to private sector breeding efforts that result in the exclusivity of patents. The latter may create obstacles to the widespread use of performing varieties, notably among smallholder households, thus reducing their effect on food security.

Sustainability of results, meaning that benefits can be expected to continue after the evaluation without negative impact on the environment, was highest among interventions in land ownership regulation. These interventions also impact positively on vulnerable groups, therefore contributing to the sustainability adage ‘people, planet and profit’.

Good results in the past are no guarantee for the future. Impressive results from international research depended upon collaboration with national research and extension services. Under structural adjustment programmes of national governments, these national institutions have been downsized over the last two decades. Especially in Africa, investments in agricultural research and extension have been extremely low in recent decades. In many African countries, research budgets are inadequate to meet the need for knowledge inputs in agricultural development. Government extension services have been privatised on a large scale. The conditions for effective research and extension, embedding past initiatives in an enabling institutional environment, have changed significantly. As such, it must be questioned whether results from the past are still applicable under the new conditions.

Customary land use rights, without certificates, have already been the cause of conflict over land, affecting food production in many African countries. The situation in Africa is changing rapidly through the modernisation of agriculture and increasing pressure from domestic and international investors accumulating land titles. This could increase conflicts over land where land tenure rights are not clear. Large-scale farming may contribute, in principle, to enhancing food security. Yet, land titles are also used for speculative purposes that take land out of production or even degrade its productive capacity. Smallholder farmers, amongst whom are young farmers, may be denied access to land, which will impact negatively on food security, both directly (lower production) and indirectly (young people migrating to urban centres). Finally, large-scale farming may benefit through export to foreign consumers, while reducing domestic access to food. In this way, land ownership titles can be both a threat and a measure to protect local farmers - it all depends on the transparency and purpose in developing and implementing land legislation.

There is sufficient evidence that in Asia, irrigation schemes have contributed to large crop production increases. However, many schemes are nowadays over-exploiting water resources, while climate change may aggravate water shortages in the future. There is a need for increasing water efficiency, requiring adapted crop varieties and water regimes. Meanwhile, there is still untapped irrigation potential in Africa. Sustainable use of these water resources not only requires technologies adapted to the prevailing conditions, but also sound governance structures.

About intensifying Africa's food production

In many countries in Asia, spectacular production increases resulted in national food self-sufficiency; many countries have become net exporters of food. However, due to poverty this food is still inaccessible for millions of people. In many African countries, poverty is a problem as well, but on top of that, production has made too little progress; many countries have become net importers of food. Therefore, Africa receives more attention in the current debate on food security than other continents. Even though the majority of malnourished people still live in Asia, Africa has the highest proportion, 30%, of its population, being malnourished. While worldwide food security improvements have been substantial, progress has been much slower in Africa. Nevertheless, this review has also shown some impressive successes in Africa and examples from other continents that are worthwhile considering for Africa.

Large successes have been realised in reducing production losses, by the introduction of biological control against cassava mealy bug, and disease resistant varieties of cassava in various countries. There is certainly scope for continued research to reduce production losses, as long as research efforts are complemented by multiplication and dissemination schemes. The diversity of agro-ecological zones in Africa calls for more intensive breeding and selection efforts at national and local level, using the half-products of regional and international research. The successful example of participatory variety selection and multiplication in Nepal merits consideration for use in Africa.

Africa is in transition from expanding the area under extensive cultivation to agricultural intensification. Though there are African countries where expansion of land under agricultural production is still an option, many African countries are reaching or will reach their expansion limits soon, and will need to intensify production. A major constraint that needs to be tackled is the high transaction costs in Africa, resulting in unfavourable price ratios between crops and the inputs required for intensification, and high costs of transportation and other logistics. Irrigation can trigger further intensification. Even though the total irrigation potential in Africa is limited, a large part of its potential (82%) is still untapped.

About evaluating food security

Many evaluations did not meet the criteria for systematic review and were therefore not suitable for the comparison across evaluations: a missed opportunity for learning. This was due to the methods of evaluation which did not respect general conventions on quality evaluation. This frequently resulted in lack of evidence to attribute observed effects on food security to interventions. Based on this observation we would advocate more harmonisation of evaluation methods if attribution and cross-intervention comparison are the objectives.

From the large variety of indicators of food security impact used, child malnutrition is probably the most suitable, because it reflects well-targeted effects. The methodology is well described and accompanied by reference tables, results are objective and reliable, and in many countries such surveys are already undertaken on a regular basis. The latter do not have to be conducted by individual programmes. Several evaluations used national level data to support their impact findings: data collected by, for example, the Ministry of Health for child malnutrition. This has several advantages: the expensive monitoring effort can serve several programmes in the same sector, it is more objective, data are more relevant for national governments, and it provides continuous time series rather than snapshot information. This method also has an important disadvantage, as these data are often aggregated up to a level that does not allow a comparison between beneficiaries and non-beneficiaries of a certain intervention.

Many evaluations were unable to attribute observed changes to project interventions. Some evaluations, lacking baseline data or a control group, used creative analyses to 'prove' the intervention impact afterwards. Other projects made attribution much easier by a baseline survey and by monitoring both beneficiaries and non-beneficiaries. For national level programmes, some evaluations used models and multivariate analyses to convincingly attribute impact to interventions, while other evaluations made comparisons between countries.

Evaluations are not always aimed at attributing causes to effects. Evaluation can also serve to enhance understanding of processes or to inform management of progress. In those cases, more qualitative evaluation methods can also be used and may yield better insight

than evaluations aiming at attribution. Qualitative evaluation methods can also be applied for identifying 'good practice' or learning lessons from multiple cases. If the objective of evaluations is to contribute more effectively to new policy and development programmes, a better quality standard, combining both qualitative and quantitative methods, will be most appropriate.

Among the evaluations included in this review we found little information about cost-benefits of food security interventions. In times when government expenditures on international cooperation are being reduced and there is growing public scepticism about aid effectiveness, the inclusion of cost-benefit analyses in evaluations is highly recommended. Systematic application of such analyses would facilitate the gradual development of benchmarks and ratios for impacts and their costs. This will contribute to greater transparency of public expenditure on international cooperation.

Retrospective of the systematic review methodology

For this review, a hybrid methodology was used. It combined a strict systematic review protocol with a more general summary of other reviews. The latter provided comprehensive 'common knowledge' with which to confront and balance the case study results. What is the added value of using this hybrid methodology compared to a regular systematic review, without additional review, or than a normal literature review, without strict selection criteria? There would have been some disadvantages if the format of a regular systematic review was used. First, food security, even when delimited to only four pathways, is a very extensive subject to be covered by only 38 case studies. A large number of studies on a more restricted subject would be desirable. Secondly, one advantage of a systematic review is that evaluations can be compared in order to draw more generic conclusions. The selected case studies were often too diverse in subject, complexity, scale and indicators used, to undertake meta-analysis-like comparisons. These disadvantages have been mitigated by adding information from 46 other reviews. There would have been some disadvantages if only a normal literature review was used. One then risks confirming and repeating long-standing conclusions that have been drawn without critically verifying whether the evidence is based on good evaluation methodology. In addition, it would be difficult to compare studies on a similar set of indicators, and to draw more generic conclusions based on such comparisons. In conclusion, we think that this hybrid method of systematic review using strict selection criteria, plus a summary of other reviews to confront and balance case study results can help us to move forward towards more evidence-based conclusions, and, at the same time, to reduce the narrow information base caused by the evaluation quality criteria. A recommendation for future use of this hybrid systematic review methodology is that a good delimitation will allow the use of sufficient homogeneous studies, in terms of subject, complexity, scale, and indicators reported on.

Annexes

Annex 1 About IOB

Objectives

The remit of the Policy and Operations Evaluation Department (IOB) is to increase insight into the implementation and effects of Dutch foreign policy. IOB meets the need for the independent evaluation of policy and operations in all the policy fields of the Homogenous Budget for International Cooperation (HGIS). IOB also advises on the planning and implementation of evaluations that are the responsibility of policy departments of the Ministry of Foreign Affairs and embassies of the Kingdom of the Netherlands.

Its evaluations enable the Minister of Foreign Affairs and the Minister for Development Cooperation to account to parliament for policy and the allocation of resources. In addition, the evaluations aim to derive lessons for the future. To this end, efforts are made to incorporate the findings of evaluations of the Ministry of Foreign Affairs' policy cycle. Evaluation reports are used to provide targeted feedback, with a view to improving the formulation and implementation of policy. Insight into the outcomes of implemented policies allows policymakers to devise measures that are more effective and focused.

Organisation and quality assurance

IOB has a staff of experienced evaluators and its own budget. When carrying out evaluations it calls on assistance from external experts with specialised knowledge of the topic under investigation. To monitor the quality of its evaluations IOB sets up a reference group for each evaluation, which includes not only external experts but also interested parties from within the ministry and other stakeholders. In addition, an Advisory Panel of four independent experts provides feedback and advice on the usefulness and use made of evaluations. The panel's reports are made publicly available and also address topics requested by the ministry or selected by the panel.

Programming of evaluations

IOB consults with the policy departments to draw up a ministry-wide evaluation programme. This rolling multi-annual programme is adjusted annually and included in the Explanatory Memorandum to the ministry's budget. IOB bears final responsibility for the programming of evaluations in development cooperation and advises on the programming of foreign policy evaluations. The themes for evaluation are arrived at in response to requests from parliament and from the ministry, or are selected because they are issues of societal concern. IOB actively coordinates its evaluation programming with that of other donors and development organisations.

Approach and methodology

Initially IOB's activities took the form of separate project evaluations for the Minister for Development Cooperation. Since 1985, evaluations have become more comprehensive, covering sectors, themes and countries. Moreover, since then, IOB's reports have been submitted to parliament, thus entering the public domain. The review of foreign policy and a reorganisation of the Ministry of Foreign Affairs in 1996 resulted in IOB's remit being extended to cover the entire foreign policy of the Dutch government. In recent years it has extended its partnerships with similar departments in other countries, for instance through joint evaluations and evaluative activities undertaken under the auspices of the OECD-DAC Network on Development Evaluation.

IOB has continuously expanded its methodological repertoire. More emphasis is now given to robust impact evaluations implemented through an approach in which both quantitative and qualitative methods are applied. IOB also undertakes policy reviews as a type of evaluation. Finally, it conducts systematic reviews of available evaluative and research material relating to priority policy areas.

Annex 2 Terms of Reference

Rationale

Food security is receiving new interest as one of the key themes for international development cooperation. Food security is usually understood as: food availability, food access, and food utilisation. Some add a temporal aspect to it: stability, within the year and between years. According to the FAO, food security exists 'when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life' (Rome, World Food Summit, 1996). This goal was at the heart of the Rome Declaration on World Food Security, and formed the basis of the first Millennium Development Goal.

The roots of today's food insecurity go back 30 years, when investment in agriculture started to decline. Aid to agriculture was 18 per cent of total assistance in 1979, but declined to 4.3 % in 2008. In developing countries, government investment in agriculture also fell in this period, by one third in Africa and by as much as two thirds in Asia and Latin America. In many low-income developing countries this was accompanied by policy reforms that dismantled public institutions that supported agriculture.

When global food prices almost doubled between September 2006 to June 2008, it became apparent that the world was facing a new era of uncertainty. Indeed, volatility returned to some food commodities markets in 2010. Targeted investments for reinforcing food security are needed, along with comprehensive policy frameworks at global, regional and national levels. In July 2009, the G8 summit produced a Food Security Initiative, promising to mobilize more than US$20 billion to strengthen global food production and security. In 2010, the Global Agriculture and Food Security Program (GAFSP) was established as a multilateral financing mechanism to help implement these pledges.

In order to support future policy making with respect to food security, the DAC EvalNet meeting in 2010 expressed the need for a systematic review of recent evaluations and other research that would provide evidence-based information on successful approaches. This international request coincided with a renewed interest in food security in Dutch development policy. Therefore IOB proposed to take the lead in preparing this systematic review.

Demarcation of the subject of Food Security

Given the large domain of food security programs, the analysis should start with a concise delimitation of key priority areas. A first step is to reconstruct and agree on a general set of theories of change (pathways to impact): how would different development interventions contribute to improved food security. This set of theories may be adjusted and complemented during the study. This also helps to set the selection criteria for reports to be considered. Based on the set of theories of change contributing to food security, it will be decided what themes will be part of this systematic review and what themes will be excluded. In terms of the results chain it seems logic to include up to the level of *food access*, including stability in food access, and to exclude the level of *food utilisation*, and the related accompanying interventions for safe water, sanitation, health care, and balanced diet.

It is still to be seen what indicators for food access are used in the available reports. Possibilities are number of meals per day, calorie intake, number of months per year with adequate household food availability. If the reports allow for more emphasis on the most vulnerable, then the effect on the % of the population not meeting minimum food access requirements will be considered. If indicators at food utilisation are available (i.e. USAID food security projects measuring child malnutrition), these will be considered as proof of food access (even though this higher level is not the impact level foreseen in this study). Indicators at the level of household food production and household income are not ideal. However, if too little information is available at the level of food access, household food production and household income, as the underlying level for food security will be interpreted as proxys for food access. The review will primarily focus on rice, wheat, maize and tubers.

Among the food insecure households, roughly 35-40% live in cities, and this group is expected to increase substantially in the coming decades. Urban food security will thus be considered in this study. Interventions (and indicators) that target the urban population include: peri-urban agriculture, agricultural processing / value chains, agricultural policy, and food prices. Interventions aiming at non-agricultural income will not be considered, even though these will affect household food security.

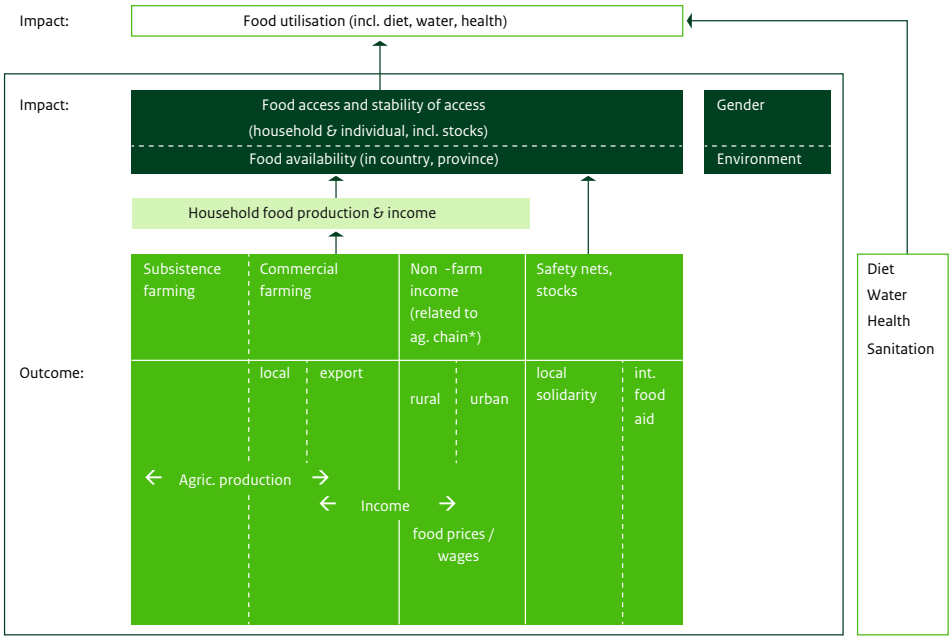
Although the focus will be donor interventions the review will also consider studies that evaluated the effect of policies (including national policies without donor interventions) on food security. Several studies are available about e.g. the Indian agricultural policy and its impact on food security.

Another dimension of demarcation is the interpretation of 'success'. It is, for instance, worthwhile to include studies that compare policies with the reality (i.e. the needs to improve food security). Examples are e.g. the fertiliser subsidy scheme in Zambia that benefited the larger farms, and not the smallholder farmers. Or the opposite effects of increasing food prices: encouraging production and increasing farmer income, but decreasing food access for part of the (urban) population. Increasing food prices can lead to social unrest in cities.

Key attention should be given to transversal issues of gender participation (and intra-household food security) and environmental management.

The following figure gives a preliminary indication of the themes that will be covered by the systematic review.

Demarcation of the subject: impact pathways to food security



** Income from activities not related to agriculture processing or value chains are not included.*

Tentatively development interventions are grouped along 6+2 themes:

1. Investments in primary production (output, efficiency, quality)
2. Rural infrastructure, and inputs and service provision (seed, fertiliser, equipment, extension, etc.)
3. Rural institutions: farmers' cooperatives, land titling & registration
4. Agricultural trade and value chain integration (prices, stocks, margins, bargaining)
5. Technical assistance, schooling and capacity development
6. National (or regional) food policy schemes

The cross-cutting themes:

7. Gender, and intra-household food security
8. Environmental management.

Given the availability of detailed reviews, the area of emergency food aid will not be included. However, structural food aid insofar as it has an effect on local food production and food prices will be part of the review. Rural microfinance will not be covered by this review because this subject has recently already been dealt with in numerous reviews.

It is not yet clear in what detail different interventions will be compared, in other words to what extent the different steps in the results chain will be split up. Two examples:

- Evaluations of different extension systems on farmer adoption of improved farm practices. It is proposed only to consider such evaluations if these are complemented by studies showing the effect of the same improved farm practices on food security (beyond the anecdotal impact).
- Evaluations of IPM interventions, increasing farmer income (by reducing costs), possibly increasing production, and improving product quality. If this can be linked in a plausible way to food security, such evaluations will be taken on board.

As a general recommendation it is proposed to cut the results chain between intervention and impact in pieces, especially if too few evaluations are found showing the impact of interventions on food security. But this only makes sense if it is possible to match the different evaluations up to the food security level.

Tentatively the review will cover the last ten years (2001 – 2010). If too little information is available, it will be decided whether it is useful to go back further (e.g. fifteen, twenty years).

Systematic Review

The purpose of a systematic review is to sum up the best available research (evaluations and academic research) on a specific question. This is done by synthesizing the results of several studies. Following the guidelines and procedures mentioned in the protocol of the Campbell Collaboration a systematic review uses transparent procedures to find, evaluate and synthesize the results of relevant research. Procedures are explicitly defined in advance, in order to ensure that the exercise is transparent and can be replicated. This practice is also designed to minimize bias.

Studies included in a review are screened for quality, so that the findings of a large number of studies can be combined. Peer review is a key part of the process; qualified independent researchers control the author's methods and results. Key components of a systematic review are: (i) Clear inclusion/ exclusion criteria; (ii) an explicit search strategy; (iii) Systematic coding and analysis of included studies and (iv) Meta-analysis (where possible).

There are two types of selection criteria:

- General evaluation quality assessment, as used by IOB (see Supplement 1), which looks at the quality of the evaluation and includes e.g. an assessment of triangulation. It will be useful to use (part) of these criteria used by IOB in the first screening of evaluation reports.
- Specific evaluation subject assessment, for the use in this food security review. This includes questions as: is there evidence-based information on food access; is there a

comparison with a reference group; is the scale sufficient? For the evaluation of the impact of national policies the question is whether cross-country comparisons were required and applied.

The intention is to select evaluations that have a minimum scale of impact. A minimum number of e.g. 5000 households targeted for improving food security seems to be a fair criterion. Apart from bilateral donors there is a number of larger NGO food security projects that typically spent 1-4 m€ over a 2-4 year period, targeting 6,000 – 18,000 households (of 5-6 persons / hh). Projects targeting up to 1000 farmers are too small to represent an impact.

At this stage a broad list of selection criteria for the first selection of reports is developed (see Supplement 2). The intention is not to exclude evaluation reports too quickly. Later the selection criteria can be narrowed down. Note that it is rather strict on the impact, but flexible on the interventions. There may be relevant interventions contributing to food security that are not yet captured in the 6+2 intervention groups (but excluding general income generating activities outside agricultural value chain development).

Data Sources

The systematic review is based on evidence-based evaluations (and research) that are recorded in the following materials:

- IOB evaluation studies
- OECD-DAC evaluation studies (derived from DEReC database)
- FAO, IFAD and IFPRI (evaluation) studies
- World Bank, AfDB, ADB & IADB (evaluation) studies
- 3IE
- Evaluation articles in professional journals (i.e. Food Policy, World Development, Agricultural Systems, etc).
- IFDC

Content of the report

In line with the protocol for systematic reviews the report will include the following sections:

1 Ackowledgements
2 Background for the review
3 Objectives of the review/ the review question
4 Methods of the review
  a) Clear inclusion and exclusion criteria (subject and quality of studies)
  b) Explicit search strategy (not limited to scientific publications)
  c) Systematic coding and analyses of included studies
  d) Meta-analysis where possible
5 Results of the review
6 Conclusions and issues

Annexes

Audience for the systematic review

The study is first of all backward looking: what worked well and what did not, to achieve food security. The most important audience for this report will be the (Northern) donors, so it should help policy makers in development work. Therefore, the results should also be interpreted in the current context and the trends for the coming decades. It will be interesting to present differences between Asia, where production per land area has increased, Latin America, where production per unit labour has increased and Africa, where production has stagnated. Moreover, the growing urban population, the changing diet, climate change, rising food prices, (consider the ILRI analyses, ...) will be considered as relevant context. A last, forward looking chapter in the report will consider the consequences for future policy.

Period

Staff involvement of 4 months (full time) for senior researcher and 4 months half time for research assistant.

Output

Systematic review paper, to be published as an IOB Study
Approx 60 pp. (excl. annexes and references)

Organisational set-up

IOB will contract an external inspector on a temporary basis, Ferko Bodnar, through a mediating organization, KIT. KIT will create a peer-based team of senior staff consisting of Eric Smaling and Bart de Steenhuijsen Piters. At IOB Henri Jorritsma will be responsible for supervising the study on a regular basis. A junior IOB staff (Jisse Kranen) is part-time available for this study, and can assist for example with the search and first screening of available evaluation reports. IOB will assign an internal peer reviewer. The draft report will be submitted for comments to a selected number or external peer reviewers.

Supplement 1 to the terms of reference. Evaluations assessment form

The Policy and Operations Evaluation Department of the Dutch Ministry of Foreign Affairs uses this form to assess the quality of evaluations. The Department first records a number of characteristics of the object evaluated, the evaluation research, the actors and the evaluation report. Then it assesses the evaluation according to three criteria: validity, reliability and usefulness. These criteria have been operationalised by defining respectively six, five and three indicators, that are distinguished in one or more concrete components, amounting to 33 in total. The assessment of these components takes place using a four points scale: poor, mediocre, fair and good.

List of characteristics	
Evaluation object	
title	
type of object	
country (countries), region(s)	
financial size	
evaluation period	
Evaluation research	
purpose	
type of research	
research cost in euros (and in %)	
financing source	
duration	
Actors	
commissioning agent	
steering or guidance	
evaluators	
qualifications	
selection criteria	
Evaluation report	
date	
authors	
research questions	
terms of reference	
size	

1. Validity (has been measured what was set out to be measured?)		score
1.1	**Reason for and purpose of the evaluation**	
1.1.1	Description of the reason for the evaluation	
1.1.2	Formulation of the evaluation purpose in clear terms	
1.2	**Problem definition and research questions**	
1.2.1	Clarity of the problem definition	
1.2.2	Translation of the problem definition into relevant research questions	
1.2.3	Definition of the evaluation criteria applied	
1.3	**Evaluation object and context**	
1.3.1	Definition and demarcation of the evaluation object	
1.3.2	Description of the organisational set-up and way of implementation	
1.3.3	Position of the evaluation object in the policy and institutional context	
1.4	**Intervention logic**	
1.4.1	Description or reconstruction of the intervention logic	
1.4.2	Distinction between different result levels	
1.4.3	Operationalisation of the result measurement by means of indicators	
1.5	**Research methods**	
1.5.1	Specification of the methods used	
1.5.2	Account of the methods applied	
1.5.3	Account of the limitations of the study	
1.6	**Consistency**	
1.6.1	Data analyses and interpretation, formulation of findings	
1.6.2	Foundation of conclusions by findings	
1.6.3	Consistency between conclusions and recommendations	
2. Reliability (are the findings reliable?)		**score**
2.1	**Information sources**	
2.1.1	Identification of the information sources consulted	
2.1.2	Verification of reliability and accuracy / triangulation	
2.2	**Representativeness**	
2.2.1	Account of the sample studied	
2.3	**Independence**	
2.3.1	Independence of the information sources from stakeholders	
2.3.2	Independence of the evaluators from stakeholders	
2.4	**Evaluation process**	
2.4.1	Implementation of the evaluation within the intended time and available budget	

2.4.2	Undisturbed research process	
2.4.3	Account of the research process	
2.5	**Quality control**	
2.5.1	Incorporation of the comments of stakeholders	
2.5.2	Internal and/or external control by a guidance or steering group	
3. Usefulness (can the results be used?)		**score**
3.1	**Connection**	
3.1.1	Unambiguous and accessible evaluation results	
3.1.2	Operational nature and realism of recommendations or lessons	
3.2	**Completeness**	
3.2.1	Evaluation questions answered by the conclusions	
3.2.2	Explanation of difference between the intended and achieved results	
3.3	**Presentation**	
3.3.1	Clarity and representativeness of the summary	
3.3.2	Distinction between the conclusions and recommendations	

Clarification of terms

Attributes	
title	According to the final version of the end report
type of evaluation object	E.g. programme, project, sector, theme, instrument or organisation
country(ies), region(s)	Geographical area(s) to which the evaluation relates
financial volume	Amount of money spent on the evaluation object during the evaluation period
evaluation period	Period covered by the evaluation
evaluation purpose	Policy development (learning), accountability, or both
type of evaluation	E.g. ex post or interim; evaluation or review; evaluation & formulation;[10] or meta-evaluation
evaluation costs	In euros (and as a percentage of the financial size of the evaluation object)
financing source	Budget (or part of budget) from which the evaluation was financed
duration	Period during which the evaluation was carried out
commissioning agent	Official or agent who determines the ToR and whether the report is accepted
steering/guidance	Composition of the committee that guides or steers the evaluation
evaluators	Names (including job or position) of both the team leader and the team members
qualifications	Information on the educational history and expertise of the evaluators
selection criteria	Criteria used in selecting the evaluators (e.g. those stated in the ToR)
date	Of the final version of the evaluation report
authors	State whether they were the evaluators themselves
research questions	Are the research questions in the main text the same as in the ToR?
terms of reference (ToR)	Are the ToR (complete or short version) attached to the report as an annex?
size	Of the report in pages (including annexes)

[10] This combination applies if the evaluation assignment includes making recommendations for rather than vice versa.

Assessment criteria and indicators	
validity	
1.1.1	The underlying reason why the evaluation was carried out. The reason precedes the purpose
1.1.2	The purpose of the evaluation; the purpose for which the results will be used
1.2.1	The problem definition is what the evaluators want to find out
1.2.2	In a result-oriented evaluation, the translation of the problem definition into research questions should at least include questions about the effectiveness and efficiency of the criteria
1.2.3	An unambiguous description of the criteria used (e.g. effectiveness) so that it is clear based on what precisely the evaluation object is judged
1.3.1	(Types of) activity developed, region or country, type of financial intervention, target groups, etc.
1.3.2	Description of how the activities evaluated were put in place and how they were carried out
1.3.3	Description of the relevant policy background and principles and of the institutional/ organisational interaction in which the evaluation object operated
1.4.1	Description of the intended results of the interventions evaluated and their effect
1.4.2	Does the intervention logic contain a hierarchy of objective means with links between cause and effect?
1.4.3	The extent to which defined indicators for the various result levels are SMART[11] continuing the activity to be evaluated and the findings are guided by the recommendations
1.5.1	A clear identification of methods and techniques of data collection and processing
1.5.2	Justification of research methods and techniques used
1.5.3	An explanation of the possible limitations or shortcomings of the research and a statement of the purposes for which the evaluation results cannot be used
1.6.1	The solidity of data collection and processing
1.6.2	The extent to which conclusions are drawn directly from the findings
1.6.3	The extent to which the recommendations follow on from the conclusions drawn
reliability	
2.1.1	Documentation, respondents, literature etc.
2.1.2	Does the report show a critical attitude towards sources used, for example, by trying to verify the value; have other sources or methods been used to collect the same data?
2.2.1	Justification of the representativeness of the sample or case study selection
2.3.1	Possible influence of commissioning agents, implementers or beneficiaries on the selection and contents of the consulted documentation, respondents etc.

[11] SMART stands for Specific, Measurable, Attainable, Relevant and Timebound

2.3.2	Ditto for the evaluators
2.4.1	Implementation within the intended time and budget; causes of any deviations
2.4.2	A statement of unforeseen obstacles, possible limitations to access to sources, and/or co-operation with sources.
2.4.3	Description and explanation of the evaluation process, including any changes to the original design
2.5.1	Have the stakeholders been given the opportunity to comment on concept findings, and have these comments been incorporated by the evaluators?
2.5.2	Has the design and/or implementation of the research been controlled by an internal or external guidance or steering group
usefulness	
3.1.1	Clear and understandable findings, conclusions and recommendation
3.1.2	Practical applicability of recommendations within the responsibilities of those involved and the field evaluated
3.2.1	How completely are the evaluation questions answered by the conclusions?
3.2.2	Have the positive and negative differences between the planning and implementation of activities not only been determined, but also explained?
3.3.1	Is the summary unambiguous, and does it contain the essence of the report, at least the main findings?
3.3.2	Have the conclusions and recommendations been distinguished in the text, and has a logical distinction between them been made?

Supplement 2 to the Terms of Reference. Subject related selection criteria

Food security as important impact indicator	As key word; in project description.
Year project intervention ended: • Ideal: from 2001 onwards	Note also older evaluations, from 1991 onwards, as spare –list.
Scale of the project impact • >5,000 households (<25,000 persons)	Smaller projects will not be considered (policy measures are often national.
Impact on food security is assessed: • Ideal: access to food, household or individual • Ideal: stability of access to food • Possible: utilisation of food • Not ideal: household production of food • Not ideal: household income	Describe indicators used (meals per day, calorie intake, months adequate food, ...) Either per household or per person.
Impact on gender, of food security projects. Effect on women: • food security • production • income • labour requirements	Even if no impact on food security is presented, impact on gender is relevant
Impact on environment, of food security projects. Effects on environment: • Conservation of natural resources (forest, soil and water) • Agricultural expansion versus intensification • Pollution (?)	Even if no impact on food security is presented, impact on environment is relevant
Comparison with a 'reference group' • Food security in neighbouring area • National average Food security • (Other reference group?)	Indicate the indicators used. Indicate: qualitative of quantitative.
Comparison before – after project: is not ideal, but mark this.	Quantitative comparison food security
Alternatives: Food security not as impact indicator, but lower level outcome indicators are used: • Trends in export and import • Trends in (structural) food aid • Trends in food prices • Trends in food prices in relation to wages • Export / import tariffs • Trends in % producers involved in export	These reports on a 'spare-list', may be necessary in the future, when we split the value chain in segments.
Interventions: 1. T.A. research and extension à ag. production 2. Institutional capacity, incl. producer org. 3. Market development, including infrastructure, credit, value chain development 4. Policy, affecting the three themes above, but also land tenure. 5. Gender interventions in food security interventions 6. Environment in food security interventions	Here we should be flexible: there may be other interventions contributing to food security. However, exclude: Income generation outside agriculture or value chain development.

Annex 3 Coding sheet

General information	0a. Title: 0b. Author: 0c. Year: 0d. Source: 0e. Organisation: 0f. Article objectives: 0g. Country of intervention:
Phase 1 – Minimum requirements (content and quality)	**A. Compulsory: One quantitative indicator on impact on food security:** 1. [ ] Ideal: access to food, household or individual 2. [ ] Ideal: stability of access to food 3. [ ] Possible: utilisation of food 4. [ ] Acceptable: household production of food 5. [ ] Not ideal, only if additional: household income 6. [ ] Other, only if additional: ..... **Alternative:** if no FS indicator but a relevant quantitative outcome indicator (and B and C conditions are met), save report in 8 separate folders for possible use later on: 7. [ ] Water, soil and vegetation (environmental conservation) 8. [ ] Agricultural production (tech., infra, inputs) 9. [ ] Agricultural production value (add value, diversification, marketing) 10. [ ] Agricultural production costs (input price policy, efficiency, scale) 11. [ ] Access to land, land security (land reform, conflict mgt) 12. [ ] Food prices (policy) 13. [ ] Food stocks (strategic reserve, social safety net) 14. [ ] Access to land, inputs and capital by women / other vulnerable groups 15. [ ] Market development (also for inputs) 16. [ ] Safety net / food aid 17. [ ] Finance (credit)
	[comments / description]
	B. Compulsory: Counterfactual analysis. At least one comparisons is necessary: 18. [ ] Before – after intervention 19. [ ] With – without intervention 20. [ ] REVIEW (including comparisons) 21. [ ] Model (e.g. GEM) correlations less-more intervention and impact 22. [ ] Cross country (or province) analyses, comparing different implementation of interventions 23. [ ] Randomised experiment **Quality:** (Good, Sufficient, Insufficient) 24. [G/S/I] Validity design: Clarity of the problem definition and research questions 25. [G/S/I] Validity design: Study design suitable for measuring impact 26. [G/S/I] Validity design: Research methods suitable for answering evaluation questions
	[comments / description]

	C. Compulsory: Impact of intervention or policy (either, or) 27. [ ] Donor intervention 28. [ ] National intervention (e.g. policy) **Alternative:** if no intervention or policy, but relevant correlation between outcome and FS (and A and B conditions are met), save report in 8 separate folders for possible use later on: 29. [ ] Relation environment – FS 30. [ ] Relation ag. prod. – FS 31. [ ] Relation ag. prod. value – FS 32. [ ] Relation ag. prod. costs – FS 33. [ ] Relation land access or security – FS 34. [ ] Relation food price – FS 35. [ ] Relation food stocks – FS 36. [ ] Relation access by women or vulnerable groups – FS 37. [ ] Market development (also for inputs) 38. [ ] Safety net / food aid 39. [ ] Finance (credit)
	[comments / description]
	D. Compulsory: sample study data can be extrapolated to total population of beneficiaries 40. [ ] Quantitative impact / outcome is quantitative 41. [ ] Number of beneficiaries is known (or sample is representative for whole country) **Quality:** (Good, sufficient, insufficient) 42. [G/S/I] Validity: Definition and demarcation of evaluation object 43. [G/S/I] Reliability: Information sources 44. [ ] survey sample. . If sample: sample size: 45. [ ] If sample: power calculation is done 46. [ ] national statistics (secondary data) **Heterogeneity (consider different subgroups in beneficiaries, non beneficiaries and in sample)** 47. [ ] Different groups in population are considered (e.g. women, vulnerable groups) 48. [ ] Selection criteria of beneficiaries are considered in analysis 49. [ ] Different groups in study sample are considered 50. [ ] Matching techniques are used to correctly compare beneficiaries and non beneficiaries 51. [ ] Heterogeneity of impact is analysed (impact on women may be different) 52. [G/S/I] Reliability: Study impact / outcome is representative for beneficiaries
	[comments / description]
	Minimum requirements Conclusion: 53. [ ] Selected intervention study [criteria ABC met] > proceed to Phase 2 54. [ ] Spare intervention study at outcome level [criteria BC met] > save file for use later 55. [ ] Spare correlation study between outcome and FS [criteria AB met] > save file for use later 56. [ ] Doubtful case > re-evaluate after completion selection process, e.g. specific data missing? 57. [ ] All quality criteria above are at least scored 'sufficient'. 58. [ ] Rejected
	[comments / description]

Phase 2– Description of intervention	**G. Intervention and intermediate objectives: check all that apply and give quantified data if available** Direct interventions: indicate whether path followed [1], whether outcome quantified [1]; if quantified, give data. 59. [ ] Improving the environmental sustainability of production. [ ] outcome assessed (if yes) Data: 60. [ ] Increasing production (including infrastructure and credit) [ ] outcome assessed (if yes) Data: 61. [ ] Increasing production value (including diversification and marketing) [ ] outcome assessed (if yes) Data: 62. [ ] Reducing production costs [ ] outcome assessed (if yes) Data: 63. [ ] Land reform, land security, conflict mgt [ ] outcome assessed (if yes) Data: 64. [ ] Food price interventions [ ] outcome assessed (if yes) Data: 65. [ ] Food stocks (communal, national) [ ] outcome assessed (if yes) Data: 66. [ ] Improve access to land, inputs, capital for women or vulnerable [ ] outcome assessed (if yes) Data: 67. [ ] Market development (also for inputs) [ ] outcome assessed (if yes) Data: 68. [ ] Safety net / food aid [ ] outcome assessed (if yes) Data: 69. [ ] Finance (credit) [ ] outcome assessed (if yes) Data: 70. [ ] Other: [ ] outcome assessed (if yes) Data: **Quality:** (Score: Good, Sufficient, Insufficient) 71. [G/S/I] Intervention logic: clear indicators and steps in FS pathway 72. [ ] besides the final impact, the outcome at intermediate objectives is assessed (plausible pathway)
	[comments / description]
	H. Intervention strategy 73. [ ] Research, Extension [code: R, E] 74. [ ] Physical infrastructure (roads, water, irrigation) [add coding: R, W, I] 75. [ ] Irrigation 76. [ ] Roads 77. [ ] Other infrastructure 78. [ ] Financial infrastructure (credit, saving) [add coding: C, S] 79. [ ] Organisation of inputs (seed, fertiliser, pesticides) [add coding: S, F, P] 80. [ ] Organisation of output markets (diversification, processing, trade) [add coding D, P, T] 81. [ ] Diversification 82. [ ] Processing 83. [ ] Trade (of agricultural products) 84. [ ] Organisation of beneficiaries (producer organisations, village committees) [PO, VC] 85. [ ] Government policies, incl. lobbying (trade, prices, land tenure, food stocks) [T, P, L, S] 86. [ ] Social safety nets (community level, FFW, cash for work, cereal banks) [CL, FFW, CFW, CB] 87. [ ] Capacity building (govt and other permanent organisations) 88. [ ] Govt budget support 89. [ ] Other:
	[comments / description]

	Scale and duration of intervention 90. Scale of intervention: number of beneficiaries: 91. [ ] Regional level (group of countries) 92. [ ] National level 93. [ ] Intermediate level (e.g. province) 94. [ ] Local level (village) 95. Duration (from year to year):
	[comments / description]
	Intervention partners: 96. [ ] Government 97. [ ] INGO and UN organisations 98. [ ] WB and other international banks 99. [ ] Research institutes or universities 100. [ ] Community based organisations, local NGO 101. [ ] Private sector, local 102. [ ] Private sector, international 103. [ ] Other:
	[comments / description]
	Target group of beneficiaries: 104. a. [ ] rural; b [ ]urban 105. a. [ ] subsistence; b. [ ] commercial farmers 106. a.[ ] land owners; b. [ ] landless 107. [ ] women 108. [ ] vulnerable groups 109. [ ] processors or traders **Quality:** (Score: Good, Sufficient, Insufficient) 110. [G/S/I] Clear description of intervention strategy
	[comments / description]
Phase 3: Impact. efficiency, positive and negative factors	**I. FS Impact indicators assessed at household or person level (define and quantify impact)** 111. [ ] (optional) Food utilisation: 112. [ ] Food access: 113. [ ] Stability in food access: 114. [ ] (not ideal) food availability: Intermediate outcome indicators (quantify if no FS is quantified) 115. [ ] food production per household/per person 116. [ ] income per household/per person 117. [ ] food price (main staple food, $/kg) 118. [ ] household reserve (food stock, capital, livestock, agricultural tools à $) **Impact on environment and women** 119. [ ] Describe impact on environment: 120. a. [ ] Describe FS impact on women:... Level of result: 1: impact; 2: proxy; 3: outcome. b. [ ] Describe other impact on women: ... 121. [ ] Describe FS impact on other vulnerable groups: Level of result: 1: impact; 2: proxy; 3: outcome.

Phase 3: Impact. efficiency, positive and negative factors	**Sustainability and scaling up of intervention** 122. [ ] Indication that benefits continue after project ended? 123. [ ] intervention at pilot scale (e.g. group of villages, one district) 124. [ ] if pilot: any proof of scaling up? 125. [ ] intervention at scaling-up phase 126. [ ] intervention at national scale **Quality:** (Good, Sufficient, Insufficient) 127. [G/S/I] Validity: Consistency: independent data, foundation of conclusions:
	[comments / description]
	J. Efficiency: costs and benefits 128. [ ] Total intervention costs: 129. [ ] Total intervention benefits converted in money: 130. [ ] Total benefits in other unit than money: 131. [ ] Number of beneficiaries: 132. [ ] Average impact per beneficiary: 133. [ ] Cost per beneficiary: 134. [ ] IRR: 135. [ ] ERR 136. [ ] other efficiency indicator 136. **Quality:** Is the assessment of costs and benefits convincing and representative? (G/S/I)
	[comments / description]
	L. Intervention impact on food security: positive and negative factors contributing or compromising impact (distinguish project management factors, project design factors, and context factors). Describe key factors: Fill in as much as possible in predefined factors; what is left, put under other factors. -1: negative factor; +1: positive factor 138. [ ] design pathway: ... 139. [ ] design strategy: ... 140. [ ] choice target group: ... 141. [ ] combination of interventions: ... 142. [ ] synergy other projects/programmes: ... 143. [ ] different actors involved: ... 144. [ ] institutional embedded: ... 145. [ ] project mgt: ... 146. [ ] country context: ... 147. [ ] combine different levels (village...national) : ... 148. [ ] intervetion duration : ... Other positive factors 149. [ ] + 150. [ ] + 151. [ ] + 152. [ ] + 153. [ ] + 154. [ ] + 155. [ ] + 156. [ ] + 157. [ ] + 158. [ ] +

	Other negative factors 159. [ ] – 160. [ ] – 161. [ ] – 162. [ ] – 163. [ ] – 164. [ ] – 165. [ ] – 166. [ ] – 167. [ ] – 168. [ ] – 169. [ ] There is an indication of government commitment to this intervention (level of govt initiative, contribution) **Quality:** 170. [G/S/I] Usefulness: Connection between findings, conclusions and recommendations
	[comments / description]
Phase 4 – Summary	**M. Summary of main findings (for report summary table).**
Study Quality	**Conclusion on study quality** 171. [ ] All quality criteria above have scored at least 'sufficient'. 172. [ ] good quality evaluation: no doubt about conclusions 173. [ ] good quality evaluation, but the size of the intervention limits the reach of conclusions 174. [ ] quality of evaluation is only just sufficient; take conclusions as indicators only 175. [ ] quality of evaluation is not sufficient > spare folder: poor quality evaluations
	[comments / description]
Alternative	**These alternatives will be decided on later, in May** **A) Alternative impact (if good study but no FS indicator)** Quantify the outcome, using the indicators as presented under 'G intermediate objectives' above. **B) Alternative correlations (if good study on correlation between 'outcome indicators' and FS indicator, but no intervention)** Describe and quantify the relation between outcome indicators (as presented under G above) and FS impact.
Own judgement	**Own judgement intervention results** 176. [ ] Outcome assessed (0:no; 1:yes) 177. [ ] (if yes) outcome: 0: nil; 1: unsatisfactory; 2: satisfactory 178. [ ] Proxy assessed (0:no; 1:yes) 179. [ ] (if yes) proxy: 0: nil; 1: unsatisfactory; 2: satisfactory 180. [ ] Impact assessed (0:no; 1:yes) 181. [ ] (if yes) impact: 0: nil; 1: unsatisfactory; 2: satisfactory 182. [ ] Efficiency assessed (0:no; 1:yes) 183. [ ] (if yes) efficiency : 0: nil; 1: unsatisfactory; 2: satisfactory 184. [ ] overall average judgement of results: empty: no judgement; 0:nil; 1: unsatisfactory; 2: satisfactory
	comments on own judgement of intervention results

Annex 4 Summaries of 38 selected case studies

Author, year	Project Eval / Develop Analysis	Int. donor / national	Country	Pathways	Strategies	Dura-tion	Pos. factors	Neg. factors	Outcome
Bolwig 2008	PE: impact of organic certification on farmer income	Int	Uganda	Value chain Production Environm.	Value add. Output market. Process.	1998-2005	Link farmers to experienced exporter. Combine prod value: cert+quality, with prod volume. Group cert reduced costs.		+ Coffee revenue: +75% (price and volume).
Bruce 2009	DA: Impact land reform	Nat	China	Land reform. Food price. Market. Production. Prod costs.	Policy. Output market. Diversif.	1978-1984	Combine land reform, contract quota fixed price, surplus market price. Trial and error gradual reform.		+ 160 m hh land use cert. Prod+34%: 305m t 1978 -> 407m t 1984. Reduced labour -22-53% -> off-farm work.
Carletto 2009	PE: Non traditional export	Int.	Guatemala	Value chain Credit	Output market. Diversif. Process. Extension Org producers	1979-2005	Export initially lucrative; some flexibility (late); export earnings invested elsewhere	Inflexible no diversif. (early on); no market info; poor project mgt; cap build stopped too early.	

Proxy impact	FS impact	Effect on vulne-rable	Sustai-nable Benefits; Environment	Scale and scaling up	Benefi-ciaries	Costs	Efficiency	Eval quality	ref nr
+ HH income: +12% ~ +$95/ hh/y			B:+Export continues E:+Organic farming	-Villages +: limited scaling up	3,870 hh (case study)	$350,000 for 6 years. $90/hh	++ Increased income: $95/hh/y.	Control Matching	24
+ Poverty 33% 1978 -> 11% 1984.	+ Consump-tion: kcal/p/d 2,227 1978 -> 2,450 1984. kg/p/y from 195 in 1978 to 250 in 1984.	+ Egalitarian land rights and ag income. Land women (widows, divorced) more secure. Men -> industry; W remain in ag.	B:+Ag. growth continues	+ National + Scaled up after pilot	160m farm hh			Baseline (Trends) Model	33
+/0 Income initially +20%; later income was best for those who abandoned after 'boom'.	+/0 Energy intake initially up. Later best for those who abandoned after 'boom'.		B:-Export declined. E:-Land degradation excessive use chemicals	-Villages -No scaling up (but different export opportun.)	1,600hh max			Baseline (Trend) Control (diff. level particip)	23

Author, year	Project Eval / Develop Analysis	Int. donor / national	Country	Pathways	Strategies	Dura-tion	Pos. factors	Neg. factors	Outcome
Coulibaly 2003	PE: Impact of production, credit, water supply	Int: CARE	Mali	Production Environm. Credit Water hygiene	irrigation, swamp, credit, safety net, cap build.	1997-2002	credit to women increased food production; synergy irrigation and credit.	swamp failure, relies on rain	
David 2006	PE: Impact hybrid rice	Nat: govt.	Philippines	Production	Research, extension. Inputs	2001-2006	Govt. budget for seed, incentives.	Hybrid unproven. Costs. Inefficient seed prod, low adopt.	+ Adopt: 5%. Yld demo: +30%
Deininger 2008	PE: Impact land registration	Nat+int.	Ethiopia	land registration	Policy. Org benef. Capacity local govt.	2003-2008	Participatory and decentralised land use registration effective and efficient.		+ Farmers feel more land secure, invest more in land, and rent out land easier.
Deininger 2010	DA: Impact inheritance act on women	Nat	India	Land tenure	Policy	1994	Policy successfully improving position women		+Land access. 22% higher land inheritance by daughters

Proxy impact	FS impact	Effect on vulne-rable	Sustai-nable Benefits; Environment	Scale and scaling up	Benefi-ciaries	Costs	Efficiency	Eval quality	ref nr
+ Prod (kg/p/y): non part: 182; swamp: 167; credit 249; irr: 261; >=2 act: 372. Prod insuf: non part: 81%, credit 76%, irr: 67%, swamp: 76%;	+ % eating 3 meals/day: non part: 76%; credit: 85%. Irr: 85%; swamp: 78%. F stability (m/y) non part: 5.5; swamp: 5.7; credit: 6.0; irr: 6.7.	(impact not assessed; W participate in credit)		-Villages	8,700 hh			(Baseline not used) Control (non-partic.)	12
0 $ B/C farm: -20%...+61%. Only in 3/15 sites positive		-High costs and farm mgt require-ment: less appropriate poor farmers	B:-Not profitable yet; slow adoption.	+National (should have been pilot)	5% Phil rice area. Other beneficia-ries: seed producers, civil servants.	$190m	- $19m /y (estimated benefits). Outsourcing would be more efficient	Control (Trend)	5
		+ All, esp. women, face less risk of losing land.	B:+Benefits continue E:+Soil conserv.	+National +Scaling up	6m hh	$20m	$1/parcel; $3,2/hh.	Baseline Control Matching	35
		+ W: inheritance land +22%. W: 0.5 year later marriage. 0.3 year more elementary school	B:+Law remains enforced	+National +Scaled up from state	Young women in 2 states in India.			Control Matching	38

Author, year	Project Eval / Develop Analysis	Int. donor / national	Country	Pathways	Strategies	Dura-tion	Pos. factors	Neg. factors	Outcome
Del Ninno 2003	DA: Impact trade liberalisa-tion on recovery after flood	Nat.	Bangla-desh	Market dev. Production Safety net. Stable access / price	Policy. Irrigation. Roads. Output market	1999-1999	Trade reduced vulnerability after flood. Policy encouraged private trade. Synergy roads, irrigation.		+ Reduced price peaks. 1974: public import, small stocks. 1988: larger stocks. 1998: public and private import, good markets.
Dorward 2011	PE: Impact fertiliser subsidy	Nat+int.	Malawi	Production Safety net	Inputs	2005-2009	Prod vol by fertiliser subsidy. Coverage 54-65% hh. Govt commitment. Learning. Quick results	Expensive (6-16% nat budget); Poor targeting women	+ Nat. prod. increase 406,000-969,000 t/y add maize.
Dubin 2009	PE: Impact breeding rust resistant wheat	Int+nat.	World-wide	Production	Research, extension. Inputs	1950-2005	Increase prod by breeding. Collab. CIMMYT-NARS-Uni. Economic project steering. Long duration. Free exchange germplasm. Multi location testing.	Decreased funding. Narrow gen base. New rust, is risk.	+ Production +5%. Fewer crop failures.
Erenstein 2009	PE: Impact zero tillage in rice-wheat rotation	Int+nat.	India Pakistan	Production /Prod costs Environ.	Research, extension Inputs	1985-2008	Link research, farmers, local manufact. Regional consortium Cost saving. Quick planting. ZT controls weed. First public, then private.	Subsidies against ZT. Limited / no environ-mental benefits. Low adoption in dryer areas...	+ Yld India +$25/ha, Pak -$20/ha. Cost Ind-$45, Pak-$40. Inc.Ind +$70, Pak+$20.

Proxy impact	FS impact	Effect on vulne-rable	Sustai-nable Benefits; Environment	Scale and scaling up	Benefi-ciaries	Costs	Efficiency	Eval quality	ref nr
+ Limited price rise due to market. 1974: price +58%. 1988: price + 7%. 1998 price +12%	+ Quick recovery 1998. 1974/75: famine. 1998: impact trade: +4-8% kcal.	+ Limited price rise during shortage protect especially poor.	B:+Trade reform lasting effect	+National	4m hh targeted by govt aid. Whole Bangladesh benefited from limited price rise.			Baseline Control Model	26
+ HH prod: +500kg/hh. contributed to poverty reduction from 52% to 40%.		+ Poor hh targeted (initially women poorly, later better targeted). Poverty reduced.	B:-Requires large annual funds	+National	1.6m hh directly. Whole population Malawi indirectly.	$524m in 4 years/ (avg $131m/y) $82/hh/y	+ Benefits: $122/hh/y Costs $0.20/kg maize. B/C: 1.06.	Baseline (Trend) Model	17
+ Food prices reduced by -15%.	+(extrapola-ted) +2% kcal intake. -4% malnutrition.	(impact not assessed)	B:0 Continued maintenance breeding needed.	Worldwide	60-120 m hh growing wheat in dev. countries	$196m/y $2/hh/y	+++ Benefits: $13/hh IRR: 19-66%	Model (review)	1
+ Avg income effect: +$280/ hh.		(Impact not assessed. Women less involved in till or ZT, but appreci-ate time saved).	B+: farmers continue. E+: saves 8% fuel; saves water; limited impact soil	+Regional +scaling up	620,000 hh		Cimmyt study: IRR 57%. NPV: $94m. B:C: 39. (Farmer: ZT equip costs earned back in 2 yrs)	Control (multi location)	10

Author, year	Project Eval / Develop Analysis	Int. donor / national	Country	Pathways	Strategies	Dura-tion	Pos. factors	Neg. factors	Outcome
Guardian 2003	PE: Impact of land redistribu-tion	Int+nat.	Philippines	Land tenure Production Credit	Policy. Org. benef. Irrig. road. water. Org. market. Process	1988-2008	Target landless. Govt initiated. Land reform plus add support to produce and market.	Opposition land owners and legislators. MoA not het decentra-lised. No confidence private - coops.	+ 5.8m ha redistributed to 3m hh. Add support for 0.8m hh. Farmer-owner-ship 2->23%. Share cropping 67->3%.
Hossain 2003	DA: Impact rice research on poor	Int: research	Bangla-desh	Production	Research, extension. Irrigation. Inputs	1967-2000	Small farms. Var+irr. Private+public. Farmer to farmer. Reduction costs low prices. Land use rights.	Limited contact farmers govt or NGO extension	+ 1965-2000: Yld.+130% Prod+150% Cost-40%
Hossain 2009	DA: Import Shallow Tube Wells irrigation	Nat: govt.	Bangla-desh	Market Prod costs. Production	Input market Irrigation Policy	1989-2008	Diff. actors. Govt invest 1960s. Var+irr+liberalise import. Private pump serve neighbours. Reduce crop failure. Water payment improved.		+ Yld and prod:+140%, of which 38% due to irrig. Reduction costs:-20%
Huang, 2006	DA: Irrigation effect on prod and income China	Nat: govt.	China	Production Value chain	Irrigation				+Yld $/ha/y +79%

Proxy impact	FS impact	Effect on vulne-rable	Sustai-nable Benefits; Environment	Scale and scaling up	Benefi-ciaries	Costs	Efficiency	Eval quality	ref nr
0 Negligible decline rural poverty: benef 48 -> 45% (Non-benef: 55 -> 56%)		+ Landless targeted: more ownership, less share cropping	B:+ Land reform ongoing	+National	Land: 3m hh. Add support: 0.8m hh.	$5.6 billion	Seems expensive. Land: $1,200/hh. Land+add support: $3,700/hh.	Baseline Control	37
+ Farm inc. +100% All inc. +100%. Ag wage (rice/ day) +90%. Increased assets $.		+ Higher adoption, increased income. Low food prices. Year-round employm. Better tenancy. Assets reduced.	B:+Farmers continue E:-Water pollution; Reduced wetland	+National	Pop Bangl. 128m			Baseline (Trend) Model	3
+ Food price since 1980:-50%; -1%/y (2007$)			B:+Private investm. continues E:-Over-exploit. ground water	+National	10.2m HH.			Baseline (Trend) Model	32
0 Crop value/ hh +76% excl costs. Incl costs: 52-62% hh: profit; 38-48% hh loss.		= Prod effect poor: income benefits less in absolute terms, but more in % of their income.	B:-Not profitable for 43% farmers.	+National			-(Farmer BCA: 52-62% hh: profit; 38-48% hh loss)	Control Matching	14

Author, year	Project Eval / Develop Analysis	Int. donor / national	Country	Pathways	Strategies	Dura-tion	Pos. factors	Neg. factors	Outcome
Kaminski 2009	DA: Reform cotton sector Burkina Faso	Int+nat.	Burkina Faso	Market Value chain Prod costs Production Stable price Credit	Output market. Policy. Instit. cap. Research extension Org. producers. Inputs	1996-2006	Stakeholders (farmers, donors and govt) negotiated pathway. Gradual privatisation; limited liberalisation. Synergies. Sequencing.	Sustainabi-lity new org? More cotton less food.	+ Yld -5%. Cotton hh+80% Area +380% Prod +360%. Prod kg/pers: +140%. Export$: +245%.
Kassie 2007	PE: Impact SWC on crop prod	Int. donor	Ethiopia	Production Environm. Safety net	Research extension.	1991-2000	SWC benefits in dry area	No SWC benefits in wet area	+ Dry Tigray: yld+$47/ha ~$23/hh Wet Amhara: nil.
Kirk 2009	DA: Impact land and agriculture reform	Nat	Vietnam	Land reform. Food price. Market. Prod volume.	Policy. Output market. Org producers. Org inputs. Diversif.	1987-2007	Combine land reform with market reform. Policy created incentives. Foreign investment. National, local, coop, private. Gradual reform.	Land insecurity persists locally. No improved access to credit yet.	+ From coops to hh land: 91% hh land use certificate 2001. No effect credit. 3.8%/y Ag GDP (86-05). $1b coffee export. From food import to export.
Lang-worthy 2001	PE: Impact export sesame groundnuts paprika.	Int: CARE	Mozambi-que	Production Environm.	Output market. Extension. Diversif. Org producers Processing.	1996-2001	value chain, involve private, flexible, synergy other proj, coll govt,	market info weak	+ Cash crop yld: + 17-40%;

Proxy impact	FS impact	Effect on vulne-rable	Sustai-nable Benefits; Environment	Scale and scaling up	Benefi-ciaries	Costs	Efficiency	Eval quality	ref nr
+ Cotton income +$69/ hh. Poverty reduced from 62% to 47%	+/0 Extrapola-ted: Food insecure (inc < 90Eur/p/y) reduced by 5%. Survey: no FS trend in cotton provinces.		B:+Trade continues (weak new prod. org.) E:-Soil mining	+National	176,000 cotton HH.			Baseline (Trend) Model (compare countries)	29
+ HH prod: +$23/hh (excl SWC costs)			E: +Soil and water conserv.					Control Matching	9
+ Per capita food prod from 281 in 1987 to 470 in 2007. Poverty from 58% in 93 to 16% in 06.	+ Child malnutr. from 53% in 93 to 33% in 98.	+ Majority (86% in 2004) land access. (Women also on certificates) Increased income. Reduced food prices. Reduced poverty.	B:+Ag. growth continues. E:+Tree crops, erosion control; (E-Conversion wetland, fragile coast)	+National	12m rural hh. Whole country.			Baseline (Trends) Plausible attribution	34
+ Cash crop inc+63%~$35/ hh Total hh inc: stable, but non-part inc declined	+ Stability: Food shortage from 4 to 2 m/y. 18% under-nou-rished, against 27% non-part. Stunting from 54% to 43% (n.s.) ~national trend.	(impact not assessed. W participate less. Poor participate equally. W participate better in W-groups.)	B:+Export continues. E:+Adoption compost, control burning	-Villages +Other NGO copy elsewhere.	65,000 hh.	$10m $154/hh	+ Benefit $35/hh/y	Baseline Control (non-parti-cip.)	21

Author, year	Project Eval / Develop Analysis	Int. donor / national	Country	Pathways	Strategies	Dura-tion	Pos. factors	Neg. factors	Outcome
Lang-worthy 2006	PE: Impact export sesame groundnuts.	Int: CARE	Mozambi-que	Production Environm.	Output market. Extension. Diversif. Org benef. Instit. cap.	2001-2006	market continues, w-groups, collabor, extension, flexibility open for new ideas	narrow focus on associati-ons, care and extension centralised, reliance one exporter risky.	+ Adoption practices x higher yields practices.
Langyin-tuo 2009	PE: Maize seed relief Zimbabwe	Int.	Zimbabwe	Production Safety net	Inputs	2003-2006	Target vulnerable. With more NGOs.	Choice seed. Informa-tion. (Targe-ting)	0 Only 12% beneficiaries re-used seed.
Lutz 2006	DA: Market integration after policy reform	Nat	Vietnam	Market dev. Stable access prices. Production. Land security	Policy Research extension. Output market. Diversif.	1981-2000	Policy: gradual inclusion private sector. Synergy market - prod - tenure - diversification	State subsidies not transparent	+ Integrated, competitive domestic market. Contributes to: 27% deficit 1980 - 40% surplus 1999.
McSween 2006	PE: Impact tolerant cassava on prod	Int.	Mozambi-que	Production	Inputs. Research extension. Org. producers	1999-2006	Tolerant cassava avoids crop losses. Multiplication and dissemina-tion scheme. Collaboration with int. and nat. research and govt. Good monitoring. Duration: 3+5 years		+ Avoided cassava losses by tolerant variety: 18-32%.

Proxy impact	FS impact	Effect on vulne-rable	Sustai-nable Benefits; Environment	Scale and scaling up	Benefi-ciaries	Costs	Efficiency	Eval quality	ref nr
+ HH food prod: maize +20% (+50kg/ hh), g'nut +80% (+50kg/ hh). Crop value 20% higher than non-partici-pants. HH inc +$10/p/y. Assets 100% higher among long-term participants;	+ Stability: Food shortage reduced from 2.5 to 1.4 to 1.7months/y.	(impact mot assessed. W adopt better child nutrition practices)	B+:Export continues E:+Soil conserv. Reduced erosion	-Villages. +Scaling up.	41,000 hh		Benefits 41000hh x 5p x $10/p/y = $2m/y	Baseline Control (non-parti-cip.)	22
		(impact not assessed. Fair, not perfect, targeting women headed and poor)	B:- Farmer use stops when donor stops.	+National +Scaled up.	[>10,000hh]			Control Matching	19
			B:+Ag. growth continues	+National	population Vietnam			Baseline Model	27
+ Avoided cassava losses: $25/hh/y 2006.			B:+Continued spreading of tolerant variety. 6 districts, spreading.	0: Districts + Spreading	100,000 hh in 2006; spreading.	$0.9m (research and project) $9/hh	+++ Benefits $25/hh/h (2006). Assuming adoption ceiling 50%: IRR in 2028: 75%. NPV 2028: $29m.	Baseline Control	16

Author, year	Project Eval / Develop Analysis	Int. donor / national	Country	Pathways	Strategies	Dura-tion	Pos. factors	Neg. factors	Outcome
Moseley 2010	DA: Food prices after liberalisa-tion	Nat.	Gambia, Ivory Coast, Mali	Market dev, Stable access prices	Output market. Input market Policy.	1980s-2008	Reduced food prices, initially. Reduced government spending.	Reduced food production. Vulnerable to world market prices. Poor local market	0 Open markets and reduced govt support to agriculture: more cheap import but lower production
Munro 2003	PE: Impact drought recovery crop pack	Int+nat.	Zimbabwe	Production Safety net	Inputs	1992-1996 (3x1-year prog)	High coverage: 80% of Zim farmers. Free inputs effective prod. Synergy donors-govt. Effective drought recovery	Tillage low coverage, lack of (working) tractors. In spite of failure, govt keeps pushing tillage	+ >80% receive inputs. Area under crops +20%.
Ngam-pana 2004	PE: Impact production, credit, water, capacity building	Int.	Mali	Production Credit. Safety net. Water	Irrigation Org. producers. Instit. cap.	1999-2003		irr design susceptible to droughts	+Prod. developed irr ‘+10%; Undeveloped irr -26%. Buffer: better functioning cereal banks
Place 2004	PE: Impact agrofores-try on the poor.	Int.	Kenya	Production Environm.	Research, extension. Org. producers	1997-2001	Field demo. Contact farmer extension.	Small plots. no FS impact. Wrong motivation.	+ Yld+121%. 0.04ha/f. Yld trend neg.
Pyakuryal 2010	DA: FS after trade liberalisa-tion	Nat.	Nepal	Market dev, safety net	Policy, Output market	1980s-2001	Market dev. by policy should increase food availability.	Lack of internal market dev, roads. Inefficient govt food agency	Food prod growth (+3.5%/y) cannot be attributed to policy reform

Proxy impact	FS impact	Effect on vulne-rable	Sustai-nable Benefits; Environment	Scale and scaling up	Benefi-ciaries	Costs	Efficiency	Eval quality	ref nr
+/- Food prices initially went down. Food prices 2007/08 peaked in food importing Gambia and Ivory Coast. Food prices peaked less in self sufficient Mali.		+/- Consu-mers first benefited from low, then suffered from high prices. Producers discouraged by cheap import.			populations Gambia, Ivory Coast, Mali			Baseline (Trends) Model Compare countries	30
+ HH prod+20% ~+200kg/hh/y		(impact not assessed. Poor equally reached	B:-Requires annual funds	+National	0.8m hh	$30m/year (avg) for seed+fert. $37/hh/y	-Benefits $20/hh/y. Costs $0.19/kg maize. (food import is more expensive)	Control Matching	18
	+ Stability: Participants 2.6m/y food shortage. non-part: 3.5m/y shortage.	(Impact not assessed. W participate equally, and more in credit)		-Villages	4,000 hh			(Baseline not used) Control (non-partic)	13
0 Income: +2$/hh	0 No impact on energy intake	(impact not assessed. W-headed and poor hh adopt as easy)	B:+Farmers continue. E:+Soil quality. Wood. Erosion control	-Villages +Pilot scaled up	15,000 hh			Baseline (Trend) Control	8
0 Model impact poverty: Nepal: nil; Valley: -0.19%. Mountain / hills: +0.15%.	Kcal/p/d increased, cannot be attributed to policy reform	- Remote consumers: high prices; remote producers: reduced govt support to ag.			Population Nepal			Baseline Control Model	28

Author, year	Project Eval / Develop Analysis	Int. donor / national	Country	Pathways	Strategies	Dura-tion	Pos. factors	Neg. factors	Outcome
Roeder 2009	PE: Impact rinderpest eradication	Int+nat.	World-wide	Production	Research extension. Inputs. Org. producers. Instit. cap.	1960-2005	Vaccine simple and effective.int. coll. Political support. Accreditation R. free countries. Vaccine buffer zones. Field monitoring. Based on epidemiologic studies.	No surveillance (1960s). Not cleaned R reservoirs W + E Afr. Unneces-sary vaccine Nigeria. Slow int reaction in 1970s.	+ (PARC in 10 countries) Avoi-ded loss: 126,000 t beef. 39,000 t milk. 14,000 t manure. 86,000 ha traction.
Ruben 2009	PE: Impact of fair trade	Int	Peru, Costa Rica	Value chain Credit	Value add. Org producers		Fair trade: stable market and price, facilitate credit -> long-term investment	Higher costs. Competi-tion w other income. Not all sold as FT.	+ Access credit
Shanmu-gasndaram 2009	DA: Improved mungbean and FS	Int+nat.	Asia	Production. Food quality. Environm.	Research extension. Inputs	1997-2004	Farmers involved in selection. Regional network: govt, NGO, NARS, IARC. Fit in rice-wheat rotation.		+ Mungbean yld: +28-55%. Prod: +35%. Fits in rice-wheat rotation : +450kg rice/ha.
Swanson 2009	PE: Impact dairy develop-ment	Int.	Zambia	Value chain	Output market. Inputs. Diversif. Org. producers	2004-2009	Smallholder dairy is profitable. Value chain: milk collection centres. Breeding and distribution scheme. Vulnera-ble targeted. Govt involved.	Coops lack business mind, skills and focus. Depen-dence on electricity and roads. No ownership coops by smallhol-ders.	+ Milk value 1000 farmers: $2.8m/y. Milk value 19 collection centres $3m.

Proxy impact	FS impact	Effect on vulne-rable	Sustai-nable Benefits; Environment	Scale and scaling up	Benefi-ciaries	Costs	Efficiency	Eval quality	ref nr
		+ Many poor among beneficiary livestock keepers.	B:+Little risk of returning rinderpest	+Worldwide	41m livestock keepers in dev. countries		(PARC in 10 countries) BCR: 1.85	Trend Model (review)	7
0/+ Income negligible: 4/6 cases: n.s. 1 case +38%. 1 case -22%. (excl FT premium) Assets: positive		- Cash crop: role men reinforced. 1 case women income decreased.	B:+Trade continues E:+More organic, less chem. fert.	-Villages +Limited scaling up	2,800 hh in 6 case studies.			Control Matching	25
+ Extrapola-ted: +600 kg mungbean/hh; +900 kg rice/ hh. Inc: +$100/hh	Partial: Mungbean cons: +22-66% (Vit A, iron)	+(impact not assessed) Vit A and iron especially good for women. Cheap protein for poor.	B:+Farmers continue E:+Mungbean fertilises soil (30kgN/ha)	+Regional	1.5m farmers.	(not presented)	Other studies: IRR: 108-144%. B:C: 1.44-2.21.	Control (Trends)	4
+ Assets (cows): +$2700/hh. Income: +$340/hh.	+ Stability. Months FS benef: 7.5-> 9.2; non-benef: 7.5-> 8.2. Diet diversity benef: 6.0->6.4 food groups; non-benef: 6.0-> 4.8.	- Vulnerable and women targeted. W participa-tion lower than planned. W milk income lower	B:+ Profitable business continues. Multiplication scheme. Coops weak.	-Villages	2,732 hh trained. 1,000 hh received cow.	$10m $3660/hh	- Additional income $340/hh/y.	Baseline Control	20

Author, year	Project Eval / Develop Analysis	Int. donor / national	Country	Pathways	Strategies	Dura-tion	Pos. factors	Neg. factors	Outcome
Tiwari 2010	PE: FS by farmer participa-tion in breeding and propaga-tion	Int.	Nepal	Production	Inputs Org. producers	1999-2006	Large scale by govt, iNGO and CBO. Cross pollination. Participatory breeding.		+ Yld+45%.
Torero 2005 (+info Fort 2008 Zegarra 2008)	PE: Impact land titling on land investment, credit and collective action	Int+nat.	Peru	Land tenure.	Policy Instit. cap.	1993-2000	Political will: laws, with flexible additional regulations. Institutional capacity. Large scale efficient.	Difficulties with ex-coops and communal land	+ Land access. 477,000 hh hold title. Land value: +$2148/ hh. Prod value +$921/hh/y. No effect on credit.
WB 2007	PE: seed and fertiliser supply	Int+nat.	Ethiopia	Market dev. prod vol.	Org. inputs. Research extension Instit.cap.	1995-2002		No sector strategy or analysis. WB objectives not supported by govt. No synergy between projects.	0 Reduced participation private sector. No change in fertiliser use.
WB 2008	PE: Impact irrigation project	Int	India	Production Value chain	Irrigation. Org. producers Extension. Roads. Diversif.	1988-2007		Delay, cost overrun. WUA lacked support, conflict. Policy discourages water saving.	+ Yield: +35% Cropping int +30% Prod: +50%

Proxy impact	FS impact	Effect on vulne-rable	Sustai-nable Benefits; Environment	Scale and scaling up	Benefi-ciaries	Costs	Efficiency	Eval quality	ref nr
	+ Stability: +1.6 months / y FS (from 6.7 to 8.3)	= Low castes and women headed hh well targeted. Impact similar.	B:+Farmers continue.	0 Provinces +Scaling up				Baseline Control (Diff. cat. adopters)	15
+ HH expenditure: +$274. Assets: land value: +$2,148			B:+ Land titling continues.	+National	477,000 hh	$100m $210/hh	+++ benefits: $274/hh/y	Baseline Control Matching	36
			B:0 No benefits yet. Donor - govt conflicting poli-cies. Has improved after project end.	+National	Farmers Ethiopia (56m p)	$156m	- nil benefits	Baseline Plausible attribution	31
+ Direct: Net farm income +61%. Total income: +25%. Indirect: more employm, higher wages. More employment over the year (stability) Stability in prod: fewer crop failures;		= Absolute income: vulnerable benefit less; Relative: vulnerable benefit equally. Women more employ-ment.	B:-Water fees insufficient for maintenance; continued govt subsidy still needed.	0 Province	212,000 hh	$390m $1,840/hh $1,000/ha irr.	+ Benefits $225/hh ERR 2%	Baseline Control	11

Author, year	Project Eval / Develop Analysis	Int. donor / national	Country	Pathways	Strategies	Dura-tion	Pos. factors	Neg. factors	Outcome
WB 2009	PE: Impact institutional reform ag. research and extension	Int.	Kenya	Production Environm.	Research, extension. Instit. cap. Org. producers	2004-2008	Multi-stakehol-der committees. Govt committed. Sector wide. Indep. coord.	Project mgt. Unrest 2008. droughts.	+ Adoption hybrid+6.6%, fert.+4.3%. mulch+3.1%.
Zeddies 2001	PE: Impact bio control cassava mealy bug	Int+nat.	Africa	Production	Research, extension. Inputs	1979-2001	Reduce crop loss by bio pest control. Collaboration IITA, nat govt, donors. Long duration.		+ Cassava prod in Africa: +10%, or +2.1m t (dry cassava)

Proxy impact	FS impact	Effect on vulne-rable	Sustai-nable Benefits; Environment	Scale and scaling up	Benefi-ciaries	Costs	Efficiency	Eval quality	ref nr
0 No impact on hh food production			B:+/0 Govt plus WB continue reform. No benefits farmers yet. E:+Mulching	+National plus pilot. +Scaling up	>100,000hh	$40.5m	(Fake IRR)	Baseline Control	6
			B:+No indication of resistance against bio control	+Regional	(estimate: >10m hh)	$47m (1979-2013) $5/hh	+++ Benefits $19/hh/y BCR: 170	Model Different countries	2

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Colophon

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This systematic review attempts to answer the question: '*what is the evidence for, and nature of, the impact of development interventions on food security in developing countries?*'. A combination of 38 qualified case studies plus 46 other reviews are used to evaluate the impact of interventions aimed at increasing production, developing value chains, reforming market regulations, and improving land security. Although the subject is rather comprehensive for a review of this size, a few interesting conclusions come out. Increased production in Asia has been the result of increased yield, but also of increased labour productivity that reduced production costs and food prices - which benefited poor consumers, while farmers compensated their low prices with higher yields and off-farm income. Value chain development increased farm income, but so far there is little indication that most vulnerable people benefited. Market reform had poor results if it simply consisted of reducing trade barriers and reducing government support to agriculture, but had good results when there was a gradual shift of roles from government to (new) institutions and private sector.
Land tenure security has encouraged farmer investments, and was an important part of the economic reform in China and Vietnam. The best results were achieved by combinations of interventions, in a context where other pre-conditions were already met.

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