



Meta-evidence review on the impacts of investments in agricultural and rural development on Sustainable Development Goals 1 and 2

Detailed evidence reviews of the papers

by
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This online annex presents detailed evidence reviews of all papers included in each row of the evidence map presented in appendix 1 of Bernstein et al. 2019.¹ Each section starts with the row of the Evidence Map that corresponds to the intervention and then presents a detailed discussion of studies reviewed in each paper in the table. In some cases additional papers that are not included in the Evidence Map (i.e. that were not systematic reviews or rigorous cross-country studies) are also discussed to provide contextual background, where relevant.

1. Bernstein, J., Johnson, N. and Arslan, A. 2019. *Meta-evidence review on the impacts of investments in agricultural and rural development on Sustainable Development Goals 1 and 2*. IFAD Research Series 38, International Fund for Agricultural Development, Rome, Italy.

1 Agricultural interventions

1.1 Promotion of improved agricultural technologies/practices

Table 1 Systematic reviews regarding agricultural technology/practice promotion/adoption

	Extreme/moderate poverty	Average income	Productivity	Food security (diet quantity)	Nutrition security (diet quality and/or nutrition)	Stunting for children aged <5	Malnutrition for children aged <5
Improved agricultural technology/practice (includes crops, livestock, fisheries)	 IOB 2011 (limited evidence) Jayne et al. 2016 (limited evidence) Pray et al. 2017 Garbero et al. 2018	 Ruel 2001 (limited evidence) Berti et al. 2004 (limited evidence) Leroy and Frongillo 2007 World Bank 2007 Arimond et al. 2011 IOB 2011 Loevinsohn et al. 2013 Jayne et al. 2016 (limited evidence) Pray et al. 2017 Garbero et al. 2018	 Berti et al. 2004 (limited evidence) World Bank 2007 (limited evidence) Arimond et al. 2011 IOB 2011 Loevinsohn et al. 2013 Jayne et al. 2016 (limited evidence) Pray et al. 2017	 Berti et al. 2004 Leroy and Frongillo 2007 (limited evidence) World Bank 2007 Bhutta et al. 2008 (limited evidence) Gibson and Anderson 2009 (limited evidence) Arimond et al. 2011 (limited evidence) IOB 2011 Jayne et al. 2016 (limited evidence) Pray et al. 2017 (limited evidence)	 Ruel 2001 Berti et al. 2004 Leroy and Frongillo 2007 World Bank 2007 Bhutta et al. 2008 Gibson and Anderson 2009 Arimond et al. 2011 Masset et al. 2011 IOB 2011 (limited evidence) Stewart et al. 2015 Jayne et al. 2016 (limited evidence) Pray et al. 2017 Ruel et al. 2017	 Berti et al. 2004 (limited evidence) World Bank 2007 (limited evidence) Bhutta et al. 2008 (limited evidence) Gibson and Anderson 2009 Arimond et al. 2011 Masset et al. 2011 Girard et al. 2012 (limited evidence) Stewart et al. 2015 (limited evidence) Ruel et al. 2017	 Berti et al. 2004 (limited evidence) World Bank 2007 (limited evidence) Bhutta et al. 2008 (limited evidence) Gibson and Anderson 2009 (limited evidence) Arimond et al. 2011 (limited evidence) Masset et al. 2011 Girard et al. 2012 (limited evidence) Jayne et al. 2016 (limited evidence) Ruel et al. 2017

Note: Cell colours indicate the direction of impact of evidence. ● Dark blue=sufficient evidence of beneficial impact; ● light blue=suggestive evidence of beneficial impact; ● grey=despite evidence, impact is in doubt; ○ white=insufficient evidence to determine trend. Border colours indicate strength of methodology of impact evaluations. ● Yellow=concerns with methodology; ● black=methodology is generally strong. IOB, Policy and Operations Evaluation Department of the Ministry of Foreign Affairs.

IOB (2011) reports on the impacts of a variety of agricultural programme types on income, productivity, yields, and food and nutrition security. Of the 31 studies that fit our intervention types (excluding policies such as trade policy), 9 showed positive effects on income, 2 had mixed effects and 1 showed no change. Of the 13 studies on productivity, all found positive effects. Of the 10 studies on diet quantity, 8 showed positive effects on diet (quantity), 1 mixed results and 1 no change; 4 studies on diet quality and/or nutrition all found positive effects; however, the statistical significance of the findings is not reported, and the authors report that the majority of the studies did not present a plausible counterfactual, so the results must be interpreted with caution.

Pray et al. (2017) provide an overview of the relationship between agricultural R&D and poverty reduction, nutrition and resilience. They found that, "The literature on agricultural development reveals clearly how past research investments have made large contributions to poverty reduction, nutrition improvement and resilience, through systemic transformation of local agriculture and food systems. The causal pathway for these impacts is that a flow of locally-adapted innovations gets adopted by farmers and agribusinesses, raising real incomes for those at risk of poverty and offering more stable, lower-cost access to healthy diets and living conditions around the year to those at risk of malnutrition". They also include various examples from the literature showing that agriculture. R&D increases productivity. Their review includes both studies of household-/farm-level impact evaluations from specific interventions to national and multi-country models. They conclude that the leverage of agriculture for poverty reduction depends on the sector's relative size, and the difference between poverty levels of farmers and non-farmers.

Ruel (2001), in a review of food-based strategies to address vitamin A and iron deficiencies, mainly focuses on the impacts of home garden projects (see detailed results below) and also reports impacts on food and nutrition security and income indicators. The paper found consistent positive impact on at least some forms of food and nutrition security, weak evidence of positive impact regarding income and that, overall, the evidence base in this area is weak.

Leroy and Frongillo (2007) examined the effects of interventions to promote animal-sourced foods on diet and nutrition as well as income. Of the four livestock programmes with data on income, all four showed positive effects. Two studies on livestock programmes had measurements on diet quantity and both found positive effects. Nine out of 10 livestock projects showed positive impacts on diet quality and/or nutrition, with the other showing mixed effects. Only one aquaculture project had results reported on income and that was a positive effect. Of the three aquaculture programmes with data on diet quality, one found no significant changes and the findings for the other two were unclear.

World Bank (2007) systematically reviewed the evidence on the links between agriculture and nutrition. The report defines five pathways between agriculture and nutrition linking food production with consumption and nutrition: subsistence-oriented production for the household's own consumption; income-oriented production for sale in markets; reduction in real food prices associated with increased agricultural production; empowerment of women as agents instrumental to household food security and health outcomes; and the indirect relationship between increasing agricultural productivity and nutrition outcomes through the agriculture sector's contribution to national income and macroeconomic growth. They include 38 project interventions including staples (which focused on agricultural commercialization), horticulture and animal-sourced foods. Of the 9 studies that looked at household income or expenditures, 7 showed positive effects and 2 no effect; of the 7 studies that considered diet quantity, 5 found positive effects, 1 mixed effects and for 1 the results were unclear; of the 28 studies on diet quality and/or nutrition, 21 found positive effects, 2 mixed effects, 1 negative effects, 2 no effects and 2 were unclear; of the 2 studies that considered

stunting/height, 1 showed beneficial effects and 1 mixed effects; of the 2 studies on wasting/weight, 1 showed beneficial effects and 1 mixed effects.

Arimond et al. (2011), primarily drawing on previous reviews with a focus on homestead gardening, livestock and aquaculture interventions, concluded that agriculture interventions have the potential to improve nutrition, but that the evidence to date was weak. They make an important point, however, that is not noted in all reviews on agriculture and nutrition: "To impact nutrition, agriculturalists, in partnership with nutritionists, must supplement this with information about deficits in local diets and micronutrient intakes, as well as information concerning the motivations and constraints that determine household consumption decisions. Agricultural and nutrition extension and communication packages must be designed to address these realities". (For details on results, see sections on home gardens and agricultural commercialization.)

Masset et al. (2011) systematically review evidence of the effects of a range of agriculture, aquaculture and livestock interventions on household income, food security and nutritional status. Of the 5 studies on household income, all 5 showed positive effects (but only 1 considered statistical significance); of the 23 studies on diet quality and/or nutrition, 16 showed at least 1 positive effect; 5 showed no effects and 2 showed mixed effects; of the 8 studies on wasting, 2 found beneficial effects and 6 no effects; of the 8 studies on stunting, 1 found a beneficial effect and 7 no effects.

Stewart et al. (2015), in a systematic review of the effects of agricultural training, innovation and new technology in Africa, identified a total of 19 studies, 13 of which cover our outcomes of interest. The authors found that of the six studies with results on total income (household or per capita), five showed positive effects and one no effect; of the two studies with results on HAZ, both showed positive results; and of the five studies with results on nutrition security (all serum retinol measurements), all five showed positive effects. Some of these studies fall into the categories of biofortification or extension and advisory services, and are also included in those subsections below. However, the authors caution that the size of the evidence base is too small to draw definitive conclusions, especially considering the variety of intervention types. Loevinsohn et al. (2013) systematically reviewed the effects of agricultural technology on productivity. The authors found just five studies that met their inclusion criteria, four of which found positive results on productivity. The types of technologies covered in the reviews included biotechnology/GMO, hybrid seeds, SRI, irrigation and water management, and multiple technologies. The authors determined that the number of studies was too small to draw any meaningful conclusions. Also, the methodology of at least two of the studies is unclear.

The analysis in Berti et al. (2004) included 30 projects (36 papers): 13 vegetable/home gardening, 2 livestock, 2 mixed livestock/gardening, 8 cash cropping, 2 irrigation and 3 other (land redistribution, promotion of production with credit and extension services, duck–fish production system). They found that the intervention group showed better status than the control group in terms of income (1 out of 1 case), productivity (2 out of 2 cases), diet (21 of 25 cases), anthropometrics (7 of 16 cases), biochemical/clinical indicators (5 of 10 cases) and morbidity (5 of 8 cases). They also reported that improved diet was always correlated with improvements in the anthropometric, biochemical/clinical or morbidity indicators. Agricultural interventions that simultaneously invested in both human capital (especially nutrition education and consideration of gender issues) and other types of capital had a greater likelihood of affecting positive nutritional change, but the authors state that such investment is neither sufficient nor always necessary to affect change. (The home garden, livestock, agricultural commercialization and irrigation sections below provide more detail.)

Bhutta et al. (2008), in a wide-ranging review of interventions affecting maternal and child undernutrition and survival, reviewed 29 studies and 2 systematic reviews on dietary diversification strategies including home gardening, livestock and dietary modifications, and determined that these types of programmes are “potentially promising and culturally relevant, but in general, have only been implemented at a small scale, and have not been adequately assessed”. (Details provided in the home garden and livestock sections below.)

Gibson and Anderson (2009) reviewed evidence on the effects of a range of dietary diversification strategies, including home gardens, aquaculture and animal husbandry interventions on dietary intake and nutrition, with a focus, although not exclusively, on zinc. They found that of the 3 studies on the effect of agriculture on food quantity, 2 found positive effects and 1 no effect; 17 studies showed positive effects of agriculture interventions on diet quality and/or nutrition and 3 no changes; of the 5 studies measuring the effect of agriculture on stunting/HAZ, 4 showed beneficial effects and 1 no significant effects; and of the 4 studies measuring the effect of agriculture on wasting/WHZ, 3 found beneficial effects and 1 no effect. The authors conclude that, “Dietary diversification or modification can have an impact on behavior change and on certain indicators of nutritional status in the short term, most notably increases or greater intakes of animal-source foods and certain nutrients, including zinc, depending on the setting and the study design. Whether the interventions also have an impact on biochemical, anthropometric, or other functional health outcomes, even over the short term, is less clear. The impact depends on the age of the participants, their baseline nutritional and health status, the duration and type of intervention strategies employed, and the setting. The long-term impact was evaluated in so few of the interventions that a statement on this issue cannot be made”.

Girard et al. (2012) systematically reviewed evidence on the effects of household food production strategies on nutrition of women and children. They found that of the four studies with results on stunting, one showed beneficial effects and three were not statistically significant (a meta-analysis confirmed that the effects were not statistically significant), and of the four studies with results on wasting, one showed beneficial effects and three were not statistically significant (through meta-analysis). This paper could not be broken down by intervention type because of the way in which the results were reported.

Ruel et al. (2017) reviewed recent literature on nutrition-sensitive agriculture. Most papers showed a positive effect on nutrition security in terms of diet or micronutrient status, but of the five papers that looked at stunting/HAZ, only two found beneficial effects whereas the others showed no significant effects, and of the six papers that looked at wasting/WHZ, four found positive effects and two found no significant effects.

Some studies were reviewed but are not included in the evidence review database (and the table above) for various reasons. For example, Ruel and Alderman (2013) provide a wide-ranging literature review of the effects of nutrition-sensitive agriculture programmes, including home gardens and biofortification, on the nutritional status of women and children.² They found that these programmes have a positive effect on diet, but that there is “little evidence of effectiveness of homestead food production programs on maternal or child nutritional status” including anthropometry. They do not identify any evaluations of the effect of biofortification on children’s anthropometry.

2. Ruel and Alderman (2013) is not included in the Evidence Map because it is not a systematic review or a collection of impact evaluations, but rather it mainly references other systematic reviews and meta-analyses.

Webb and Kennedy (2014) review 10 existing systematic reviews of the link between agriculture and nutrition. (This is not included in the Evidence Map because it covers systematic reviews rather than impact evaluations per se.) They conclude that the evidence from the existing reviews consistently points to the following conclusions: “The current state of empirical evidence for impacts on nutrition ascribed to defined agricultural interventions is weak and mixed at best. Statistically significant impacts have been documented in a few cases, mainly in terms of micronutrient status (usually vitamin A), but even in such instances net effects across all nutrients have not been documented. Where impacts on child growth lean toward the positive, it appears that key factors may involve integration of behaviour change communication activities with whatever agricultural intervention is promoted; actions that increase income, overall dietary quality (and quantity), as well as consumption of the one target nutrient-rich food—not just one or the other; women’s empowerment through decisions on resource use in agriculture, control over derived income and knowledge on best uses of such income and home-produced foods to support desired nutrition outcomes in children; and attention to net effects of interventions, such that gains in one area (such as increased animal husbandry) are not offset by increased zoonotic diseases that result in lost nutrients through, say, diarrhoea. The lack of sound empirical evidence on efficacy, effectiveness at scale and cost-effectiveness of all kinds of agricultural interventions on nutrition remains a significant hurdle to policy advocacy and investment. The sooner methodologically rigorous studies can produce findings that offer guidance on how best to leverage the potential of agriculture for nutrition the better”.

Carletto et al. (2015), in an introduction to a special issue of *The Journal of Development Studies* on agriculture and nutrition, identify four pathways that are commonly cited in the literature as ways through which agriculture can influence nutrition: “(i) food prices, (ii) income from agriculture, (iii) consumption of own production due primarily to market imperfections, and (iv) factors linked to gender”. Based on the eight studies in the special review, Carletto et al. conclude: “While links to crop production and diversity of production are found to matter in certain contexts, livestock seems to emerge as particularly important and positively linked to nutrition. The results suggest that support to agriculture can play a direct role in promoting nutrition, but that the effects might not be as dramatic as anticipated and depend on local conditions”.

1.2 Homestead food production/home gardens

Table 2 Homestead food production/home gardens

	Extreme/moderate poverty	Average income	Productivity	Food security (diet quantity)	Nutrition security (diet quality and/or nutrition)	Stunting for children aged <5	Malnutrition for children aged <5
Home gardens/ homestead food production		● Ruel 2001 (limited evidence) World Bank 2007 (limited evidence) Arimond et al. 2011 (limited evidence) Masset et al. 2011 (limited evidence)	○ Berti et al. 2004 (limited evidence)	○ Berti et al. 2004 (limited evidence) World Bank 2007 (limited evidence) Gibson and Anderson 2009 (limited evidence) Arimond et al. 2011 (limited evidence)	● Ruel 2001 Berti et al. 2004 World Bank 2007 Bhutta et al. 2008 Gibson and Anderson 2009 Arimond et al. 2011 Masset et al. 2011 Ruel et al. 2017	● Berti et al. 2004 (limited evidence) World Bank 2007 (limited evidence) Bhutta et al. 2008 (limited evidence) Gibson and Anderson 2009 Arimond et al. 2011 (limited evidence) Masset et al. 2011 Ruel et al. 2017 (limited evidence)	● Berti et al. 2004 (limited evidence) World Bank 2007 (limited evidence) Bhutta et al. 2008 (limited evidence) Gibson and Anderson 2009 (limited evidence) Arimond et al. 2011 (limited evidence) Masset et al. 2011 Ruel et al. 2017 (limited evidence)

Note: Cell colours indicate the direction of impact of evidence. ● Dark blue=sufficient evidence of beneficial impact; ● light blue=suggestive evidence of beneficial impact; ● grey=despite evidence, impact is in doubt; ○ white=insufficient evidence to determine trend. Border colours indicate strength of methodology of impact evaluations. ● Yellow=concerns with methodology; ● black=methodology is generally strong.

Ruel (2001), in a review of food-based strategies to address vitamin A and iron deficiencies, considers the impacts of home garden projects. The review includes detailed results on 12 papers that have an agricultural production component. Of the three studies that considered the effect on household income, two found positive effects (one slight) and one no effect; of the 12 studies that considered a measure of nutrition security, 11 found at least one positive effect and one had a negative effect. "In sum, although relatively few studies have quantified the impact of home gardening projects on household production, income, and women's control over income, those that have seem to indicate a positive trend". The authors also note that food-based strategies to address vitamin A and iron deficiencies are at different stages of development, with vitamin A programmes being generally more advanced than those that address iron deficiency.

Berti et al. (2004) found evaluations of 15 projects on home gardening or mixed home gardens/livestock. The 1 home garden study on diet quantity found a positive effect; 13 home garden studies on diet quality and/or nutrition found positive effects, 1 negative, 1 no significant change and 1 mixed; the 2 home garden studies on yields found positive effects; the 2 home garden studies on stunting found beneficial effects; and the 1 home garden study on WHZ/wasting found beneficial effects.

World Bank (2007) systematically reviewed the evidence on the impacts of agriculture interventions on nutrition, including home garden programmes with and without animal-sourced food components. The 1 study with an evaluation on household income found positive effects; the 1 study on diet quantity saw positive effects; of the 18 studies that included a measure of diet quality and/or nutrition, 15 showed positive effects, 2 mixed and 1 negative; the 1 study on stunting showed beneficial effects; and the 1 study on wasting showed beneficial effects.

Bhutta et al. (2008), in detailed web appendixes accompanying their paper, reported that 22 home gardens programmes showed improvements in diet quality and/or nutrition, 2 showed no significant change and 1 showed mixed results; 3 home garden programmes showed beneficial effects on stunting, while 1 showed no change; and 3 home garden programmes showed beneficial effects on wasting, while 1 showed no change.

Gibson and Anderson (2009) found that of the 2 studies of the effect of home gardens on food quantity, 1 found positive effects and 1 no effect; 14 studies showed positive effects of agriculture interventions on diet quality and/or nutrition and 2 no changes; of the 5 studies measuring the effect of agriculture on stunting/HAZ, 4 showed beneficial effects and 1 no significant effects; and of the 4 studies measuring the effect of agriculture on wasting/WHZ, 1 found beneficial effects and 1 no effect.

Arimond et al. (2011) drew on previous reviews to conclude that “homestead gardening interventions after the mid-1990s succeeded in improving diets, nutrient intakes and/or child nutritional status if they incorporated communication and nutrition education activities targeting behaviour change among their audiences and if they incorporated gender considerations in their design”. They found that the 1 study with data on food security (quantity) found a positive impact; 15 home garden projects with data on diet quality and/or nutrition showed increases, 2 showed no significant effects and 1 showed mixed results; the 1 study on stunting/HAZ showed beneficial effects and the 1 study on wasting/WHZ showed beneficial effects; and the 2 studies on income showed positive effects.

Masset et al. (2011) systematically reviewed agriculture interventions including home gardening interventions, of which they found 16 impact evaluations. Of the 2 studies on household income, both were positive but did not show statistical significance; of the 16 studies that included a measure on diet quality and/or nutrition, 11 showed positive effects, 3 showed no effects and 2 showed mixed effects; of the 5 studies that considered impact on stunting, none showed an impact; and of the 5 studies that considered impact on wasting, none showed an impact. However, Masset et al. state that the diversity of home gardens means that it is not feasible to generalize about the nutritional impact of all home garden interventions.

Ruel and Alderman (2013) summarize the findings from eight previous reviews and one impact evaluation of HFP/home garden programmes, and they found that while effects have been shown on dietary diversity and consumption of micronutrient-rich foods, the evidence is limited regarding the effects of these programmes on micronutrient status and anthropometry.

Ruel et al. (2017) include several impact evaluations of homestead food production programmes throughout Asia and sub-Saharan Africa. They found positive effects on various measures related to diet, micronutrient status and, to some extent, anthropometric status, yet no impacts on child stunting were found. In the four papers that looked at effect of home garden-type programmes on wasting/WHZ, two saw beneficial effects and two saw no effects; of the four papers that looked at the effect of home garden-type programmes on stunting, none found an effect; all eight papers that looked at diet quality and/or nutrition found at least one positive impact. The reported studies do examine contextual factors related to programme impact. For example, although maternal knowledge and food production were both shown to

have a positive impact on children’s haemoglobin levels, food production was more influential in cases where market access is limited (Kennedy et al. 2017). Also, a study from Burkina Faso found that the positive effects on child anaemia levels were greater when the intervention also included water, sanitation and hygiene (WASH) components and nutrition supplements (Olney et al. 2017).

Masset et al. (2011) systematically reviewed agriculture interventions, including biofortification programmes, for which they found two impact evaluations. Both biofortification studies with data on diet quality and/or nutrition found positive effects. The one biofortification study that considered wasting showed a beneficial effect. An additional study found positive effects on the rate of growth of weight. The one biofortification study that considered stunting showed no significant change.

Ruel and Alderman (2013), in a literature review of nutrition-sensitive interventions, report on two effectiveness trials of biofortification interventions and found that there is an effect on vitamin A intake and status, but no results are reported on anthropometry.

Saltzman et al. (2013) review the evolution and characteristics of biofortification programmes. This is not included in the Evidence Map because it does not focus on impact evaluations; however, it provides useful insight into the contextual factors that influence implementation of biofortification schemes. Important factors include “whether the biofortified trait is visible or invisible, and the availability of good infrastructure (including the presence of well-developed seed sectors and seed markets) for dissemination”.

Stewart et al. (2015) systematically reviewed the effects of agricultural training, innovation and new technology, including biofortification, in Africa. Of the five biofortification studies, all five had evidence on nutrition security (all serum retinol measures) and all five saw positive effects; the one study with evidence on HAZ also saw a positive effect.

1.3 Biofortification

Table 3 Biofortification

	Extreme/moderate poverty	Average income	Productivity	Food security (diet quantity)	Nutrition security (diet quality and/or nutrition)	Stunting for children aged <5	Malnutrition for children aged <5
Biofortification					 Masset et al. 2011 (limited evidence) Stewart et al. 2015 Ruel et al. 2017 (limited evidence)	 Masset et al. 2011 (limited evidence) Stewart et al. 2015 (limited evidence)	 Masset et al. 2011 (limited evidence)

Note: Cell colours indicate the direction of impact of evidence. ● Dark blue=sufficient evidence of beneficial impact; ● light blue=suggestive evidence of beneficial impact; ● grey=despite evidence, impact is in doubt; ○ white=insufficient evidence to determine trend. Border colours indicate strength of methodology of impact evaluations. ● Yellow=concerns with methodology; ● black=methodology is generally strong.

Ruel et al. (2017) reported that studies on biofortification show that these interventions have had an impact on vitamin A intake and status and dietary diversity for mothers and children.

Pandey et al. (2016) state that biofortification has strong promise in South Asia because infrastructure and markets are relatively strong, allowing for seed and input distribution and marketing of surplus production.

Leroy and Frongillo (2007) conducted a literature review of animal production (and aquaculture) interventions and their effects on diet and nutrition. They found a total of 15 papers. Two studies on livestock programmes had measurements on diet quantity and both found positive effects. Nine out of 10 livestock projects showed positive impacts on diet quality and/or nutrition, with the other showing mixed effects. Of the four livestock programmes with data on income, all four showed positive effects. Just two studies mentioned child growth, and the exact indicators are unclear. These were generally positive, but there were only a limited number of studies and not all were rigorous.

1.4 Livestock interventions

Table 4 Livestock interventions

	Extreme/moderate poverty	Average income	Productivity	Food security (diet quantity)	Nutrition security (diet quality and/or nutrition)	Stunting for children aged <5	Malnutrition for children aged <5
Livestock interventions		 <p>Leroy and Frongillo 2007 (limited evidence) World Bank 2007 (limited evidence) Masset et al. 2011 (limited evidence)</p>		 <p>Berti et al. 2004 (limited evidence) Leroy and Frongillo 2007 (limited evidence) World Bank 2007 (limited evidence) Bhutta et al. 2008 (limited evidence) Gibson and Anderson 2009 (limited evidence) Iannotti et al. 2013 (limited evidence)</p>	 <p>Berti et al. 2004 (limited evidence) Leroy and Frongillo 2007 World Bank 2007 Bhutta et al. 2008 (limited evidence) Gibson and Anderson 2009 (limited evidence) Masset et al. 2011 (limited evidence) Iannotti et al. 2013 Ruel et al. 2017 (limited evidence)</p>	 <p>Masset et al. 2011 (limited evidence) Iannotti et al. 2013 (limited evidence) Ruel et al. 2017 (limited evidence)</p>	 <p>Masset et al. 2011 (limited evidence) Iannotti et al. 2013 (no evidence) Ruel et al. 2017 (limited evidence)</p>

Note: Cell colours indicate the direction of impact of evidence. ● Dark blue=sufficient evidence of beneficial impact; ● light blue=suggestive evidence of beneficial impact; ● grey=despite evidence, impact is in doubt; ○ white=insufficient evidence to determine trend. Border colours indicate strength of methodology of impact evaluations. ○ Yellow=concerns with methodology; ○ black=methodology is generally strong.

World Bank (2007) systematically reviewed the evidence on the impacts of agriculture interventions on nutrition, including livestock interventions (drawn mainly from Leroy and Frongillo 2007). They found seven studies in total. Of the four studies that considered effects on income/expenditures, all four found positive effects; of the four livestock programmes with data on diet quantity, three found positive effects and for one the effects were unclear; and of the five livestock studies with data on diet quality and/or nutrition, four found positive effects and for one the effects were unclear.

Masset et al. (2011) systematically reviewed the effects of agriculture interventions on nutrition, including livestock interventions for which they found two impact evaluations. Both studies considered household income, and both found a positive effect; both studies considered diet quality and/or nutrition, one found positive effects and one no effect; the study on stunting found a beneficial effect; and the study on wasting found a beneficial effect.

Berti et al. (2004) identified three livestock projects, all of which were evaluated on diet quantity and all of which showed positive impacts. Of the two livestock projects with data on diet quality and/or nutrition, one found positive effects and one found no change.

Bhutta et al. (2008) found that the three livestock programmes with data on food quantity showed positive effects, and of the three livestock programmes with data on diet quality and/or nutrition, two found positive changes and one no significant change.

Gibson and Anderson (2009) found one study on the effect of livestock/aquaculture interventions on diet quantity that showed positive effects, and three out of four livestock/aquaculture projects had positive effects on diet quality and/or nutrition while one had no impact.

Iannotti et al. (2013) conducted a “comprehensive review” of milk and dairy programmes including dairy production and agriculture programmes, school-based milk programmes, fortified milk programmes, and milk powder and blended foods. They found that three out of three dairy production and agriculture evaluations that looked at measures of diet quantity showed positive effects; six out of six of these programmes with measures of diet quality and/or nutrition showed positive effects; and the one study that looked at HAZ showed positive effects. Yet, these were ranked as medium to poor in terms of quality. “With investments in agricultural development and corresponding claims for reducing hunger and malnutrition, improved programme design and evaluation should be a high priority for researchers and policymakers in this category”.

Ruel et al. (2017) report on three impact evaluations covering two livestock programmes run by Heifer International in Rwanda and Nepal. The impact evaluations include a Randomized Controlled Trial (RCT) and regression analysis with matching methods. Only one paper looked at stunting/height-for-age z (HAZ) score/height and found beneficial effects but just in one region (Nepal’s Terai); two papers looked at child weight-for-height z (WHZ) score/weight and both found positive impacts for some groups; two papers had some other measures of diet quality and/or nutrition and both found positive effects. Contextual factors are important, including the increased programme impact for programmes implemented in areas well-suited to livestock production.

Carlson-Bremer et al. (2013) registered a protocol for a systematic review covering the effects of livestock interventions on a range of outcomes including nutritional status. The protocol states that, “To date, no systematic review of livestock interventions and the resulting impact(s) on health or well-being (or both) has been conducted”.

1.5 Aquaculture interventions

Table 5 Aquaculture interventions

	Extreme/moderate poverty	Average income	Productivity	Food security (diet quantity)	Nutrition security (diet quality and/or nutrition)	Stunting for children aged <5	Malnutrition for children aged <5
Aquaculture interventions		 Leroy and Frongillo 2007 (limited evidence) World Bank 2007 (limited evidence) Kawarazuka 2010 Masset et al. 2011 (limited evidence)	 World Bank 2007 (limited evidence)	 Kawarazuka 2010 (limited evidence)	 Leroy and Frongillo 2007 (limited evidence) World Bank 2007 (limited evidence) Kawarazuka 2010 Masset et al. 2011 (limited evidence)	 Masset et al. 2011 (limited evidence)	 Masset et al. 2011 (limited evidence)

Note: Cell colours indicate the direction of impact of evidence. ● Dark blue=sufficient evidence of beneficial impact; ● light blue=suggestive evidence of beneficial impact; ● grey=despite evidence, impact is in doubt; ○ white=insufficient evidence to determine trend. Border colours indicate strength of methodology of impact evaluations. ● Yellow=concerns with methodology; ● black=methodology is generally strong.

Leroy and Frongillo (2007) conducted a literature review of animal production interventions, including four aquaculture studies, and their effects on diet and nutrition. With only four projects evaluated, even effects on dietary intake were inconclusive. Of the three aquaculture programmes with data on diet quality, one found no significant changes and the findings for the other two were unclear. Only one aquaculture project had results reported on income and that showed a positive effect.

World Bank (2007) included three projects on aquaculture. The one study that looked at income showed a positive effect; of the three studies that looked at diet quality and/or nutrition, one found a positive effect, one no effect and for one the results were unclear; and the one study that looked at yield showed a positive effect.

Kawarazuka (2010) examines the effects of aquaculture interventions (10 studies) on diet, nutrition and income. All 10 studies of aquaculture interventions had at least one food or nutrition security measure, mainly fish consumption. Of these 10 studies, five showed positive effects on diet quality or nutrition, two showed no effects on diet quality or nutrition, two with positive effects on diet quantity and one was unclear. No results were shown on stunting and/or wasting. Regarding income, four studies showed positive effects on income while for one study the results were unclear. The paper concluded that many but not all studies found increases in household consumption because of adoption of pond-based aquaculture. Total household income increased not only because of increased aquaculture income but also increased agricultural income as households used waste nutrients derived from fish ponds in agriculture. Evidence of positive changes in nutritional status among households that adopted aquaculture was reported to be thin.

Kawarazuka and Béné (2010) provide a literature review (not included in the Evidence Map) of the direct and indirect nutritional impacts of aquaculture and fisheries, although not focusing exclusively on interventions, but also including some observational studies. They concluded that the processes and mechanisms through which aquaculture and fisheries affect nutrition outcomes are still poorly documented. They called for more systematic and rigorous studies to document especially the ultimate stage, that is the impact of these pathways on the nutritional status of fishers, fish farmers, or fish traders and their household members.

Masset et al. (2011) systematically review a range of agriculture interventions, including aquaculture and fisheries for which they find three impact evaluations. Of the one study on household income, the effect was positive but no test of statistical significance was reported; all three fisheries studies looked at some measure of diet quality and/or nutrition, two had some positive impact and one had no impact; the one study that considered stunting and wasting found no effect.

1.6 Agricultural commercialization

Table 6 Agricultural commercialization: cash crops, contract farming, certification schemes, value chains, etc.

	Extreme/moderate poverty	Average income	Productivity*	Food security (diet quantity)	Nutrition security (diet quality and/or nutrition)	Stunting for children aged <5	Malnutrition for children aged <5
Agricultural commercialization		● Berti et al. 2004 (limited evidence) World Bank 2007 (limited evidence) Arimond et al. 2011 IOB 2011 ITC 2011 Otsuka et al. 2016 Ton et al. 2017 Oya et al. 2017	● Arimond et al. 2011 (limited evidence) IOB 2011 (limited evidence) ITC 2011 Oya et al. 2017	● Berti et al. 2004 (limited evidence) World Bank 2007 (limited evidence) Arimond et al. 2011 (limited evidence) IOB 2011 (limited evidence) ITC 2011 (limited evidence) Ton et al. 2017 (limited evidence)	● Berti et al. 2004 (limited evidence) World Bank 2007 (limited evidence) Arimond et al. 2011 (limited evidence) Hawkes and Ruel 2011 (no studies found) IOB 2011 (limited evidence) ITC 2011 (limited evidence) Ruel et al. 2017 (limited evidence)	● Berti et al. 2004 (limited evidence) World Bank 2007 (limited evidence) Arimond et al. 2011 (limited evidence)	○ Berti et al. 2004 (limited evidence) World Bank 2007 (limited evidence)

Note: Cell colours indicate the direction of impact of evidence. ● Dark blue=sufficient evidence of beneficial impact; ● light blue=suggestive evidence of beneficial impact; ● grey=despite evidence, impact is in doubt; ○ white=insufficient evidence to determine trend. Border colours indicate strength of methodology of impact evaluations. ● Yellow=concerns with methodology; ● black=methodology is generally strong. *The majority of evidence here is on certification schemes. IOB, Policy and Operations Evaluation Department of the Ministry of Foreign Affairs; ITC, International Trade Centre.

Berti et al. (2004), in a broad review of agricultural interventions, evaluated the effects of cash cropping interventions on food security and nutrition. The one cash crop study on income found a positive effect; the one cash crop study on stunting found a detrimental effect; the one cash crop study on wasting/WHZ found a beneficial effect; of the three cash crop studies on diet quantity, two found positive effects and one found negative effects; and of the three cash crop studies on diet quality and/or nutrition, one found an increase, one found a decrease and one found no significant difference.

World Bank (2007) systematically reviewed the evidence on the link between agriculture and nutrition, including studies focused on agricultural commercialization. Of the three studies that considered effects on household income, one showed positive effects and two showed no effect; of the two studies that considered effects on diet quantity, one showed a positive impact and the other showed mixed effects; of the two studies that studied diet quality and/or nutrition, one showed positive effects and one showed no effect; the one study that considered the effect of agricultural commercialization on weight showed mixed effects; and the one study with reported evidence on child height showed mixed results based on age.

Humphrey and Navas-Alemán (2010) did a desk review of value chain projects and found a total of 30 case studies, six of which included some assessment of the impact on poverty. (This was not included in the Evidence Map because the focus was not on agricultural value chain projects and because the review included case studies rather than impact evaluations.) The conclusion of the authors is valuable; however, they found that, despite a wealth of positive anecdotal evidence, the vast majority of projects did not rigorously assess their impacts on poverty and therefore conclude that it is unclear whether the value chain interventions were responsible for the improvements observed; whether they benefited the poor disproportionately; and whether they are more cost-effective than other alternative approaches.

Arimond et al. (2011) examined the early literature on the agriculture and nutrition connection, which focused on cash crop programmes. These studies were prompted by concern that promotion of cash crops would be detrimental to the participants' nutrition levels. The authors found that the case studies documented fairly consistent positive impacts on focus crop production, household income and food expenditures; however, no substantial impacts on young child anthropometry were documented. They also report that household dietary energy intakes increased in most cases (with decreases in some) because they purchased more expensive items such as meat and fruits, although potential improvements in diet quality were suggested but not documented. They found that the one study on productivity/yields showed positive effects; of the five studies with data on income, three showed positive effects and two showed no effects; four projects with measures on diet quantity all showed positive effects; of the three studies with data on diet quality and/or nutrition, two showed positive effects and one mixed effects; and of the four agricultural commercialization studies on stunting/HAZ, one showed beneficial effects, one detrimental effects, one mixed effects and one no significant effects.

Hawkes and Ruel (2011) searched the published and grey literature extensively for studies of interventions that took a value chain approach and their impact on nutrition and could not identify examples that evaluate the effectiveness of value chain approaches for nutrition outcomes.

IOB (2011) reviewed a variety of agricultural programme types including value chains. Of the six case studies on value chains, four showed improved farmer incomes and two showed mixed effects. One study considered productivity and found beneficial effects. Three studies showed positive effects on diet (quantity) and for one study the effect was mixed, and one study considered diet quality and/or nutrition and found a positive effect.

In a comprehensive review, ITC (2011) looked at the impacts on producers of participation in private certification schemes. They included a total of 19 studies that had an appropriate counterfactual. Of the 14 studies that looked at net income, 8 found positive effects, 4 found no or mixed effects and 2 found negative effects; of the 11 studies that looked at yield, 5 found positive effects, 3 found no or mixed effects and 3 found negative effects; 2 studies looked at food and nutrition security outcomes (variety and total amount of food consumption) and found positive effects. The authors concluded that the evidence points to private standards having the potential to contribute positively to the economic and social well-being of producers in developing countries. However, they remain cautious when interpreting the evidence as conclusive as it is not clear whether private standard systems make a significant contribution to decreasing poverty and reversing deforestation.

Otsuka et al. (2016) conducted a comprehensive review of the literature on contract farming (CF). They found 25 studies, 7 of which looked at household income and 1 that looked at productivity, yet the results on productivity are not reported (the others looked at crop income, farm income and other outcomes). Regarding income, all seven studies that looked at total household income showed a positive effect of CF (although the authors suggest that profitability or more thorough studies would be preferred). They reported that rigorous empirical studies on the impact of CF on productivity in developing countries are relatively few, with the exception of Rao et al. (2012). Existing evidence is strongly suggestive of increases in productivity, as it shows that the introduction of CF has substantially increased farmers' income from contracted crops. Regarding the factors that affect smallholder participation in the modern supply chain, Otsuka et al. found it unlikely that farm size constrains participation, which supports the conclusion of studies compiled by the Food and Agricultural Organization of the United Nations (FAO) (da Silva and Rankin 2013). The authors also looked into the role of producer cooperatives, and concluded that little is known about their potential role in including smallholders in the modern supply chain and about conditions under which cooperatives promote both efficiency and equity.

Ton et al. (2017) conducted a systematic review of contract farming on income and food security. For the eight studies that looked at household income, the pooled effect was positive. Out of the 26 empirical instances of contract farming covered by the studies, only two had a negative effect on income, and even in those studies, the negative effect was not significantly different from zero. The one study that looked at food security showed a reduction in the length of the hungry season. They concluded that the average increase in income for contract farmers (compared to others) is 62 per cent as a result of the contractual arrangement, although this effect decreases to 38 per cent when controlling for publication bias. They interpreted this as evidence that farmers need relatively high expected income effects to compensate for the transaction costs and loss of autonomy, as well as to prevent farmers from stepping out.

Ton et al. (2017) also looked carefully at the contextual factors that contributed to success. They found that for crops a price premium was important to the success of the arrangement, whereas for animal husbandry inputs plus credit were important components to the arrangement. Further, they found that the poorest farmers rarely participate in contract farming arrangements and that these arrangements work better for the relatively better-off farmers. The main reason driving this conclusion is the risks (of non-compliance) faced by both firms and farmers, with which relatively larger or richer farmers can better cope.

Oya et al. (2017) systematically reviewed the evidence on certification schemes (CS) on a range of intermediate and final outcomes including household income and yields. Of the five studies on yield, one found positive effects, two negative effects and two had no statistically significant results; and of the eight studies on household income, three found positive effects and five found the effects not statistically significant. Their meta-analysis shows that the overall effects on both of these outcomes are not statistically significant, which they attribute to the heterogeneity of results, types of

interventions and contextual factors. They concluded that there is an absence of evidence on the effects of CS on socio-economic outcomes of producers and workers and that only a limited number of studies analyse quantitative effect sizes per outcome. There is more evidence for some intermediate outcomes (e.g. yields and farm income), but little on more immediate outputs (e.g. PO strengthening, training and input provision) and final outcomes. Oya et al. also emphasize that the most robust result of their analysis is the (“unsurprising”) fact that context matters more than anything and that the heterogeneity across primary studies makes it impossible to produce a general statement about whether certification works or does not work for the well-being of producers and workers.

Anderson and Feder (2004) provide an overview of extension programmes, including their evolution, challenges and impacts over time. Although not a systematic or comprehensive review (and therefore not included in the Evidence Map), the overview is still informative. The training and visit model, prominent from 1975 to 1995, emphasized training of selected “contact farmers” who would then ideally pass on information to other farmers, although this suffered from lack of accountability and high costs. Also in the 1980s and 1990s, decentralization was attempted, whereby extension services were managed by local governments or farmers’ organizations. In the case of extension through local governments, the downside was that economies of scale were lost and extension staff were pulled to provide services other than extension. Extension through farmers’ organizations was reportedly successful, although not practiced widely. Fee for service arrangements comprise groups of farmers who seek out and pay for extension on areas of interest to them; however, these can exclude disadvantaged farmers. Finally, farmer field schools aim to train farmers and farmer-trainers using a specific curriculum, in part emphasizing integrated pest management methods. A concern regarding the model is the high cost of implementation. Anderson and Feder cite a handful of examples from the literature evaluating the economic impact of extension, with some showing high rates of return for economic investment, whereas others found disappointing results.

1.7 Extension and advisory services

Table 7 Extension and advisory services

	Extreme/moderate poverty	Average income	Productivity	Food security (diet quantity)	Nutrition security (diet quality and/or nutrition)	Stunting for children aged <5	Malnutrition for children aged <5
Extension and advisory services	○ Ton et al. 2013 (limited evidence)	● Posthumus et al. 2013 (limited evidence) Ton et al. 2013 (limited evidence) Stewart et al. 2015 (limited evidence)	● Davis et al. 2012 Posthumus et al. 2013 (limited evidence) Ton et al. 2013 (limited evidence) Waddington et al. 2014 Stewart et al. 2015 (limited evidence)	○ Ton et al. 2013 (limited evidence)			

Note: Cell colours indicate the direction of impact of evidence. ● Dark blue=sufficient evidence of beneficial impact; ● light blue=suggestive evidence of beneficial impact; ● grey=despite evidence, impact is in doubt; ○ white=insufficient evidence to determine trend. Border colours indicate strength of methodology of impact evaluations. ● Yellow=concerns with methodology; ● black=methodology is generally strong.

Feder et al. (2010), also not included in the Evidence Map because it is not a review of impact evaluations, described the market and state failures that plague extension programmes and explored the community-based extension (CBE) model as an alternative. This includes the fee for service arrangements described in Anderson and Feder (2004), as well as the decentralized model whereby farmer organizations solicit extension services. However, the authors found that rigorous evaluations of CBE programmes are lacking, and anecdotal evidence suggests that CBEs are “no panacea”.

Davis et al. (2012) examined the impact of FAO’s farmer field school (FFS) project in East Africa, including Tanzania, Kenya and Uganda. The study found that FFS increased yields in two out of three countries, and in the aggregate measure for the three countries. The study also measured livestock and agricultural income, but not overall income per household or per capita. The authors concluded that the FFS had a positive impact on production and income among women, on low literacy, and among farmers with medium land size, and that the participation in FFS increased income by 61 per cent, and improved overall crop productivity.

Fanzo et al. (2013) provide an overview (not included in the Evidence Map) of the integration of extension and advisory services with nutrition, which is a direct objective of some programmes or projects, whereas in others, it takes place indirectly as new technologies present unique opportunities for integration. They found that very few of the integrated approaches are at scale with very little documentation on their effectiveness. Fanzo et al. do not elaborate on the evidence that does exist other than to mention that evidence exists on home gardens. However, they laid out a valuable overview of the potential for and landscape of the integration between extension and advisory services and nutrition.

According to Snilstveit et al. (2016), in a report accompanying a 3ie Gap Map that included agricultural extension, a systematic review focusing on the effects of agricultural extension and training interventions would be valuable given the large number of studies assessing the effects of these interventions.

Ton et al. (2013) systematically reviewed the literature on the effects of innovation grants to smallholder farmers on innovation as well as smallholder livelihoods. Of the four studies that looked at household or farmer income, three had a positive effect and one neutral; the one study that looked at poverty status found poverty decreased; of the two that looked at productivity/yields, one found a positive effect and one mixed; and of the four that looked at food security, all found positive effects (note that the effects on food security were general, simply reported as “food security”, and thus are assumed to be quantitative without evidence that diet quality or nutrition were included). However, the strength of the methodologies is generally poor, with simple before/after treatment/control studies considered to be of the highest methodological rigour.

Posthumus et al. (2013) systematically reviewed the effects of capacity strengthening of agricultural research systems for development, both in terms of performance of NARS and agricultural productivity. Of the four studies that considered impacts on agricultural productivity, three found that capacity strengthening led to increased agricultural productivity. The one study that considered the impact on farmers’ income found that capacity strengthening had a positive effect. Overall, they found that the evidence base was weak, requiring them to rely mainly on qualitative studies given the paucity of quantitative studies. They reported that most evaluations found benefits at the initial stages of the impact pathway, such as at the postgraduate training level, which improves knowledge and skills among researchers, leading to improved performances. It is, however, unclear how this capacity-building of researchers translates into the performance of National Agricultural Research Systems (NARS) and agricultural development in general.

Waddington et al. (2014) conducted a systematic review of impacts of FFS participation on outcomes for rural farmers. Of the 11 studies that considered the effects on yields, the review found overall a statistically significant 13 per cent increase in yields of participants on average relative to a comparison group (this excludes the studies at high risk of bias). For these studies, the authors consider the quality to be low because of “moderate risk of bias and publication bias strongly suspected”. They also reported that the positive evidence on agricultural outcomes is mostly limited to short-term evaluations of pilot programmes, and that the few studies that analysed larger-scale FFS do not suggest effective improvements in agricultural outcomes among participating farmers or neighbouring non-participants.

Phillips et al. (2014), in a companion piece to Waddington et al. (2014), conducted a systematic review of how FFSs are targeted and how targeting affects take-up and performance of the programmes. This is not included in the Evidence Map because it uses the same evaluations as Waddington et al., yet the results are informative nonetheless. They found that some FFS programmes are targeted to farmers who are better off, and that such participant characteristics can significantly impact outcomes. For example, relatively more educated participants are found to be more effective in improving the adoption of farming practices, increasing yields and spillover effects to neighbouring farmers. The authors caution against elite capture of FFS programmes, and suggest that programmes should be deliberate about the extent to which they are trying to reach poor farmers.

Stewart et al. (2015), in a review of a variety of agricultural interventions in Africa, including training/extension/FFS, identified three studies that considered the effect on total income (household or per capita income), two of which found positive effects and one no effect. The one training study that evaluated effect on productivity showed a positive effect.

1.8 Sustainable agriculture practices

Table 8 Sustainable agriculture practices

	Extreme/moderate poverty	Average income	Productivity	Food security (diet quantity)	Nutrition security (diet quality and/or nutrition)	Stunting for children aged <5	Malnutrition for children aged <5
Sustainable agriculture practices (organic, integrated pest management, conservation agriculture)			 Pretty et al. 2006 Rusinamhodzi et al. 2011 Bayala et al. 2012 de Ponti et al. 2012 Seufert et al. 2012 Wall et al. 2013 Brouder and Gomez-Macpherson 2014 Garibaldi et al. 2017				

Note: Cell colours indicate the direction of impact of evidence. ● Dark blue=sufficient evidence of beneficial impact; ● light blue=suggestive evidence of beneficial impact; ● grey=despite evidence, impact is in doubt; ○ white=insufficient evidence to determine trend. Border colours indicate strength of methodology of impact evaluations. ● Yellow=concerns with methodology; ● black=methodology is generally strong.

Pretty et al. (2006) examined 286 agricultural sustainability projects, including integrated pest management (IPM), integrated nutrient management, conservation tillage, agroforestry, aquaculture, water harvesting and livestock integration. They reported that for the 360 reliable yield comparisons from 198 projects, the mean relative increase was 79 per cent across the very wide variety of systems and crop types. (Following the availability of what is in the literature, this and other systematic reviews in this section include studies from both research stations and farmers' fields.)

Rusinamhodzi et al. (2011) conducted a meta-analysis of the effects of conservation agriculture (CA) on maize yields from experiments that had been in effect for five years or longer. They found that the results were mixed: "Our meta-analysis gave the following findings: (1) 92% of the data show that mulch cover in high rainfall areas leads to lower yields due to waterlogging; (2) 85% of data show that soil texture is important in the temporal development of conservation agriculture effects, improved yields are likely on well-drained soils; (3) 73% of the data show that CA practices require high inputs especially N for improved yield; (4) 63% of data show that increased yields are obtained with rotation but calculations often do not include the variations in rainfall within and between seasons; (5) 56% of the data show that reduced tillage with no mulch cover leads to lower yields in semi-arid areas; and (6) when adequate fertiliser is available, rainfall is the most important determinant of yield in southern Africa". They found that the conditions are influential on yields and concluded that the meta-analysis clearly indicates that the success of CA in improving crop yields depends on appropriate targeting to climatic and edaphic conditions with adequate inputs (fertiliser and herbicides).

Bayala et al. (2012) performed a meta-analysis of the effects of CA on crop yields in West Africa. They adopted a broader definition of CA, defining it as a concept for natural resource-saving that strives to achieve acceptable profits with high and sustained production levels while concurrently conserving the environment (FAO 2009). The authors found significant variability in cereal yield response (and hence risk) across all the practices they examined, and concluded that despite the variability, the mean effects of the six CA practices on crop yield were more positive than negative (except for parkland trees). Yet, the authors also noted the following: "Negative yield differences were observed in all practices for grain yield and dry matter with parkland showing the highest values. Such negative impact constitutes one of the reasons for the low adoption of practices such as improved fallows and cover crops that very often reduce the yields during the first year". The authors emphasized that context is hugely important, particularly because the benefits of CA are greater relative to controls when soil quality is poor; also, rainfall levels affect success of CA in different ways depending on the particular practices in question. They concluded that CA should be pursued, yet caution against taking a "one-size-fits-all" approach.

de Ponti et al. (2012) conducted a meta-analysis of yield data for organic versus conventional farming, focusing on wheat, corn, barley, potatoes and soybeans. They found that in developing countries, based on 33 paired data sets of organic and conventional data, average yield of organic agriculture is 84 per cent of the average yield for conventional agriculture.

Seufert et al. (2012) also conducted a meta-analysis of yield data for organic versus conventional farming. "Our analysis of available data shows that, overall, organic yields are typically lower than conventional yields. But these yield differences are highly contextual, depending on system and site characteristics, and range from 5% lower organic yields (rain-fed legumes and perennials on weak acidic to weak-alkaline soils), 13% lower yields (when best organic practices are used), to 34% lower yields (when the conventional and organic systems are most comparable). Under certain conditions—that is, with good management practices, particular crop types and growing conditions—organic systems can thus nearly match conventional yields, whereas under others it at present cannot". "Comparing organic agriculture across the world, we find that in developed countries organic performance is, on average, -20%, whereas in developing countries it is -43%. In the few cases from developing countries where organic yields are compared to conventional yields typical for the location or where the yield data comes from surveys, organic yields do not differ significantly from conventional yields because of a wide confidence interval resulting from the small sample size (n = 8 and n = 12, respectively)".

Wall et al. (2013), in a comprehensive review, examined the evidence on CA versus conventional agriculture in eastern and southern Africa. They found that for maize, CA had higher yields than conventional agriculture in 32 cases, and lower yields in 9 cases, based on data from farmers' fields. For other crops, 8 studies showed CA had higher yields, 11 showed CA had lower yields and 1 showed no difference.

Brouder and Gomez-Macpherson (2014) conducted a scoping review of the effects of CA (specifically focusing on zero tillage) on yields in Africa and south Asia. Based on data from the first two years, zero tillage had higher yields than conventional tillage in 36 cases, lower yields in 48 cases and no difference in 5 cases. The authors concluded that within two years of adoption, zero tillage generally resulted in lower yields than conventional tillage in the four staple crops but this effect could change in time. They mention that these reductions could be linked to direct effects (e.g. increased soil compaction in rice), but failure to adapt other field management activities (e.g. weed control) to the CA system was a common and confounding indirect effect. For maize, sufficient maize data existed to show that immediate negative impacts on yield improved over time, in some cases accompanied by higher soil water infiltration and soil organic matter,

especially when mulch was added. Direct effects of mulching or rotation, however, could not be established because of the low number of studies, the missing supporting data and the large variation in treatments.

Rosenstock et al. (2016) put forward a systematic review protocol regarding climate-smart agriculture (CSA), which is a multilevel approach to agricultural development to improve food security and climate change adaptation while capturing mitigation co-benefits. Agricultural practices that can contribute to CSA objectives include a wide variety of farm-level practices and are highly site-specific. Rosenstock et al.'s protocol aims to create scientific evidence on these by addressing the following question: "How do farm-level CSA management practices and technologies affect food production and/or farmers' incomes, resilience/adaptive capacity, and climate change mitigation in farming systems of developing countries"? The meta-analysis results from this protocol had not been published at the time of this review.

Garibaldi et al. (2017), in a comprehensive review of the effects of alternative farming systems, found the following: "61% of the comparisons showed greater crop yield for alternative rather than conventional practices, while 20% found the opposite trend and 19% showed no differences. Similarly, 66% of the comparisons achieved greater farm profitability for alternative than conventional practices, while 11% found the opposite trend and 23% showed no differences. Similarly, despite widespread literature about the pros and cons of organic versus conventional farming systems, most of the socio-economic evidence relates only to crop yields and profits".

1.9 Irrigation

Table 9 Irrigation

	Extreme/moderate poverty	Average income	Productivity	Food security (diet quantity)	Nutrition security (diet quality and/or nutrition)	Stunting for children aged <5	Malnutrition for children aged <5
Irrigation	 Knox et al. 2013	 IOB 2011 (limited evidence) Knox et al. 2013	 Pinstруп-Andersen and Shimokawa 2008 (limited evidence) IOB 2011 (limited evidence) Knox et al. 2013	 IOB 2011 (limited evidence)	 Berti et al. 2004 (limited evidence) Ruel et al. 2017 (limited evidence)		

Note: Cell colours indicate the direction of impact of evidence. ● Dark blue=sufficient evidence of beneficial impact; ● light blue=suggestive evidence of beneficial impact; ● grey=despite evidence, impact is in doubt; ○ white=insufficient evidence to determine trend. Border colours indicate strength of methodology of impact evaluations. ● Yellow=concerns with methodology; ● black=methodology is generally strong. IOB, Policy and Operations Evaluation Department of the Ministry of Foreign Affairs.

Knox et al. (2013) reviewed a range of infrastructure investments, including irrigation. They found that of the 15 measures of the effect of irrigation on poverty, all 15 are positive. Of the 18 measures of the effect of irrigation on income, all 18 measures are positive, and the 1 measure of consumption is also positive. Of the 13 measures of the effect of irrigation on agricultural productivity, 12 are positive and 1 negative. (These numbers are based on the tables in section 4.5 of the paper.) It should be noted that the authors include labour productivity and total factor productivity in their findings.

According to IOB (2011), of the included studies on irrigation, one study showed a positive impact on household income; three studies included productivity and all showed positive effects; and two studies on diet (quantity) both showed positive effects. Pinstруп-Andersen and Shimokawa (2008) described the importance of infrastructure including irrigation for agricultural growth and poverty alleviation. Regarding the effect of irrigation on productivity, they included three papers with measures of total factor productivity or output per worker, all of which showed positive effects. They found additional papers that showed positive effects of irrigation on agricultural output. Regarding poverty, the authors reported, "These studies consistently show the importance of infrastructure in promoting poverty alleviation". However, the statistical significance of the poverty studies is unclear and so these are not reported here.

Berti et al. (2004) found that of the two studies on irrigation, both showed no difference on children's anthropometrics (no specifics were given), and both showed mixed effects on dietary intake or biochemical indicators.

Stewart et al. (2015) systematically reviewed the evidence on a range of agricultural interventions on food security and wealth in Africa. They found just two studies on irrigation, but determined that these are at high risk of bias and therefore do not report the results of the studies.

Ruel et al. (2017) cited one review of irrigation, food security and nutrition (Domènech 2015) and one new impact evaluation. The authors concluded that the key message from their review is evidence of the contribution of irrigation to improving food security, but impacts on nutrition have not yet been examined. The impact evaluation is consistent with this conclusion, finding a positive impact on the amount of nutritious foods consumed but no result on nutrition outcomes.

Domènech (2015), in a literature review covering irrigation, food security and nutrition (not included in the Evidence Map because of the lack of detailed information on the included studies), determined that there is generally a positive impact of irrigation on food and nutrition security, with some mixed results, yet determined that the impact pathways are unclear. Although the review identified positive impacts of irrigation on income in some cases, the author emphasized that lack of access to markets can negatively affect the income-enhancing potential of irrigation of interventions. There are several other reviews that purport to show that irrigation reduces poverty and improves food and nutrition security, yet none are comprehensive, and the methodological rigour of the included studies is unclear (Hussain and Hanjra 2003; Hussain and Hanjra 2004; Domènech and Ringler 2013).

1.10 Agricultural input subsidies

Table 10 Agricultural input subsidies

	Extreme/moderate poverty	Average income	Productivity	Food security (diet quantity)	Nutrition security (diet quality and/or nutrition)	Stunting for children aged <5	Malnutrition for children aged <5
Agricultural input subsidies	○ IOB 2011 (limited evidence) Jayne et al. 2016 (limited evidence)	○ Jayne et al. 2016 (limited evidence)	● IOB 2011 (limited evidence) Jayne et al. 2016 (limited evidence)	○ Jayne et al. 2016 (limited evidence)	○ Jayne et al. 2016 (limited evidence)		○ Jayne et al. 2016 (limited evidence)

Note: Cell colours indicate the direction of impact of evidence. ● Dark blue=sufficient evidence of beneficial impact; ● light blue=suggestive evidence of beneficial impact; ● grey=despite evidence, impact is in doubt; ○ white=insufficient evidence to determine trend. Border colours indicate strength of methodology of impact evaluations. ○ Yellow=concerns with methodology; ○ black=methodology is generally strong. IOB, Policy and Operations Evaluation Department of the Ministry of Foreign Affairs.

Included in the Evidence Map are IOB (2011), a systematic review that covers a wide range of agricultural programme types including limited evidence on agricultural input subsidies, and Jayne et al. (2016), the most comprehensive review on agricultural input subsidies that could be located. Regarding poverty, IOB (2011) included evidence from just one impact evaluation, showing a positive effect, and Jayne et al. (2016) included two studies that showed no impact on poverty incidence, but reductions in poverty severity. Jayne et al. also included national data from Malawi on poverty, showing that the input subsidy programme brought down the poverty rate. Jayne et al. included three studies from three countries on the effect on income, which showed mixed results (one positive, one mixed, one no effect). Only Jayne et al. had studies on diet quantity, diet quality and/or nutrition, and child wasting, with just one or two studies for each outcome type, making it impossible to determine the trend. Regarding the effect on productivity, Jayne et al. found that three out of four studies with evidence showed positive effects on yields, and concluded that there is a positive effect, but that it could be made stronger by improvements in programme delivery. IOB (2011) found two studies on yields, both showing positive effects.

Dorward et al. (2004), not included in the Evidence Map because of the case study format, provided an overview of investments in pro-poor agricultural growth at the national level, based on experiences and data from India, Malawi and Zimbabwe. From the example in India, they found “initially high but then declining poverty reduction impacts from fertiliser subsidies”. They found, however, that careful sequencing of investments and consideration of context is critical: “In areas which have not yet achieved an agricultural transformation it may be appropriate for governments to spend significant sums on fertiliser and credit subsidies. However, the failure of such spending in many African countries in the 1970s argues for caution on two counts: (i) in India such spending was preceded by important investments in infrastructure, technology and land reform, and without such investments establishing the right conditions for the agricultural transformation, subsidies to kick-start markets cannot succeed; (ii) subsidies need to be administered reasonably effectively and efficiently, without too much leakage”.

IOB (2011), in a systematic review covering a wide range of agricultural programme types, found that one study considered poverty and found a beneficial effect, and both studies showed positive effects on productivity. However, no statistical significance of the studies is reported.

Jayne and Rashid (2013) reviewed the literature on input subsidy programmes since the mid-2000s. Again, not included in the Evidence Map because of the literature review approach, the findings are nonetheless revealing: “The weight of the evidence indicates that the costs of the programs generally outweigh their benefits. Findings from other developing areas with a higher proportion of crop area under irrigation and with lower fertilizer prices—factors that should provide higher returns to fertilizer subsidies than in Africa—indicate that at least a partial reallocation of expenditures from fertilizer subsidies to R&D and infrastructure would provide higher returns to agricultural growth and poverty reduction”. Morris et al. (2007) came to similar conclusions.

Jayne et al. (2016) provided an overview of the history of input subsidy programmes in Africa, whereby most of the programmes were phased out in the 1990s up to 2005, followed by a new wave of input subsidy programmes that vowed to be “smart” and overcome the shortcomings of the previous programmes. In reviewing the evidence on input subsidy programmes in seven countries, they found that the empirical record suggests that these programmes have positive but modest effects on maize production and net crop income for some segments of the population. In terms of our outcomes of interest, they found the following according to household-/farm-level data: three out of four countries with data on the effects of input subsidies on crop yields showed positive effects and one country showed no difference on yields and a negative effect on labour productivity. Only two countries had any data on food security (quantity) and the effects were neutral or mixed (considered a “dearth of research on this topic”). Only one country had data on diet quality, and this showed no significant effect of input subsidies. Effects on income were mixed (one positive, one mixed and one no effect) and were from only three countries. Two studies showed no impact on poverty incidence, but reductions in poverty severity.

2 Rural development interventions

2.1 Groups/organizations

Table 11 Groups/organizations (e.g. savings/lending groups, farming cooperatives)

	Extreme/moderate poverty	Average income	Productivity	Food security (diet quantity)	Nutrition security (diet quality and/or nutrition)	Stunting for children aged <5	Malnutrition for children aged <5
Farmer groups/ organizations (e.g. savings/lending groups, co-ops)		○ Biscaye et al. 2014	○ Biscaye et al. 2014	○ Biscaye et al. 2014 (limited evidence)	○ Biscaye et al. 2014 (limited evidence)		

Note: Cell colours indicate the direction of impact of evidence. ● Dark blue=sufficient evidence of beneficial impact; ● light blue=suggestive evidence of beneficial impact; ● grey=despite evidence, impact is in doubt; ○ white=insufficient evidence to determine trend. Border colours indicate strength of methodology of impact evaluations. ○ Yellow=concerns with methodology; ○ black=methodology is generally strong.

Biscaye et al. (2014) systematically reviewed the literature on self-help groups, including savings groups, women's health groups and farmers' groups (although larger farmers' cooperatives were excluded from the analysis). They found that the one study that considered calorie and protein consumption found positive effects for both (this was a savings group intervention); of the 11 studies that looked at income, 8 found positive effects and 3 found no significant effects, and of the 5 that looked at agricultural productivity, 3 found positive effects and 2 no effects. However, the authors caution that productivity is not well measured, with the exact indicators used in the studies unclear. They also state that the methodology for the study covering nutrition is weak, and that none of the studies that considered the effects on income quantitatively evaluated income relative to a control group. Overall, this review confirms that there is very limited evidence in this area.

2.2 Land tenure security

Table 12 Tenure security

	Extreme/moderate poverty	Average income	Productivity	Food security (diet quantity)	Nutrition security (diet quality and/or nutrition)	Stunting for children aged <5	Malnutrition for children aged <5
Tenure security	 IOB 2011 (limited evidence) Lawry et al. 2014 (no evidence) Meinzen-Dick et al. 2017 (no evidence)	 IOB 2011 (limited evidence) Lawry et al. 2014 (limited evidence) Higgins et al. 2017 Meinzen-Dick et al. 2017 (no evidence)	 IOB 2011 (limited evidence) Lawry et al. 2014 Higgins et al. 2017 (limited evidence) Meinzen-Dick et al. 2017 (limited evidence)	 IOB 2011 (limited evidence) Higgins et al. 2017 (limited evidence) Meinzen-Dick et al. 2017 (limited evidence)	 IOB 2011 (limited evidence) Higgins et al. 2017 (limited evidence) Meinzen-Dick et al. 2017 (limited evidence)		 Bouillon and Tejerina 2007 (limited evidence)

Note: Cell colours indicate the direction of impact of evidence. ● Dark blue=sufficient evidence of beneficial impact; ● light blue=suggestive evidence of beneficial impact; ● grey=despite evidence, impact is in doubt; ○ white=insufficient evidence to determine trend. Border colours indicate strength of methodology of impact evaluations. ● Yellow=concerns with methodology; ● black=methodology is generally strong. IOB, Policy and Operations Evaluation Department of the Ministry of Foreign Affairs.

Bouillon and Tejerina (2007) systematically reviewed the effects of a wide range of social programmes in Latin America. They considered land titling programmes, and found that of the three evaluations of land titling programmes, just one looked at one of our outcomes of interest: child wasting/WHZ scores. The land titling programme in Argentina showed increased weight for height.³

IOB (2011) systematically reviewed the evidence of the impact of a range of interventions related to agriculture including land tenure security (LTS). Six papers on tenure security met their inclusion criteria. One study considered diet (quantity) and found positive effects and one study considered diet quality and/or nutrition and found positive effects. One study considered income/expenditure and found a positive effect. Three studies considered poverty and found beneficial effects. One study considered productivity and found beneficial effects.

Fenske (2011) reviewed the literature on land tenure and investment decisions in Africa. This is not included in the Evidence Map because it is not a systematic review and does not look at our outcomes of interest, yet the results are worth considering given that investment may be an important intermediate outcome in the impact pathway to our outcomes of interest. Fenske states that, “While the a priori case for a link between land tenure and agricultural investment is strong, twenty years of empirical studies have failed to show its robustness in Africa”. In particular, context matters, including the specific provisions for land rights. For example, in West Africa land rights are often conditional on use, and so land left fallow may be expropriated. “While the link between tenure and investment is significant for fallow and tree planting, it

3. The programme was described as follows: “a government land titling project in the mid-1980s in which landowners were offered monetary compensation for their land and squatters who occupied the land since 1982 were given formal titles”.

is less robust for labor use and other inputs, such as manure or chemical fertilizer". Also, gender and political status are important in terms of tenure security and investment decisions.

Doss et al. (2014) (not included in the Evidence Map) wrote about the ways in which women's land rights were threatened, both with and without land tenure reform interventions. "Women's land ownership and property rights impact a range of outcomes relevant to the well-being of women and their families and communities". These include women's bargaining power, household expenditures and children's nutrition.

Lawry et al. (2014) conducted a systematic review and meta-analysis of the evidence regarding the effects of LTS interventions on productivity, income/consumption, poverty and gender-based welfare outcome measures. Based on their criteria, their search yielded 20 quantitative studies and nine qualitative studies. Six out of eight quantitative studies on productivity found positive effects and two found no clear effects. "The available evidence suggests that de jure recognition of tenure boosts productivity, as measured in terms of the monetary value of land productivity, by around 40 per cent on average (random effects mean=0.35, s.e.=0.10, $\exp(\text{mean})=1.42$). This is a substantively huge effect, although this estimate masks substantial heterogeneity, and the predictive 95% interval crosses zero". Two of four studies with impact on consumption found positive effects, two found no effects. "The average effect on welfare, as measured by consumption or income, is about a 15 per cent increase (random effects mean=0.14, s.e.=0.04, $\exp(\text{mean})=1.15$). In this case the 95% predictive interval is squarely in the positive domain, and the level of heterogeneity is deemed quite low". The authors concluded that, "The findings of this systematic review underscore the importance of tenure security. The evidence indicates clear benefits measured in terms of productivity and consumption expenditure or income". However, they state that the evidence base is weak: "The available quantitative evidence provides a weak basis for establishing the general effectiveness of land tenure programs. This is due to reasons of quality and completeness".

Holden and Ghebru (2016) provide a literature review entitled, "Land tenure reforms, tenure security and food security in poor agrarian economies". They provide examples of impact evaluations that have shown that improved tenure security has improved agricultural productivity, food security and nutrition outcomes; however, it is not a comprehensive review of the literature, does not reach any definitive conclusions and is not included in the Evidence Map.

Higgins et al. (2017) conducted a systematic review of the impacts of LTS on rural people in low- and middle-income countries. "Based on the analysis of 60 robust studies, the paper finds strong evidence for positive effects of LTS on productive and environmentally-beneficial agricultural investments as well as on female empowerment, but a lack of support for links with productivity, access to credit, and income". There are nine studies that looked at impact on income, and of these just two showed positive effects, one showed mixed effects and six showed no effect. Four impact evaluations on productivity are included, and three showed positive impacts and one no impact. Of the two studies of diet quantity, one showed positive effects and one no effect. There were two studies on diet quality or nutrition, with one showing positive effects and one no effects. "The very few studies on food security and nutrition effects leaves little that can be taken from the link between increased LTS and these". In terms of heterogeneity of effects, they found, "Another key theme from the qualitative research is the common issue of certain groups being excluded or hindered from obtaining a title, for a variety of reasons but mainly due to local institutions tasked with distributing the titles doing so unfairly, with common instances of corruption, elite capture and clientelism leading to poorer households and women being unable to benefit from these interventions". In terms of contextual factors, the authors determined that "Given that an increase in perceived, as well as actual, tenure security is a key assumption within the LTS theory of change, contextual factors such as historic

instances of State-sponsored land appropriation could act as a major mitigating factor of the effects of LTS activities on their immediate outcomes”.

Meinzen-Dick et al. (2017) used systematic review methods to examine the links between women’s land rights (WLR) and poverty. Although they did not find any papers directly evaluating the effect of WLR on poverty, they developed a conceptual framework linking WLR and poverty and examined the evidence of impacts for intermediate outcomes, including food and nutrition security, agricultural productivity and “full income” (income plus value of home production and leisure time). They found, in each case, that the evidence base is limited. Regarding food security, of the four papers that looked at food quantity, three found a positive effect of tenure security, but in some cases the differences were only for men or women or for female- or male-headed households. Regarding food quality or nutrition, one paper found no effect and one paper found that tenure security led to an improvement. Regarding WLR and agricultural productivity, there are just three impact evaluations and the results are mixed. The authors determined that there is assumed to be a positive relationship between WLR and food security, but that there is insufficient evidence to document the relationship. “The evidence is strongest (with high levels of agreement and a larger body of evidence) in the areas of bargaining power and decision making on consumption and bargaining power and decision making on human capital investment and intergenerational transfers”.

2.3 Landscape-scale natural resource management

Table 13 Landscape-scale natural resource management (forestry, community-based natural resource management (CBNRM) and payments for environmental services (PES))

	Extreme/moderate poverty	Average income	Productivity	Food security (diet quantity)	Nutrition security (diet quality and/or nutrition)	Stunting for children aged <5	Malnutrition for children aged <5
Landscape-scale natural resource management	Landell-Mills and Porras 2002 (no evidence)	 Landell-Mills and Porras 2002 (no evidence) Bowler et al. 2010 (limited evidence) Samii et al. 2015a (limited evidence) Samii et al. 2015b (limited evidence) Caplow et al. 2011 (limited evidence) Pelletier et al. 2016		 Bowler et al. 2010 (no evidence) Caplow et al. 2011 (limited evidence)	Bowler et al. 2010 (no evidence)		

Note: Cell colours indicate the direction of impact of evidence. ● Dark blue=sufficient evidence of beneficial impact; ● light blue=suggestive evidence of beneficial impact; ● grey=despite evidence, impact is in doubt; ○ white=insufficient evidence to determine trend. Border colours indicate strength of methodology of impact evaluations. ● Yellow=concerns with methodology; ● black=methodology is generally strong.

Landell-Mills and Porras (2002) reviewed markets for forest environmental services and their impacts on the poor. These included markets for biodiversity conservation, carbon sequestration, watershed protection, landscape beauty and bundled services. On review of 287 projects involving markets for forest environmental services, they concluded: "Very few thorough assessments of the impacts of emerging markets are found in this review. For the most part, market descriptions are general, ad hoc and vague. Virtually none focus on impacts for poor households". However, the authors do caution that the livelihoods of poor communities may be threatened by the market through increased exclusion, lower incomes and a weaker asset base. Although some project descriptions provide basic information regarding the contribution of the PES projects to household income, there is no information provided regarding the methodology of the studies.

Bowler et al. (2010) systematically reviewed the effects of community forest management on environmental and local welfare outcomes. Forty-two articles were included in the review, of which 34 reported data on forest condition or cover, 8 on resource extraction (fuelwood collection and number of cut stems) and 13 on livelihoods. No studies were found on food or nutrition security with "comparators". Just two studies looked at total household income, but these do not lead to any definitive conclusions because of methodological issues. The authors conclude "Collectively, and taking the methodological robustness of studies into consideration, these studies do not provide convincing evidence that participatory forest management (PFM) has any significant impact on income levels over the medium time periods they cover".

Samii et al. (2015a) considered the effects of decentralized forest management programmes (DFM) on poverty and deforestation in a systematic review. The authors refer to a DFM programme as a "significant de jure transfer of management responsibilities for natural forests, including authority to grant concessions or establish use restrictions, from centralized to local authorities". They found that of the three studies that considered household welfare, only one looked at total per capita consumption expenditure (positive effect) and two looked at forest income and found positive effects; however, impact on poorest households, including those living in proximity to DFM areas, is not always positive. The authors concluded: "We cannot say that the evidence indicates non-negative effects on poverty for DFM. This is a troubling finding, but it is based on only a handful of cases and therefore deserves much more empirical attention".

In a systematic review, Samii et al. (2015b) reviewed the evidence regarding the effects of PES on deforestation and welfare. They found only 11 quantitative impact evaluations of PES interventions on their outcomes of interest, and only 2 of these considered the impacts on income. Although positive, the evidence suggests that the poor are less likely to benefit from the PES programmes than the well-off. The authors also determined that the quantity and quality of research in this area is weak. "For PES to contribute to poverty reduction, poorer households must be able to participate at high rates. But participation in PES programs is typically more difficult for poor households than wealthier households (a fact documented by in a number of the studies included in the review) ... Available evidence shows that PES programs are less effective in poor areas and are less likely to attract participation of poor households than wealthier ones. These are troubling findings but they are based on only a handful of cases and therefore deserve much more empirical attention".

Caplow et al. (2011) systematically reviewed the literature on projects avoiding deforestation or degradation or promoting sustainable forest management. In terms of our outcomes of interest, they found only two studies (from one project) that looked at income and one paper that looked at food security that had counterfactuals. Of the two papers (one project) that looked at effect on household income, the effect was positive; the one paper that looked at food security (monthly food expenditures) found no effect. The authors conclude, "the counterfactual scenarios for establishing socio-economic

impacts are vague, unscientific, or omitted completely. We conclude that drawing specific lessons from pre-REDD+ projects for the design or evaluation of current REDD+ projects is tenuous”.

Pelletier et al. (2016) systematically reviewed the literature on community forest management in the context of REDD+. They found that of the 25 studies that measured the impact on income, 2 had mixed results, 11 had positive effects, 11 had neutral effects and 1 had a negative effect. However, it is not clear how many of these showed total income as opposed to solely forest income. The authors concluded that, “In terms of social benefits, there is some evidence of positive outcomes, but it would be prudent to say that, although CFM could provide a contribution to poverty alleviation, it is by no means a panacea to rural poverty. It is also clear that CFM does not deal very well with equity issues at the local level”.

Snilstveit et al. (2016) report on a Gap Map exercise conducted for 3ie regarding land use change and forestry programmes, including PES programmes. They looked specifically for impact evaluations and systematic reviews published between 2000 and 2016 regarding PES programmes, and found no systematic reviews that covered the effects of PES on productivity, and only one systematic review (Samii et al., described above) covering health, food security, income or household expenditures. Although there is a chance that the author’s criteria could have ruled out a systematic review that would have been included here, this seems unlikely given that the criteria were quite broad.

Börner et al. (2017), in a literature review on PES, stated the following: “The few evaluation studies that addressed social outcomes of PES have found small positive effects at best, but also no negative impacts. Readers should note, however, that this literature is still far from representing a systematic evidence base that would allow drawing externally valid conclusions about PES”.

Reed et al. (2017) systematically reviewed the evidence on landscape approaches to conservation and development. Although they identify six papers that evaluate the impacts on income and two on food security, they do not report the results, but rather focus on general conclusions and the quality of the evidence. They state, “Our findings indicate that landscape approaches show potential as a framework to reconcile conservation and development and improve social capital, enhance community income and employment opportunities as well as reduce land degradation and conserve natural resources. However, comprehensive data on the social and environmental effects of these benefits remain elusive”.

2.4 Improved access to financial products

Table 14 Improved access to financial products: credit, insurance and savings

	Extreme/moderate poverty*	Average income	Productivity	Food security (diet quantity)	Nutrition security (diet quality and/or nutrition)*	Stunting for children aged <5	Malnutrition for children aged <5
Improved access to financial products	 Radermacher et al. 2010 (limited evidence) Stewart et al. 2010 (limited evidence) Pande et al. 2012 (limited evidence) Stewart et al. 2012 (limited evidence) Biscaye et al. 2015 (limited evidence)	 Bouillon and Tejerina 2007 (limited evidence) Stewart et al. 2010 (limited evidence) Stewart et al. 2012 Cole et al. 2012 (no evidence) Pande et al. 2012 (limited evidence) Awaworyi et al. 2014 Biscaye et al. 2015 Marr et al. 2016 (limited evidence) Steinert et al. 2017	 Cole et al. 2012 (no evidence)	 Stewart et al. 2010 (limited evidence) Cole et al. 2012 (no evidence) Biscaye et al. 2015 Steinert et al. 2017	 Stewart et al. 2010 Cole et al. 2012 (no evidence) Biscaye et al. 2015 (limited evidence)	 Stewart et al. 2010 (limited evidence)	

Note: Cell colours indicate the direction of impact of evidence. ● Dark blue=sufficient evidence of beneficial impact; ● light blue=suggestive evidence of beneficial impact; ● grey=despite evidence, impact is in doubt; ○ white=insufficient evidence to determine trend. Border colours indicate strength of methodology of impact evaluations. ● Yellow=concerns with methodology; ● black=methodology is generally strong. *These designations are primarily driven by the evidence on microcredit.

The Bouillon and Tejerina (2007) systematic review of social programmes in Latin America included microfinance programmes. Of the four evaluations of microfinance on income, two found positive effects and two mixed effects.

Dercon and Kirchberger (2008), not included in the Evidence Map because it is neither systematic nor comprehensive, identified some studies in the literature on microinsurance products of various forms including agricultural insurance and health insurance. They found that there is very little evidence of impacts, with the exception of one study showing an impact of a health insurance programme in Viet Nam on height-for-age and weight-for-age for children.

Radermacher et al. (2010) conducted a systematic review of microinsurance interventions in low- and middle-income countries on a wide range of social and economic impacts. They identified 31 studies, 29 of which are focused on microhealth insurance and only one of which examined an outcome of interest for our review. The one study that looked at an outcome of interest for this report (poverty) found that the group of households with microhealth insurance had a lower rate of increase in the poverty headcount and in the normalized poverty gap than control households. The review also identified many intermediate outcomes, including use of health services that were largely positive, and financial

protection for which the evidence was less clear. Overall, the authors concluded that evaluation of microinsurance needs to be improved in several regards to better understand its effects.

Stewart et al. (2010) examined the literature on microcredit and microsavings projects in sub-Saharan Africa. Of the two studies that measured the effect on poverty specifically, one found no statistically significant effect and one found a detrimental effect. Of the two studies that measured the effect on food security (quantity), both found no significant effect. Of the five studies that considered nutrition security (quality and/or nutrition), four found positive effects and one found no effect. Of the three studies that looked at household or individual income/expenditures, one found positive effects, one found mixed effects initially, but negative effects over time, and one found no significant change. The one study that looked at stunting found beneficial effects for girls but not for boys. Based on 15 studies that they deemed to be of medium to high quality, they concluded: "In relation to incomes of poor people, the available evidence suggests that micro-credit has mixed impacts and that micro-savings has no impact. Both micro-credit and micro-savings have positive impacts on the levels of poor people's savings whilst they also both increase clients' expenditure and their accumulation of assets. Both microcredit and micro-savings have a generally positive impact on the health of poor people, and on their food security and nutrition, although the effect on the latter is not observed across the board". Further, they take a highly cautionary tone: "We conclude that some people are made poorer, and not richer, by microfinance, particularly micro-credit clients. This seems to be because: they consume more instead of investing in their futures; their businesses fail to produce enough profit to pay high interest rates; their investment in other longer-term aspects of their futures is not sufficient to give a return on their investment; and because the context in which microfinance clients live is by definition fragile". (van Rooyen et al. 2012 is another version of this report, but is not listed here to avoid repetition.)

Cole et al. (2012) systematically reviewed the literature on agricultural index insurance but found no papers with evidence regarding the impacts on income, productivity, or food and nutrition security, despite including these in the search.

Pande et al. (2012) systematically reviewed the literature on formal banking services for income of the poor. The one paper that looked at the effect on poverty found that formal banking was beneficial, measured by a decrease in rural and aggregate headcount ratios of poverty. The three papers that examined the effects of formal banking on household income and/or consumption found positive effects. The authors concluded that, "We find compelling evidence that poor people's access to formal banking services can raise their incomes". Pande et al. is somewhat unusual in that it systematically reviews the evidence regarding impact pathways and documents the results.

Stewart et al. (2012) conducted a systematic review of the literature on microcredit, microsavings and microleasing in low- and middle-income countries. They found that of the eight studies that looked at household income or expenditure, seven found positive effects and one found negative effects. Of the two that looked at individual income or expenditures, both found positive effects. Of the three studies that considered the effect on poverty status, one found beneficial effects, one found detrimental effects and one found no change. The authors concluded, "Micro-credit appears to have a largely positive impact on borrowers' income, although these data are not completely reliable and may be prone to bias".

Awaworyi et al. (2014) conducted a systematic review and meta-analysis of the effects of microcredit on a variety of measures of well-being and business outcomes for the poor, including income and consumption/expenditures. The authors identified 25 studies, 18 of which looked at measures of income or consumption/expenditure. The authors determined that the evidence does not show that microcredit improves income or consumption/expenditures, but they do show that **access to microcredit** has a positive effect on income, yet the effect is weak. The authors concluded, "Our results are consistent with

recent systematic reviews such as Duvendack et al. (2011) that report no significant effect of microfinance on economic outcomes. Therefore, there appears to be no strong evidence, at the moment, to support the existing claims that microfinance has a positive effect on the well-being of the poor as well as their businesses”.

Biscaye et al. (2015) systematically reviewed the literature on rural and agricultural finance interventions in sub-Saharan Africa including credit, savings, insurance, and mobile money and digital products. Of the five studies that looked at food quantity, the effects were quite mixed: one found positive effects, one negative effects, one mixed effects and two no significant effects. Of the two papers that considered measures of diet quality, one found positive effects and one no significant effects. The three papers that reported on measures of poverty all found access to financial products had a positive/beneficial effect. Of the 11 papers that looked at household income/consumption, 7 found positive effects, 1 mixed effects and 3 no significant effects. The authors concluded, “Overall, the evidence suggests rural and agricultural financial products are generally associated with modest positive impacts on consumption, food security, income, production, and resilience, however the magnitude of impact is debatable. In addition, the lack of consistent measures makes comparison and generalization difficult”.

Marr et al. (2016) systematically reviewed the literature on index insurance including take-up, impacts and interactions with credit products in developing countries. They identified only two papers, both with positive results, showing empirical evidence of the effect of index insurance on income/consumption, although they included papers that modelled both negative and positive effects on income. Marr et al. also included papers that showed effects on intermediate outcomes such as investment levels and investment in riskier crops, and found mainly positive results.

A considerable number of systematic reviews covered the effects of micro- or community-based health insurance in low- and middle-income countries, but many of these did not cover our outcomes of interest but rather focused on the impact on out-of-pocket expenses and use of medical care (see Acharya et al. 2012 and Ekman 2004).

Steinert et al. (2017) conducted a systematic review and meta-analysis of the impact of savings products on intermediate outcomes such as financial literacy and outcomes including income/consumption/expenditure and food security in sub-Saharan Africa. They identified 27 RCTs, of which 11 considered income/expenditures/consumption and 7 considered food security. Meta-analysis/pooled effect sizes showed significant increases in households’ expenditures and incomes (gpooled=0.066, $p<0.01$) and significant increases in food security (gpooled=0.052, $p<0.05$). The effect sizes were small but significant. Poverty is not evaluated in the meta-analysis per se, but rather the other indicators are considered poverty-related indicators. “Our findings further suggest that programmes with formal supply-enhancing components, e.g. formal banking/mobile money, appear to be more effective in raising savings when compared to other components. Findings from this analysis may raise caution against anticipations of a ‘revolution’ in the global fight against poverty. And yet, they are promising enough to position saving promotion somewhere at the top of the agenda in international development”.

Duvendack et al. (2011) conducted a systematic review on microfinance, which is not included in the Evidence Map because the format for the reporting of results is unclear and vote counts are not possible. However, the authors’ conclusions indicated a high degree of caution in terms of the results of microfinance for the poor: “We find that most of the effects assessed occur in the early stages of the causal chain, with both positive and negative outcomes; the bulk of estimates reported were statistically insignificant even at the beginning of the causal chain, and a significant number of estimates suggest negative outcomes throughout the causal chain”. They concluded that the circumstances under which microfinance can really benefit the poor remain unclear.

Banerjee (2013), in a literature review of microcredit (also not included in the Evidence Map), reported that although microfinance is shown to increase business creation, there is a surprising lack of strong evidence linking this to large sustained consumption or income gains. They concluded that there is also no evidence of substantial gains along other dimensions of welfare, such as education and health as a result of access to microcredit.

Holmes et al. (2013) systematically reviewed the evidence of the impact of job creation interventions in fragile states on poverty and stability, where the outcome measures of interest included household income/consumption and food security. Both quantitative studies that looked at food security measures (quantity/calories) found positive effects, and two out of two quantitative studies that looked at income/consumption found positive effects. However, the authors concluded that, “Despite the centrality of employment creation as an instrument to promote stability in the fragile states policy discourse, no robust qualitative or quantitative evidence was found to illustrate this relationship in the literature. Currently there is not a strong evidence base from which to assess the efficacy of direct employment, enabling macro-policies, or the promotion of self-employment on stability. This absence of evidence is generally acknowledged within the policy community”.

Cho and Honorati (2014) systematically reviewed the effectiveness of entrepreneurship programmes in developing countries. This is not included in the Evidence Map because the outcomes of interest do not match ours exactly—they consider labour market income but not overall household income. Interestingly, although they found that of the interventions that measured the effect on labour market income, just 20 per cent found positive impacts, whereas 78 per cent found insignificant effects and 2 per cent found negative effects. The authors concluded the following, “Overall, entrepreneurship programs have a positive and large impact for youth and on business knowledge and practice, but no immediate translation into business setup and expansion or increased income”.

2.5 Rural job creation programmes

Table 15 Rural job creation programmes

	Extreme/moderate poverty	Average income	Productivity	Food security (diet quantity)	Nutrition security (diet quality and/or nutrition)	Stunting for children aged <5	Malnutrition for children aged <5
Job creation programmes (e.g. youth employment, entrepreneurship programmes)		 Bouillon and Tejerina 2007 Holmes et al. 2013 (limited evidence) Valerio et al. 2014 Kluge et al. 2017		 Holmes et al. 2013 (limited evidence)			

Note: Cell colours indicate the direction of impact of evidence. ● Dark blue=sufficient evidence of beneficial impact; ● light blue=suggestive evidence of beneficial impact; ● grey=despite evidence, impact is in doubt; ○ white=insufficient evidence to determine trend. Border colours indicate strength of methodology of impact evaluations. ● Yellow=concerns with methodology; ● black=methodology is generally strong.

Valerio et al. (2014) conducted a systematic search of the literature on entrepreneurship education and training programmes and their effects on a wide range of outcomes, mainly at the firm level. In addition to the outcomes at the level of the firm or business, they included income in their list of outcomes, and five studies could be identified as evaluating total household or per capita income/consumption. Of these five studies, two showed positive effects and three showed no effect.

The systematic review of training, entrepreneurship promotion, employment services and subsidized employment interventions for youth by Kluge et al. (2017), based on 10 studies, concluded that the effect on consumption was positive but not statistically significant at the 95 per cent confidence interval. At least 7 of these 10 studies were from low- and middle-income countries, for which the authors stated that the effects on consumption were greater. They also reported that entrepreneurship promotion interventions tend to improve the earnings and consumption of young people. Only three studies looked at household income, all of which were from the United States, with none from developing countries. The authors concluded that "effects were intensified in low- and middle-income countries where entrepreneurship interventions proved particularly effective for disadvantaged youth and in capital-constrained environments".

2.6 Social protection programmes

Table 16 Social protection programmes (cash transfers, public works programmes, employment guarantee schemes)

	Extreme/moderate poverty	Average income	Productivity	Food security (diet quantity)	Nutrition security (diet quality and/or nutrition)	Stunting for children aged <5	Malnutrition for children aged <5
Social protection programmes (e.g. cash transfers, public works programmes, employment guarantee schemes)	● Fiszbein and Schady 2009 (CT) Hagen-Zanker et al. 2011 (CT and EGS) IEG 2011 Bastagli et al. 2016 (CT)	● Bouillon and Tejerina 2007 (PWP) Fiszbein and Schady 2009 (CT) IEG 2011 Hagen-Zanker et al. 2011 (CT and EGS) Kabeer and Waddington 2015 (limited evidence) (CT) Bastagli et al. 2016 (CT) Ralston et al. 2017		● Bouillon and Tejerina 2007 (limited evidence) (CT) Bassett 2008 (CT) Bhutta et al. 2008 (limited evidence) (CT) IEG 2011 Fernald et al. 2012 (CT) Manley et al. 2013 (CT) Kabeer and Waddington 2015 (limited evidence) (CT) Bastagli et al. 2016 (CT) Burchi et al. 2016 (CT) Ralston et al. 2017	● Bouillon and Tejerina 2007 (limited evidence) (CT) Bassett 2008 (CT) Bhutta et al. 2008 (limited evidence) (CT) Leroy et al. 2009 (CT) Lagarde et al. 2009 (limited evidence) (CT) IEG 2011 Fernald et al. 2012 (CT) Ranganathan and Lagarde 2012 (limited evidence) (CT) Manley et al. 2013 (CT) Bastagli et al. 2016 (CT) Burchi et al. 2016 (CT)	○ Bouillon and Tejerina 2007 (limited evidence) (CT) Bhutta et al. 2008 (CT) Bassett 2008 (CT) Fiszbein and Schady 2009 (CT) Leroy et al. 2009 (CT) Lagarde et al. 2009 (CT) IEG 2011 Ranganathan and Lagarde 2012 (limited evidence) (CT) Fernald et al. 2012 (CT) Manley et al. 2013 (CT) Bastagli et al. 2016 (CT) Burchi et al. 2016 (CT)	○ Bassett 2008 (limited evidence) (CT) Lagarde et al. 2009 (limited evidence) IEG 2011 Ranganathan and Lagarde 2012 (limited evidence) (CT) Fernald et al. 2012 (limited evidence) (CT) Bastagli et al. 2016 (CT) Burchi et al. 2016

Note: Cell colours indicate the direction of impact of evidence. ● Dark blue=sufficient evidence of beneficial impact; ● light blue=suggestive evidence of beneficial impact; ● grey=despite evidence, impact is in doubt; ○ white=insufficient evidence to determine trend. Border colours indicate strength of methodology of impact evaluations. ● Yellow=concerns with methodology; ● black=methodology is generally strong. CT, cash transfer; EGS, employment guarantee schemes; IEG, Independent Evaluation Group.

Bouillon and Tejerina (2007), in a systematic review of a wide range of social programmes in Latin America, considered conditional cash transfer (CCT) programmes and public works employment programmes. Of the three CCT evaluations with data on food quantity, two found beneficial effects and one no effects; of the four evaluations with data on diet quality and/or nutrition, three found improvements and one found no significant change; and of the four papers with data on stunting/HAZ, three found beneficial effects and one no significant effects. Of the seven evaluations that looked at the effects of public works employment creation programmes on income, four found positive effects, two mixed and one no effects.

Basset (2008) reviewed the earlier literature on CCT programmes. Evidence from five programmes, all in Latin America, is considered. All five programmes had evidence on stunting, three found beneficial effects and two did not find significant effects. All five programmes had evidence on food quantity, and four out of five found positive effects, and the same was the case for diet quality. Just one programme evaluated wasting and found no effect. The author suggested that the size of the transfer, quality of implementation and coordination between sectors are key to success, and also acknowledged that the evaluations take a "black box" approach, whereby the effects of individual programme components cannot be identified.

Bhutta et al. (2008), in a review of diverse intervention types that could affect maternal and child nutrition and mortality, included six studies, mainly from Latin America, on large-scale CCT programmes, and found that CCTs had beneficial effects in terms of stunting in four projects, and no effect for one project. They also found that of the three CCT programmes with data on food quantity, all three showed positive effects, and the two studies with data on diet quality and/or nutrition showed positive effects. The authors emphasized that conditional cash programmes have greater potential in food-insecure populations rather than food-secure populations. They concluded that these programmes, along with nutrition education, demonstrated sufficient evidence for implementation in specific, situational contexts.

Fiszbein and Schady (2009) studied the effects of CCT programmes, primarily in Latin America. For the seven countries with data on household consumption, five saw an increase and two saw no change. At the household level, poverty was reduced among beneficiaries in four out of six programmes (Brazil was excluded because of sampling issues). No effects were seen in Cambodia and Ecuador because of small transfer size and/or transfers offset by reduction in income from child labour. At the national level, "Conditional cash transfers generally helped reduce national poverty". Of the six countries with data on stunting, three saw increases and three saw no significant effect. In terms of food and nutrition security, results suggested improvements in terms of diet quantity and quality, but a vote count was not possible. The authors concluded that CCT programmes contributed to poverty reduction, both at the household level and at the national level. In terms of the composition of consumption, they found that CCTs increased consumption of food, and in particular had a positive impact on dietary quality, measured in terms of dietary diversity and consumption of nutrient-rich foods.

Leroy et al. (2009) reviewed the effects of CCT programmes on child nutrition, studying the evidence from five programmes in Latin America. In all five studies, diet quality improved. They found that of the three programmes with data on micronutrient status, one showed weak/mixed positive effects, one showed negative effects and one showed no effect. Of the five programmes with evidence on child height and/or stunting, three found significant beneficial effects and two found no effects. Where there was a positive effect on height, the authors pointed to "a clear tendency" for younger children to benefit more. With both micronutrient status and child height, the authors suggested that the lack of effects resulted from the small transfer size and/or poor use of the nutrition components of the programmes. Of the four programmes with evidence on poverty (headcount, gap or severity), all showed a significant reduction in at least one measure of poverty. Of the four programmes with evidence on expenditure, three showed positive effects and one no effect. (Poverty and income are not included in the Evidence Map because they were only reported if studies also included nutrition.) The authors concluded that CCT programmes have high potential to improve child nutrition, but that they have not yet reached their full potential and the pathways by which they impact nutrition are not well understood.

Lagarde et al. (2009) systematically reviewed the effects of CCT programmes on health outcomes, including those relating to nutrition such as stunting, wasting, underweight and anaemia levels. They selected 10 papers in total, all but 1 of which covered programmes in Latin America. Of the six papers that considered stunting, HAZ or height, five found positive results for at least some age groups, while one paper found a mean negative effect. The one paper that considered wasting found no effect. Three papers had nutrition measures other than stunting/HAZ/height or wasting/WHZ, and of these two found positive effects in at least one category, while one found no significant effects. Important design features included the following: "All Latin American CCT programmes, which are very similar in their conception, target poor and disadvantaged groups, mostly infants and children, and pregnant and lactating women. All studies from Latin America described interventions combining nutrition, education and health conditionalities".

Hagen-Zanker et al. (2011) systematically reviewed the evidence on cash transfer (CT) programmes and employment guarantee schemes (EGS) on monetary measures of poverty in low- and middle-income countries. They noted that EGSs are much less common than CTs, with contemporary EGSs identified in only four countries compared to 36 countries with CTs. They also distinguished between EGSs that have an ongoing guarantee of work and public works programmes (PWP) that can be a one-time or limited duration programme. Of the CT studies on poverty, 15 showed a decrease in poverty and 1 showed an increase. Of the EGS studies on poverty, three showed a decrease and none showed an increase. Of the CT studies on income, six showed an increase in income and three showed a decrease. Of the EGS studies on income, one showed an increase and one showed a decrease. Weighting by quality of study showed positive and negative impacts to be closer to even. Of the studies of CTs on expenditures, 14 saw increases and 4 saw decreases. Of the EGS studies on expenditure, two saw increases and one saw a decrease. Although the majority of studies were positive, the negative results and questionable study quality are barriers to drawing strong conclusions.

Independent Evaluation Group (IEG) (2011) provided a comprehensive review, using systematic review methodology, of a variety of social safety net programmes, including 149 impact evaluations of 56 programmes throughout Latin America, sub-Saharan Africa, Asia, Europe and Central Asia. Of the nine impact evaluations that looked at income, six found positive effects, two no effects, and one a negative effect. Of the 20 evaluations that looked at food consumption (quantity), 17 found positive effects, 2 no effects and 1 negative effects. Of the 24 evaluations with data on nutrition outcomes other than stunting/HAZ and wasting/WHZ, 14 found positive effects and 10 found no effects. Of the eight programmes with data on weight-for-age z (WAZ), underweight or weight gain, five found positive effects and three found no significant effects, and two programmes with data on children older than age 6 found positive effects while two found no effects. Of the 11 programmes that studied poverty headcount ratio, 9 found beneficial effects, 1 no effects and 1 detrimental effects; of the 5 programmes with data on the poverty gap, 4 found beneficial effects and 1 no effects; of the 4 programmes with data on the squared poverty gap, all 4 found beneficial effects. Of the 14 programmes with evidence on stunting/HAZ/height, 7 showed positive effects and 7 showed no effects; and of the 7 programmes with evidence on wasting/WHZ, 2 showed positive effects and 5 showed no effects. "There is consistent evidence that various types of SSNs improve households' immediate consumption, income, poverty status as aligned with their primary goals. The effects of SSNs are also positive regarding short-term investments in children's education and health and their burden of labor, which, in some cases, reflects the compliance to program conditions. Some programs also enhance households' abilities to mitigate the negative effects of shocks. The evidence, however, is thin and mixed for the direct impacts of SSNs on the health and nutritional status of children and labor supply of adults. In terms of longer-term outcomes, although the evidence is scarce in many areas, especially adult learning outcomes, adult health status, and future employability,

there are some signs that the positive impacts in the short-term may lay the foundation for future welfare benefits". This paper points out that there is compliance with intermediate outcomes related to nutrition such as participation in growth monitoring and nutrition education programmes, but there is no evidence of impact on nutrition outcomes, although especially in terms of height this might be because insufficient time has passed for changes to materials. "While there are efforts to document the variance of impact across beneficiaries, evidence is scarce regarding the contributions of program components, implementation processes, or of local context. Furthermore, not much is known about whether the benefits of programs offset their costs and, if so, by how much". "Program impacts appear to vary depending on the characteristics of beneficiaries, yet the pattern of heterogeneity is specific to programs".

Ranganathan and Lagarde (2012) reviewed the evidence of the impact of CCTs on health-related outcomes. They found that of the four projects for which there are stunting/HAZ/height data, three found positive effects for at least one age group, with the other age groups showing no significant effect, and one project showed detrimental effects. The one project with evidence on wasting showed no effect. Of the three projects with nutrition results other than stunting/HAZ or wasting/WHZ, two showed improvements on at least one measure and one showed no effect. Notably, the evidence from Mexico showed that CCTs led to a decrease in overweight in children. Overall, they concluded that, "There is enough rigorous evidence suggesting that CCTs are a valuable tool at the disposal of policymakers in low- and middle-income countries to tackle certain health issues". However, they concede the following: "(T)here is still scope for more research to understand how they work and whether they constitute sustainable and cost-effective interventions compared to standard interventions".

Fernald et al. (2012) reviewed 39 studies in total on the effects of cash transfer programmes on a range of impacts, including food consumption, stunting and wasting. They found that of the 16 papers on height/HAZ/stunting, 11 found positive (beneficial) effects and 5 found no significant effects; of the 4 that considered wasting/WHZ, 1 found positive effects and 3 no significant effects; of the 7 studies that considered food quantity, all 7 found positive effects; and of the 17 studies that considered effects on diet quality and/or nutrition, 14 found positive effects, 1 found mixed effects and 2 found negative effects. With regard to the question of CCTs versus unconditional cash transfers (UCT), the authors state the following: "Although the studies above show that transfers tied to school enrollment conditions tend to lead to larger impacts in enrollment than transfers with no conditions, to our knowledge there are no studies comparing UCTs and CCTs on health outcomes".

Manley et al. (2013) reviewed the evidence regarding the effects of CT programmes on diet and child nutrition, with an emphasis on stunting. Of 12 studies on food quantity, 10 found positive effects, 1 no change and 1 found a negative effect. Of the nine studies on diet quality, eight found positive effects and one no effect. Of the 17 programmes with data on HAZ, 5 found positive average effects, 3 found negative average effects and 9 did not find statistically significant changes. "When effect sizes are weighted by the inverse of their standard error, on average the 17 programs increased HAZ by 0.025 with a p-value that the effect is different from zero of 0.38. The programs' average impact on height-for-age is positive, but small and not statistically significant". They also concluded that, "Conditionality is weakly negative: programs with conditions unrelated to health show a statistically significant negative impact on HAZ. Unconditional transfers do as well as anything, and transfers conditional on participation in health care are also effective. Setting other conditions may be counterproductive". Also they state, "We see girls benefiting more than boys and more disadvantaged areas benefiting more".

Ruel and Alderman (2013), in a literature review on nutrition-sensitive interventions, reviewed the literature on the effects of safety net programmes including CCT and UCT programmes on food intake and nutrition. They reported that the effects on child stunting are positive but small and not statistically significant.

Kabeer and Waddington (2015) systematically reviewed the studies regarding the economic impacts of CCTs. Of the three papers measuring the effect on total consumption, all three found positive effects. Also, of the three papers measuring the effect on food consumption, all three found positive effects. The authors concluded that, “while the income effect seems to be strong enough to reduce child labour and increase consumption, it is not sufficient to lead to a reduction in adult labour force participation”.

Bastagli et al. (2016) reviewed the effects of CTs on a range of outcomes, including poverty, income/expenditure/consumption, food and nutrition security, stunting and wasting, in a study that used systematic review methodology, but allowed for some “flexibility” according to the authors. The review reached the following conclusions: 35 studies reported findings on impact on household total expenditure, with 25 showing an increase, 1 showing a decrease, 8 showing no significant effects and 1 not reported. Of the 31 studies that looked at the overall effect on food expenditure, 23 found a positive effect, 2 found negative effects and 6 found no significant effects. Nine studies considered impacts on Foster–Greer–Thorbecke poverty measures (poverty headcount, poverty gap, squared poverty gap). Among these studies, six showed beneficial effects of interventions in at least one measure, one showed consistent detrimental effects (increase in poverty) and two showed no significant effects. “For dietary diversity, findings also consistently show increases. Among the 12 studies reporting on impacts on dietary diversity, seven show statistically significant changes across a range of dietary diversity measures, all being improvements. Evidence of statistically significant changes in anthropometric outcomes is limited to five out of 13 studies for stunting, one out of five for wasting and one out of eight for underweight. All significant overall changes were improvements”. Also, they found, “there does not appear to be strong support for differences arising from specifically targeting either men or women (4 studies); higher transfer levels are associated with larger impacts (15 studies); timing and frequency of transfers suggests that these features can have an important bearing on specific indicators (4 studies); improvements in outcomes arising from increased duration of exposure to cash transfers (24 studies); there is some evidence that making transfers conditional on certain behaviours or actions can positively affect the outcomes relating to the conditions on which the transfers are conditioned”.

Burchi et al. (2016) systematically reviewed the effects of CT programmes on food and nutrition security in sub-Saharan Africa. Of the 8 studies that looked at stunting/HAZ/height, 2 found small beneficial effects and 6 found no effects; of the 8 that looked at wasting/WHZ, 2 found beneficial effects and 6 found no effects; and of the 15 studies that looked at some measure of food security in terms of food quantity, 14 had positive effects for at least one measure and 1 showed no effects. Of the 10 studies with measures of nutrition security other than stunting or wasting, 5 had positive effects and 5 no effects. The authors stated, “The paper shows that CTs offer great potential for enhancing households’ access to food, as long as they take full account of: 1) the targeting of beneficiaries; 2) the regularity of payments; 3) the size of monetary transfers; 4) the need to amass political support”.

de Melo et al. (2016) systematically reviewed the evidence from Latin America on the effects of CCT programmes on children’s anthropometric indicators; however, this is not included in the Evidence Map because of the high proportion of studies that were observational or descriptive without showing impact relative to a counterfactual. However, the authors make an interesting point in regard to overweight. In the context of the high incidence of overweight in children

who benefit from Bolsa Familia in Brazil, the authors raised the concern that CTs may contribute to consumption of food with low nutritional value and emphasize the importance of including nutrition education as part of the programme.

Tirivayi et al. (2016) (not included in the Evidence Map because it takes the form of a literature review) reviewed the synergy between social protection programmes and agriculture, including a review of the evidence on how social protection programmes affect agriculture and how agricultural programmes affect risk and vulnerability. They found that there is evidence showing that social protection interventions increase agricultural input use and asset accumulation, and limited evidence showing that social protection interventions increase agricultural yields. Qualitative studies show that the effects are not uniform among beneficiaries, with better-off participants showing greater effects in some cases.

Ralston et al. (2017) performed a meta-analysis regarding the effects of safety net programmes in Africa on a wide range of outcomes, including food consumption and total consumption. They found that of the nine studies with measurements on total consumption, five had positive results, one negative and three no statistically significant effect, with a statistically significant mean effect of 74 per cent (95 per cent CI: 9 to 139), meaning that 74 cents are spent on consumption for every dollar that was transferred. They also found that of the 11 programmes for which there were studies on food consumption, 5 showed positive effects, 1 negative and 5 no significant effects. The meta-analysis showed an average of 36 cents per dollar transferred goes specifically towards food (mean effect of 36 per cent (95 per cent CI: 0 to 71) of the transfer size). Although they identified other measures of food and nutrition security, these were not included in the meta-analysis or reported in detail because a wide range of indicators was used.

2.7 Information services/information and communication technology (ICT)

Table 17 Information services/information and communication technology (ICT)

	Extreme/moderate poverty	Average income	Productivity	Food security (diet quantity)	Nutrition security (diet quality and/or nutrition)	Stunting for children aged <5	Malnutrition for children aged <5
Information services/ICT	○ Knox et al. 2013 (limited evidence)	● Asenso-Okyere and Mekonnen 2012 (limited evidence) Pande et al. 2012 (limited evidence) Knox et al. 2013 (limited evidence) Biscaye et al. 2015 (limited evidence)	○ Asenso-Okyere and Mekonnen 2012 (limited evidence)		● Naugle and Hornik 2014 Biscaye et al. 2015 (limited evidence) Lee et al. 2016 (limited evidence) Müller et al. 2016		

Note: Cell colours indicate the direction of impact of evidence. ● Dark blue=sufficient evidence of beneficial impact; ● light blue=suggestive evidence of beneficial impact; ● grey=despite evidence, impact is in doubt; ○ white=insufficient evidence to determine trend. Border colours indicate strength of methodology of impact evaluations. ○ Yellow=concerns with methodology; ○ black=methodology is generally strong.

Jansen et al. (2010), not included in the Evidence Map, described the importance of ICTs for improving welfare in rural areas of developing countries: "Increases in welfare occur mainly via improvements in agricultural productivity, improved market access and marketing opportunities leading to higher farm-gate prices, and changes in cropping patterns towards higher-value crops". Regarding context, the authors stress the "importance of investment in other, complementary infrastructure and services in order for telecommunications to have their maximum impact on rural welfare".

Aker (2011), also not relevant for the Evidence Map, lays out the potential ways that ICT can influence agriculture and proposes strategies for evaluating the effectiveness of this type of approach, while suggesting that existing evidence of impacts is limited.

Asenso-Okyere and Mekonnen (2012) provided an overview of the role of ICT in agriculture and described the existing literature on the impacts of ICT. "This paper looks at the evidence on the role of emerging ICTs in the agricultural sector in Africa with lessons from Asia with respect to farmers' access to information and other services that would help improve agricultural productivity, practices, and farmer livelihoods". The authors identified the following important contextual factors: "the policy environment; the rural setting, infrastructure and capacity problems; and, nature of local communities including their ability to use the technology to access information for their work".

Knox et al. (2013) included telecommunications services in their systematic review of the effects of infrastructure investments on agricultural productivity, incomes and poverty, among other factors. However, they identified only seven studies on telecommunications that fit their inclusion criteria. Of these, three measured the effects on poverty (two are positive and one showed no effect) and one measured the effect on income, showing no effect.

Pande et al. (2012), in a systematic review of the impact of formal banking services on income for the poor, identified just one study on mobile banking that met their inclusion criteria (Jack 2010). The study evaluated the M-Pesa programme in Kenya and found that "M-Pesa usage had a positive effect on consumption smoothing. Further, negative income shocks did not significantly impact on changes in consumption for M-Pesa users, while they did for others, suggesting that M-Pesa usage helps to smooth consumption. A negative income shock caused non-users to experience a 7 percent reduction in household income, while M-Pesa seemed to be able to smooth income seamlessly". The paper identified the following impact pathways whereby mobile banking could lead to increased income: "Increase/ease payment services to facilitate remittances and transfers, which helps smooth consumption and raise incomes of the receivers directly". The authors showed that this was the case. An alternative pathway was via use of a secure savings facility; however, there was only early evidence of this. Regarding contextual factors, large numbers of migrant remittance senders and light regulation were relevant in Kenya.

Naugle and Hornik (2014) conducted a systematic review of mass media interventions aimed at child survival-related health topics, including nutrition. They identified 14 relevant nutrition studies, 9 of which had moderate to stronger design according to the study authors and are included in the authors' analysis. Of these nine, all showed positive effects of the mass media intervention on a nutrition-related outcome, although in some cases the outcomes were related to knowledge and attitudes, but not practices or nutritional status.

Biscaye et al. (2015) systematically reviewed the evidence regarding the impact of rural and agricultural finance in sub-Saharan Africa, including four papers that covered mobile banking products. They found that in the one paper that considered the effect on diet quality, the results were positive, and of the three studies that looked at household income/consumption, all three saw positive effects.

Lee et al. (2016) conducted a systematic review of maternal, neonatal and child health care interventions delivered via mobile technology, primarily mobile phones. The outcomes of interest included infant feeding and breastfeeding practices, and three out of three studies showed positive effects of mobile phone interventions on infant feeding and breastfeeding practices. Meta-analysis of three studies on infant feeding showed that prenatal interventions using SMS/cell phone (versus routine care) improved rates of breastfeeding within one hour after birth, exclusive breastfeeding for three/four months, and for six months. An additional study examined the effects of interventions via mobile technology regarding iron supplementation and found positive effects on supplementation but no effect on anaemia rates.

Müller et al. (2016), in a systematic review of the impact of modern information and communications technology on diet and physical activity in developing countries, found that of the 11 studies that looked at effects on diet, 8 had positive effects. The authors found that “most Internet-based interventions were effective in improving physical activity and/or diet while the evidence for mobile-phone interventions (text messages and counselling) was mixed”. “Most studies were conducted in upper-middle income countries (n = 10) and none in a low-income country”. This study is different from most in this report because the focus was on avoiding non-communicable diseases that come with overnutrition, rather than combatting undernutrition. Yet, as this is a growing concern for the developing world and is acknowledged within the sustainable development goals, this review is included.

It should be noted that there are many systematic reviews on mHealth interventions in developing countries that do not include our outcomes of interest (e.g. see Aranda-Jan et al. 2014; Gurman et al. 2012). According to Hall et al. (2014), “There is a growing evidence base for the efficacy of mHealth interventions in LMICs, particularly in improving treatment adherence, appointment compliance, data gathering, and developing support networks for health workers. However, the quantity and quality of the evidence is still limited in many respects”.

2.8 Improved infrastructure

Table 18 Improved Infrastructure

	Extreme/moderate poverty	Average income	Productivity	Food security (diet quantity)	Nutrition security (diet quality and/or nutrition)	Stunting for children aged <5	Malnutrition for children aged <5
Improved infrastructure	 Torero 2011 Knox et al. 2013	 Knox et al. 2013	 Pinstrup-Andersen and Shimokawa 2008 (limited evidence) Torero 2011 (limited evidence) Knox et al. 2013				

Note: Cell colours indicate the direction of impact of evidence. ● Dark blue=sufficient evidence of beneficial impact; ● light blue=suggestive evidence of beneficial impact; ● grey=despite evidence, impact is in doubt; ○ white=insufficient evidence to determine trend. Border colours indicate strength of methodology of impact evaluations. ● Yellow=concerns with methodology; ● black=methodology is generally strong.

Torero (2011), although not a systematic review per se, included a summary of studies that measured the impact of access to infrastructure, which, in lieu of a formalized systematic review on infrastructure, is valuable. Torero stated, "Fan and Hazell (1999), Zhang and Fan (2000), Fan et. al. (2000a), Fan et. al. (2000b), and Fan et. al. (2002): Their studies in India and China are among the few works that attempt to link infrastructure, rural growth and poverty alleviation, by highlighting the role of investment complementarities. Their research efforts show that infrastructure investments, particularly in irrigation, roads, electricity and telecommunications, not only contribute to growth in agricultural production, but also a reduction in rural poverty and regional inequality in these countries". "Aschauer (1997) demonstrated that changes in productivity (i.e., rate of return per unit of private capital and worker) are positively related to government infrastructure spending".

Knox et al. (2013) conducted a systematic review of the effects of infrastructure investment on several factors, including agricultural productivity, poverty and incomes. They included 47 papers that met their selection criteria, some of which included multiple measures. For roads, electricity and mixed infrastructure, there were 46 measures on poverty (42 positive, 1 neutral and 3 negative); 9 measures on income (7 positive, 1 neutral and 1 negative) and 13 measures of consumption (11 positive and 2 negative); and 11 measures on agricultural productivity, all positive. In terms of roads, the authors found that "the case studies consider a range of infrastructure interventions from the opening up of inaccessible areas with basic road infrastructure to the rehabilitation of existing roads. From an agricultural perspective, the first type of intervention is more radical than the second which tends to be incremental in its effect".

Regarding poverty, Knox et al. (2013) found that for roads, electricity and mixed infrastructure, there are 46 measures on poverty, of which 42 are positive, three are negative and one shows no effect. Torero (2011) cites Fan and Hazell (1999), Zhang and Fan (2000), Fan et. al. (2000a), Fan et. al. (2000b) and Fan et. al. (2002) and states that their studies in India and China "show that infrastructure investments, particularly in irrigation, roads, electricity and telecommunications not only contribute to growth in agricultural production, but also a reduction in rural poverty and regional inequality in these countries". Taken together, we consider this to be sufficient evidence demonstrating that infrastructure reduces rural poverty. Regarding income, the evidence is all from Knox et al. (2013), which included 9 measures on income, of which 7 were positive, 1 negative and 1 showed no effects, and 13 measures of consumption, of which 11 are positive and 2 negative. Regarding productivity, the evidence on the impact of infrastructure is quite consistently positive. Knox et al. (2013) described the impacts of infrastructure on income as occurring via improvements in agricultural productivity, based on 11 measures including yields, labour productivity and total factor productivity, all of which were positive. Pinstrup-Andersen and Shimokawa (2008) found four studies with measures of labour productivity and total factor productivity, three of which showed positive effects and one that showed no change. Torero (2011) cites one study on productivity that showed positive effects.

Pinstrup-Andersen and Shimokawa (2008) described the importance of infrastructure for agricultural growth and poverty alleviation. Regarding the effect of infrastructure on productivity, they include three papers, with four measures of total factor productivity or output per worker, three of which were positive and one that was not significant. They found additional papers that showed positive effects of infrastructure on agricultural output. Regarding poverty, the authors reported, "These studies consistently show the importance of infrastructure in promoting poverty alleviation". However, the statistical significance of the poverty studies is unclear and so these are not reported here.

Hine (2014) puts forth a protocol for a systematic review on the effects of rural road networks on poverty and resilience, but the report had not been published at the time of writing of this review.

2.9 Multisectoral interventions and WASH

Table 19 Multisectoral interventions and water, sanitation and hygiene (WASH)

	Extreme/moderate poverty	Average income	Productivity	Food security (diet quantity)	Nutrition security (diet quality and/or nutrition)	Stunting for children aged <5	Malnutrition for children aged <5
Multisectoral interventions and WASH (selected studies)		 Banerjee et al. 2015		 Banerjee et al. 2015	 Dangour et al. 2013	 Remans et al. 2011 Dangour et al. 2013	 Dangour et al. 2013

Note: Cell colours indicate the direction of impact of evidence. ● Dark blue=sufficient evidence of beneficial impact; ● light blue=suggestive evidence of beneficial impact; ● grey=despite evidence, impact is in doubt; ○ white=insufficient evidence to determine trend. Border colours indicate strength of methodology of impact evaluations. ● Yellow=concerns with methodology; ● black=methodology is generally strong.

Remans et al. (2011) conducted a multi-country evaluation of the Millennium Villages Project in nine countries in sub-Saharan Africa. According to the authors, “The project implements a concurrent package of evidence-based interventions in agriculture, health, education, and infrastructure sustained over a 10-y period”. They found, “There was a significant (at = 0.05) reduction in stunting prevalence at 5 of the sites and a nonsignificant reduction in 3 additional sites. (One additional site had a nonsignificant increase in stunting.) Furthermore, children <2 y of age had a 43% lower risk of being stunted than before project initiation. Information derived from national data sources suggested childhood stunting in countries included in this study has remained largely unchanged between 1990 and 2008”. Although the results are positive, these rely on Demographic and Health Surveys (DHS) survey data as controls.

Dangour et al. (2013) conducted a systematic review and meta-analysis of the literature regarding the effects of WASH interventions on nutritional outcomes, including anthropometry and nutrient status. They identified 14 studies (17 reports). Of the 12 studies with nutrition measures other than HAZ/stunting or WHZ/wasting (WAZ, Mid-Upper Arm Circumference, Body-Mass Index and haemoglobin), 10 studies found no statistically significant effects, 1 found positive/beneficial effects (on WAZ) and 1 found negative effects (haemoglobin levels). They find that of the 10 studies that measured HAZ scores, 9 saw no change and 1 found positive effects. Meta-analysis (on RCTs only) including 4,627 children identified a borderline statistically significant effect of WASH interventions on height-for-age z score (MD 0.08; 95 per cent CI 0.00 to 0.16). Of the 10 studies that covered WHZ or wasting, all 10 found no statistically significant effect. Meta-analysis (on RCTs only) including 4,622 children identified no evidence of an effect of WASH interventions on weight-for-height z-score (MD 0.02; 95 per cent CI -0.07 to 0.11). “In subgroup analysis of data from cluster-randomised controlled trials there was some evidence to suggest a difference in effect by gender and age group, with girls more responsive than boys in weight and height growth to WASH interventions, height growth more responsive to WASH interventions in children under 24 months of age, and weight growth more responsive to WASH interventions in children 25-60 months of age”. The authors concluded, “The available evidence from meta-analysis of data from cluster-randomised controlled trials with an intervention period of 9-12 months is suggestive of a small benefit of WASH interventions (specifically solar disinfection of water, provision of soap, and improvement of water quality) on length growth in children under five years of age. The duration of the intervention studies was relatively short and none of the included studies is of high

methodological quality. Very few studies provided information on intervention adherence, attrition and costs... While potentially important, this conclusion is based on relatively short-term studies, none of which is of high methodological quality, and should therefore be treated with caution”.

Banerjee et al. (2015) studied the impacts of six graduation programmes in six different countries. The graduation model, which targeted the poorest of the poor, consisted of the following six components: “1. Productive asset transfer: a one-time transfer of a productive asset; 2. Consumption support: a regular transfer of food or cash for a few months to about a year; 3. Technical skills training on managing the particular productive assets; 4. High-frequency home visits; 5. Savings: access to a savings account and in some instances a deposit collection service and/or mandatory savings; 6. Some health education, basic health services, and/or life-skills training”. They found that in endline 1, impact on total consumption per capita was positive and statistically significant in four out of six countries. In endline 2, impact on total consumption per capita was positive and statistically significant in five out of six countries (although only at the 10 per cent level for two of these). For food consumption per capita per month, five out of six countries showed positive, statistically significant results (although one was only significant at the 10 per cent level). The food security index showed positive effects for four out of six countries for endline 1 and for four out of six countries for endline 2 (although two are only significant at the 10 per cent level). The other results were not statistically significant. The authors concluded that “the effects of the program seem durable but that the average effects are not very large and do not correspond to our intuitive sense of what it would mean to be liberated from the trap of poverty”. They also conducted a cost-benefit analysis and found that in all but Honduras, the benefits exceeded the costs of the programmes.

De Buck et al. (2017) systematically reviewed the effectiveness of WASH interventions, although they did not include impacts on nutrition or our other outcomes of interest. The review provides valuable insights nonetheless.