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Technical Innovations for Rural Poverty Reduction

Evaluation Synthesis Report

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Executive summary

I. Introduction

1. Background. Since the mid-1990s, IFAD has made concerted efforts to incorporate innovation into its key policy and strategy documents. In 2004, IFAD introduced the Initiative for Mainstreaming Innovation in an effort to explicitly focus on innovation and mainstream it in its processes. IFAD's Strategy on Innovation was developed in 2007. The 2010 corporate-level evaluation on "IFAD's capacity to promote innovation and scaling up" revealed that the Fund had paid relatively more attention to (and found more success in) innovative solutions in social engineering and institutional arrangements (e.g. promoting participatory approaches to planning and resource allocation) than in agricultural practice.

2. Evaluation synthesis report (ESR) objectives and scope. This ESR looks at the support that IFAD has provided to technical innovation for rural poverty reduction in recent years. The focus of this synthesis is specifically on the operational part of IFAD's programme, and within this, on the programme/project level of interventions that have included innovative technical features. The ESR seeks to analyse what technical innovation consists of in IFAD's portfolio and what is known about the nature of interventions, their uptake, effectiveness and impact. The time frame covered is 2010-2018.

3. The objectives of this synthesis are:

   (i) to identify technical innovation practices and lessons learned about the potential for success and scaling up that can inform future IFAD interventions;

   (ii) to identify key factors enabling (or hindering) innovation, within the limitations of the available evaluative evidence.

4. Data sources. The synthesis derives its lessons primarily from existing evaluative evidence. It followed a progressive sampling approach to identify successful innovation practices for further in-depth analysis. The final sample of 57 evaluations included: 25 country strategy and programme evaluations, 22 project performance evaluations, 3 impact evaluations, and 7 evaluation synthesis reports. Four case studies were undertaken to explore in more depth the factors that enabled or hindered innovation – such as the country policies and institutional frameworks – through a review of a wider range of project documents and/or country analyses.

5. Theory of change. Consideration of IFAD's theory of change for technical innovation initially reflected a model that envisaged a problem-solving cycle of interaction between farmers' needs and new technical solutions. Actual practice is more complicated and involves three distinct iterative cycles to identify the scope, plan the innovations and their dissemination, and provide a supportive framework. The change process for technical innovation involves a complex interaction of feedback loops associated with the adjustment of the technical innovation during piloting, adaptation and learning.

II. Findings

6. This ESR focuses on technical innovations. Technical innovation is the introduction of an idea, practice or object that is perceived by an individual or entity as new or improved. It can involve inputs, products and productive processes or complementary processes and institutional innovations, e.g. in marketing, which accelerate adoption and magnify impact. Technical innovation means applying ideas, knowledge or practices that are new to a particular context with the purpose of creating positive change. Some technical innovations might require complementary changes to institutional or social arrangements to facilitate their

adoption and magnify their impact. Very often innovations are grouped or bundled, and are much less commonly promoted in isolation.

7. Intervention types. Within the sample of 57 evaluations, the synthesis identified 416 innovative interventions. Most of the innovations belong to three categories: crop types, livestock and crop management.

8. The two most important changes were: (i) productivity enhancing; and (ii) transformative, which made up 56 per cent and 28 per cent of the sample respectively. The distinction between productivity enhancing innovations and transformative innovations is important. Productivity enhancing innovations improve returns to land, labour and capital by incremental changes to the farm business, including forestry and fisheries. Transformative change, on the other hand, includes innovations that bring a major change to farming system structure and function by introducing new enterprises or radically different ways of farming and post-harvest technologies. Transformative innovations are considered higher risk and usually require broader packages of support to be successful.

9. Productivity enhancing practices. A successful practice is linking field demonstrations with access to microcredit. A less common practice is to introduce applicator machines to overcome labour constraints. Introduction of fertilizer and pest management requires a package of support to work. This includes enhanced efficiency of fertilizer use and adoption of organic products, and tackling pests and weeds through integrated methods. Improved use of fertilizer and integrated pest management/integrated weed management bring quick and visible returns from lower costs or improved yields.

10. The system of rice improvement (SRI) is a combination of practices, chosen to meet the needs of the context. It can include: transplanting of seedlings, improved variety use, use of compost and soil nutrient management, weed management and crop establishment. SRI has been popularized across three regions, the Asia and the Pacific (APR), the East and Southern Africa and West and Central Africa.

11. Introduction of improved or quality seeds needs to ensure there is an appropriate framework for guarantees of quality; continuity of partnership with research institutions to provide foundation material; arrangements for contracting or authorizing outgrowers; and a procedure for collection, grading and distribution.

12. Transformative practices. The introduction of new crops helps to diversify production but exposes farmers to new risks. Being able to organize farmers and provide access to market information are critical for safeguarding farmers' interests and achieving an equitable relationship between farmers and buyers.

13. Improved use of water requires low-cost technology and materials that are readily available. Drip and sprinkler irrigation improve efficiency; small-scale irrigation with manual pumps and spate irrigation can transform crop options as can water harvesting in micro catchments for fodder shrubs and fruit trees.

14. Innovations for soil and water conservation and climate change adaptation are labour-intensive and generate little extra income, but they can also reduce production costs and enhance food security. Introducing new plants and trees provides additional sources of grazing or fodder and can reduce soil erosion. Combined with nitrogen-fixing varieties and composting, they improve soil structure and fertility. Water harvesting and water infiltration can extend growing seasons and enable crop diversity.

15. Alternative sources of energy have the potential to transform the household's energy efficiency and provide significant health benefits by reducing drudgery and smoke in kitchens. Biodigesters help dispose of waste products and reduce wood consumption. However, they have substantial limitations in terms of access to raw

materials, demands on labour and a suitable climate and are therefore likely to be at best a niche technology.

16. Targeting innovations. Most innovations are not specifically targeted, although there are significant examples – such as improved crop varieties and some new crop types – where innovations were directed at poorer farmers and communities and at women. While some innovations are clearly more suitable for better-off farmers (particularly those requiring access to land and livestock), overall, IFAD's technical innovations are geared towards farming households that are neither very poor nor better-off.

17. Partnerships for innovation. Research partnerships (with national and international research centres) mainly supported the introduction of new or improved crops. Partnerships with the CGIAR can catalyse important innovations, but often the partnership is confined to the project duration and does not evolve into a long-term relationship. Partnerships with the private sector focused on introduction of cash crops and product processing.

18. A third of the evaluations reviewed make reference to grant-funded activities towards technical innovation. Grants play an important role in support of technical innovations and were used to deliver a diverse set of activities for technical development, piloting, dissemination and knowledge management.

III. Key lessons

19. A collective set of technical innovations, such as SRI, provides a simple focus for project design, even though the component parts can, and should, vary according to local needs. Introducing collective sets of technical innovations for rain-fed field crops, vegetables, livestock and other activities facilitates project design, implementation support and learning.

20. Technical innovation to promote value chain development needs careful preparation. Plans to add value by increasing production to create a marketable surplus – either through improved productivity or by transforming farm enterprises and processing – need to take account of markets: provision of inputs, sale outlets, buyer concentration, farmer negotiating power and consumer demands, while avoiding over-dependency. With new products these can be hard to determine in advance.

21. Environmental damage can arise from innovations supporting diversification (new crops) and asset growth (livestock numbers) as well as productivity. Productivity improvements can stimulate more intensive use of inorganic fertilizers and pesticides and overgrazing by livestock. Poorly planned water use creates potential for salinization; and some processing (such as for cassava) generates effluent that has to be controlled to prevent environmental damage.

22. Effective partnerships are essential for input supply, technical advice, group development, dissemination and marketing. Innovations can lead to extensive demand for support from government agencies, research institutes, non-governmental organizations and private sector entities. Critical functions such as seed supply are difficult to establish. Negotiating shared objectives, resource availability, priority actions and supportive policies with partners is challenging.

23. Managing successful innovation demands transdisciplinary skills. Understanding the physical and social context, how best to engage and work with partners, the most effective mode of delivery and how to organize participating farmers calls for skills that can outweigh the technical aspects of the innovation.

24. The simpler the innovation the greater the chance of it being sustained. Low-cost, low-tech innovations with short input supply and marketing chains, local manufacture and minimal maintenance are the most viable. Some apparently

simple technical innovations can be more complex to manage and sustain. Sustainability is less certain where government ownership is in doubt, partnership support is narrowly tied to projects, and technology is dependent on scientific support. Functioning local organizations and strong market connections all help sustain relationships and manage risks.

25. Scale has to be considered when introducing innovations. Some innovations only show their benefits when implemented at scale. Others, such as post-harvest and processing equipment and machinery, can be difficult to manage at scale.

IV. Conclusions

26. Technical innovation, defined as the introduction of a process or product that is new to the context, is mainstreamed in IFAD and examples can be found in all aspects of the portfolio. According to this definition the majority of project interventions are innovative. Most technical innovations aim to enhance productivity and offer low-cost, low-tech marginal improvements in cropping practice and animal health. They are classic interventions in agricultural development that are low risk and well suited to the needs of many farmers. Most innovations are of low technical complexity and are designed to bring incremental changes to the farm business.

27. A smaller number of innovations are transformative. Transformative innovations are more risky and they entail a higher level of high-tech change. They can be more disruptive, having the potential for higher rewards but requiring higher investments in resources and knowledge. The distinction between productivity and transformation is important if IFAD wants to promote substantial changes in income and food security. Innovations of a transformational nature are needed to tackle the root causes of hunger and malnutrition within the time frame of Agenda 2030.

28. The majority of technical innovations are not targeted at specific groups. Most technical innovations are geared towards the "average" farming household in any location, i.e. neither very poor nor better-off. There are exceptions; for instance some livestock and other innovations are more suitable for farmers with access to land and finance.

29. Accompanying support and partnerships are essential for introducing innovations that require new knowledge and skills. IFAD is well positioned to provide this type of support as it is seen as a strength of IFAD’s approach across the portfolio. IFAD usually has a facilitating role with regard to the mode of dissemination, the implementing partners and the enabling environment. Grant-funded projects are the most frequent mechanism for research and technical development, but they are often not systematically linked with practical application and adaptation.

30. Impact tends to come from a package of innovation measures, not a single element. Innovation is inherently uncertain, and some technologies take time to get established. These results might well be a good reflection on the projects; after all, income is a function of more factors than just the innovation. A positive impact on household incomes was found only in 20 per cent of all projects. A higher proportion (27 per cent) registered improvements in food security and productivity.

31. Many innovations related to agricultural practices are potentially significant for natural resource management and climate change mitigation but the associated risks need to be carefully managed. Some technical innovations had positive impacts on the environment, natural resource management and climate change mitigation – for example drip irrigation and green manure; others – for example irrigation and cassava processing – can have negative unforeseen longer-term consequences.

32. IFAD is dealing with a very assorted portfolio with few repeat examples of many innovations. A small number of specific technical innovations have been replicated in many locations. Otherwise there is an extensive range of other innovations that respond to local context and needs. The challenge in scaling up comes from innovations being so numerous and varied, as they generate few clear lessons about what works where and for whom.

V. Recommendations

33. Recommendation 1: Enhance focus on transformative practices within IFAD's approach to technical innovation while continuing to promote low-risk improvements to productivity for the majority of poor smallholder farmers. IFAD should recognize and reward innovative efforts that are transformational but more risky. A working environment that rewards risk taking is at odds with a view that successful adoption is the only satisfactory outcome. A clearer distinction between the more routine productivity enhancement and less common transformational innovations would help to understand and manage the change that is being promoted, and better target the innovations. Some interventions move on from being part of agriculture's natural cycle of learning and advancement to a more transformative change. Project design would need to anticipate the point when innovations become transformative and plan for dissemination and enabling support. Scaling up needs to be mainstreamed in project design to maximize the impact of and returns on innovation.

34. Recommendation 2: Systematically monitor, evaluate and learn from innovations. Too many innovations are underreported and learning is lost. This applies to both loans and grants. There is no systematic framework to evaluate innovation in project and country evaluations. Simple measures, such as using adoption rates in a uniform and consistent manner, can be very revealing. There is a need to both address relatively simple questions about adoption rates and examine why innovations worked or did not work in the specific context. There is also a need to better document when different innovation packages are successful. Evaluation needs to understand the adoption/adaptation process and how the enabling support functioned. More challenging innovations might benefit from a counterfactual model to demonstrate outcomes. A narrow focus on impact ignores more practical questions about why an innovation works in some settings for some participants and not for others.

35. Recommendation 3: Use the forthcoming corporate-level evaluation to explore IFAD's readiness to promote transformative innovations. This synthesis has highlighted the distinction between productivity enhancement and transformative change. A deeper exploration of the extent to which IFAD as an organization is set up to actively support transformative innovations should be undertaken by the Independent Office of Evaluation of IFAD (IOE). This would include an assessment of the risk culture in the organization.

Contents

Annexes

Abbreviations and acronyms

APR	Asia and the Pacific Division
ARRI	Annual Report on Results and Impact
AWD	Alternate wetting and drying
CLE	Corporate-level Evaluation
ENRM	Environmental and natural resource management
ESA	Eastern and Southern Africa Division
FAO	Food and Agriculture Organization of the United Nations
FFS	Farmer field schools
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information and communication technology
IOE	Independent Office of Evaluation of IFAD
IPM	Integrated pest management
IRRI	International Rice Research Institute
IWM	Integrated weed management
LAC	Latin America and the Caribbean Division
NEN	Near East, North Africa and Europe Division
NGOs	Non-governmental organizations
NRM	Natural resource management
PAPSTA	Support Project for the Strategic Plan for the Transformation of Agriculture
POG	Pass-on the Gift
PPA	Project Performance Assessment
PPE	Project Performance Evaluation
SDG	Sustainable Development Goal
SHG	Self-help group
SRI	System of rice improvement
ToC	Theory of Change
VAHW	Village Animal Health Workers
WCA	Western and Central Africa Division
WFP	World Food Programme

Technical Innovations for Rural Poverty Reduction Evaluation Synthesis

I. Introduction

A. Background

1. This evaluation synthesis report looks at the support that IFAD has provided to technical innovation for rural poverty reduction in recent years.

2. The world is facing unprecedented global challenges that affect the sustainability of food and agriculture systems, and thus the livelihoods of millions of small scale farmers worldwide. These challenges include natural resource depletion and environmental degradation, an ever increasing world population, the effects of climate change and weak institutions, especially those that inhibit innovation. These global challenges pose serious threats to achieving the right to adequate food and the fundamental right of everyone to be free from hunger.

3. While efforts in the past centred on boosting agriculture to produce more food, today's focus is to tackle the root causes of hunger and malnutrition through transformative changes to our food system (FAO 2018).

4. Agricultural development demands and depends on functioning formal and informal innovation systems which generate effective technical and non-technical innovations. Innovation is a major source of improved productivity, competitiveness, and economic growth in advanced and emerging economies. Innovation also plays an important role in creating jobs, generating income, alleviating poverty, and driving social development. The challenges however imply that technology for development must go well beyond just raising yields to saving water and energy, reducing risk, improving product quality protecting the environment, and tailoring to gender differences (World Bank, 2008).

5. It is within this livelihood approach, and broader understanding of innovation, that this Evaluation Synthesis Report (ESR) analyses IFAD's work on technical innovation.

B. Synthesis objectives, key questions, scope, and definition

6. The focus of this synthesis is specifically on the operational part of IFAD's programme, and within this, on the programme/project level of interventions which have included innovative technical features. The (ESR) seeks to analyse what technical innovation consists of in IFAD's portfolio and what is known about the nature of interventions, their uptake, effectiveness and impact. The rationale behind this more narrow focus on IFAD's work on technical innovations is twofold. Firstly, the Corporate Level Evaluation (CLE) on Innovation and Capacity to Upscale (2010) found that "the Fund had paid more attention to innovative solutions in social engineering and institutional arrangements (e.g. promoting participatory approaches to planning and resource allocation) rather than agriculture". The ESR therefore addresses the need to take stock of IFAD's concrete experience in promoting technical innovations in order to learn what has worked and for whom. The analysis of the uptake of technical innovations can orient future innovation packages in a more effective way. Secondly, the Independent Office of Evaluation of IFAD (IOE) will conduct a CLE on Innovation and Productivity Growth for Inclusive and Sustainable Agriculture in 2019. The CLE will provide a wider assessment of IFAD's work on innovation and this ESR will serve as a building block for it.[1] While the focus of this ESR is on technical innovation, it fully recognizes that

[1] But the CLE will have a much broader scope and look at IFAD's role in: (i) strengthening internal capacity to identify innovations that respond to productivity; (ii) social and environmental constraints faced by rural people; (iii) incorporating and testing innovations within projects; (iv) learning from these innovations; and (v) scaling up successes

innovation is not just about technology, which on its own rarely works. Therefore enabling factors which included social, economic, institutional/organizational and policy processes are also assessed. Furthermore, most of the report focuses on direct agricultural poverty reduction with limited consideration of multipliers for non-farm employment, economic growth and poverty reduction as a consequence of effective technical innovation.

C. Objectives

7. The Synthesis focuses on learning more than on accountability. It derives its lessons primarily from existing evaluative evidence. The objectives are:

   a) to identify technical innovation practices and lessons learned about the potential for success and scaling up that can inform future IFAD interventions;

   b) to identify key factors enabling (or hindering) innovation, within the limitations of the available evaluative evidence.

8. The review of evaluations is guided by the following detailed review questions:

   a) Relevance: to what extent was the innovation pro-poor? How relevant were the innovation strategy and the choice of partners?
   b) Effectiveness: to what extent were the expected results achieved? Were associated financial, institutional and social interventions also innovative? In what ways has the innovation been scaled up? Which innovations worked and under what circumstances? What are the factors explaining success?
   c) Impact: what is the impact of the technical innovations on rural poverty?
   d) Sustainability: which practices and results have been sustainable? And what were the factors supporting sustainability?
   e) In addition IFAD specific criteria on scaling up, environment and natural resource management (NRM), and gender equality were applied.
   f) Lessons learned: what were the practices that worked (or did not) and what lessons can be learned from this

9. Scope. The timeframe covered by this ESR is 2010-2018. The analysis starts from 2010, following the completion of the CLE on IFAD's Capacity to promote Innovation (2010), which covered an analysis of 30 completed projects evaluated by IOE between 2004 and 2008. The projects evaluated during this period typically would have been designed 8-10 years earlier. Some data refers back to periods prior to 2010 (e.g. the Annual Report on Results and Impact [ARRI] ratings) in order to provide a historical perspective.

10. Definition of innovation. In the discussion of innovation theory and practice, this report recognizes that the concept of innovation has been clearly distinguished from research and invention in that innovation can and often does involve the dissemination of existing technologies in settings where they have not existed before. Schumpeter (1939) states that "innovation is possible without anything we should identify as invention, and invention does not necessarily induce innovation".

11. IFAD has adopted a broad definition of innovation. Its definition as per the 2007 innovation strategy is: "a process that adds value or solves a problem in new ways" thereby making the distinction between disseminating something new in a given context, not as something new in absolute terms The strategy further specifies that in order to qualify as an innovation, a product, idea, or approach needs to be 'new to its context, useful and cost-effective in relation to a goal, and be able to 'stick' after pilot testing".

12. More recent definitions have extended this to include "what is used and has resulted in substantial social and or economic benefit to the user" (FAO, 2014). In

for expanded and sustainable impact. It will also look at IFAD's role in supporting countries' efforts to scale up successful pro-poor rural development models, widen their geographical coverage and reach larger number of people.

short, innovation is not just a synonym for something new, but rather a process, product or arrangement that allows for new benefit when it is used. Recombination and use of existing knowledge may also classify as innovation.[2]

13. This Evaluation Synthesis Report has a more narrow focus, on technical innovations. In reality, however, many IFAD promoted innovations will be hybrids of technical innovation supported by complementary process and institutional innovations which enable or add impact to the technical innovation.[3] Farmer Field Schools is an example of such a hybrid as it is itself often an innovative way of working and can be used to introduce new agricultural practices and technical innovations.

14. A modified definition from the Inter-American Institute for Cooperation on Agriculture, adapted from the OECD 2005 Guidelines for Collecting and interpreting Innovation is therefore used for the purpose of this evaluation.

Box 1
A modified definition

> Technical innovation is the introduction of an idea, practice or object that is perceived by an individual or other entity as new or improved. It can involve inputs, products, productive processes, or complementary process and institutional innovations, e.g., in marketing, which accelerate adoption and magnify impact. Technical innovation means applying ideas, knowledge or practices that are new to a particular context with the purpose of creating positive change. Newness to context is a key feature as the innovation may be widely practiced elsewhere but new to a particular setting. Such change could be substantial (a large change or improvement) or cumulative (small changes that together produce a significant improvement). Some technical innovations might require complementary changes to institutional or social arrangements to facilitate their adoption and magnify their impact. Very often innovations are grouped or bundled, much less commonly promoted in isolation.

15. The emphasis on innovation being considered from the point of view of the individual, household or community decision maker is important. Where planned innovations have been widely adopted in other contexts, extension may be more akin to diffusion. Knowledge about their use means adopters face better-known risks. Other innovations may involve more untested features that need to be trialled and further developed. But both are innovative in their own context. This definition also provides more detail than the IFAD definition noting that changes can be substantial or cumulative and acknowledges that "soft" interventions such as institutional and social arrangements are at times needed to facilitate adoption of technical innovations and the degree of dependence on changes in social and institutional arrangements can be used to identify different classes of technical innovation.

16. This synthesis will use this definition of innovation as a conceptual framework but also point out aspects where greater clarity or focus is needed.[4]

D. Evidence base

17. IOE innovation ratings, in principle, provide a reflection of the effectiveness of project activities with regard to innovation. This synthesis has only used the ratings to a limited extent however, as the ratings until 2017 also covered scaling up, so do not only reflect performance on innovation and also they covered all types of innovations including the more process oriented innovations, which were not part of the focus of this synthesis.

18. Methodological approach. The methodological steps for this synthesis included the following: (1) review of relevant literature on innovations to elaborate the

[2] A more detailed description of innovation theory can be found in Annex IX.
[3] Interpreted in this way, the technical innovation (TI) concept would embrace three classes (1) sole TI or (2) TI + essential process and institutional innovation for effectiveness of the TI or (3) TI + optional complementary process and institutional innovation which magnifies impact of the TI.
[4] For a review of where IFAD stands in relation to partner and comparator agencies see Annex III.

theory of change and identification of the types of interventions included in the approach paper; (2) a review of IFAD background information on innovation; (3) screening of available evaluative evidence to determine the sample for review; (4) systematic review of the project sample; (5)case studies to identify and analyse successful innovation practices as well as those that failed; (6) developing a typology of innovation practices; (7) comparative analysis of innovation practices (including those from other organisations[5]); and finally (8) synthesizing findings according to IOE evaluation criteria (relevance, effectiveness, efficiency, impact and sustainability).

19. Sampling approach. The synthesis followed a progressive sampling approach to identify successful innovation practices for further in-depth analysis. As a first step, a total of 106 evaluation products were identified that had been conducted within the selected time frame (2010-2018). A rigorous screening process was conducted to assess the robustness of the evaluation findings with regards to innovation, which led to a final sample of 57 evaluation products. The screening criteria for selecting the sample were: (i) technical innovations described; (ii) reported on relevance, effectiveness, impact and sustainability outcome results that were achieved and how the results were achieved (by doing x, y and z); (iii) enabling and disabling factors described. The final sample of 57 evaluations included: 25 Country Strategy Programme Evaluations, 22 Project Performance Evaluations (PPE/PPA), 3 Impact Evaluations (IE), and 7 Evaluation Synthesis Reports (ESR). The list of sampled evaluations can be found in Annex IV. For referencing purposes, the evaluations were numbered. Whenever the synthesis refers to an evaluation, the reference number is reported in square brackets.

20. Review of innovation practice sample. The practices sampled were reviewed systematically using the Nvivo software. By applying the evaluation questions for this synthesis, data were coded and classified by innovation type (see Annex V). For each evaluation product, the relevant excerpts were collated in an Nvivo "memo" file and positive and negative examples were highlighted. A total of 50 memos were created and provided the basis for further analysis. The analysis of the ESRs was undertaken separately and was not captured in memos, as the framework questions were not applicable to the content of these products. Instead summaries of the sections of relevance to technical innovation were made.

21. Data cleaning and dataset creation. Upon completion of the data coding the data was further reviewed and cleaned. The innovations identified were then listed in an Excel dataset, which functioned as an innovation repository and allowed for quantitative analysis. This repository also allowed to identify areas where there was a sufficient body of evidence.

22. Case studies were used for an in-depth review of selected innovations. The four case studies aimed to cover a variety of innovations and explored in more depth the factors that enabled or hindered innovation, such as the country policies and institutional frameworks, and this was done through a review of a wider range of project documents and/or country analysis that could shed a light on relevant contextual issues.

23. Interviews with staff. Interviews with country programme managers and other key staff[6] were conducted to inform and discuss preliminary hypotheses before the drafting phase.

E. Limitations

24. Innovation is a dynamic field, a challenge has therefore been to assess innovations in such an evolving context. The prime source of information for a synthesis is the evidence found in independent evaluation reports. The scope of the

[5] An in-depth analysis of other IFIs approaches to innovation and benchmarking information is reported in Annex III.
[6] See Annex VI for a list of the key people met.

synthesis is therefore limited to those projects and grants that were covered in the evaluation reports.[7] The sample is not exhaustive of all IFAD's innovation activities and will not necessarily be able to comment widely on the interaction between types of funding and partnership arrangements, and uptake of innovations. The benefits on the other hand arise from drawing on standardised products using a common methodology, which brings confidence to the findings and conclusions. Another major limitation related to this is linked to the time lag between implementation and subsequent evaluation, which of course may exclude more recent advancements made in this area. For example the sample included few cases of Information and communication technology (ICT) related technical innovation or impacts of technical innovation on youth. Yet the ESR draws on 57 evaluations across all of IFAD's regions, which is by no means a small or restricted sample and can still shed light on patterns on innovation in IFAD's portfolio.

25. Another important limitation is the limited depth of the analysis included in IOE evaluations with regard to innovation. Not all innovations identified at the start of a project are systematically covered in the evaluation reports. Similarly, the process of dissemination, adoption and diffusion is not always explored in any depth, nor are the relationships with enabling factors such as social organisation, access to finance, provision of infrastructure and partnerships always evaluated in the context of technical innovation. And lastly, adoption is not always reported as an output indicator, nor are adoption statistics systematically reported for the initial uptake or wider promotion across the project area. Screening the quality of the available evidence helped identify those evaluations that include a sufficient analysis of innovation results as well as the underlying strategies. However, the available evidence inevitably put a limitation on the range and diversity of practices that could be reviewed by this synthesis and specifically meant the evaluation could not make a comparative analysis of factors enabling or hindering innovation, though the evidence that is available is presented.

26. A final limitation is related to the effort to isolate certain innovative practices from the rest of the project, with a view to determining the impact trail of technical innovations. In reality, many projects in IFAD are multi sectoral and specifically identified innovative activities are a small part of the project the success of innovations are dependent on multiple types of interventions. A challenge has therefore been to establish whether innovations did or did not lead to impact described in the reports. This challenge was addressed by only coding and reporting data where links between innovations and outputs or impacts were clearly stated.

F. Report structure

27. This report is organized in six chapters. After this introduction the context of innovation and IFAD's role within this is described (Chapter II). Chapter III describes the analytical framework for the synthesis including the typology and the ToC that guides the review throughout the subsequent chapters. The systematic review of technical innovations according to the applicable evaluation criteria (relevance, effectiveness, impact, sustainability and scaling up) is included in chapter IV. Chapter V presents good practices on technical innovations and key factors contributing to the success or failure of technical innovations and lessons learned and chapter VI gives conclusions and recommendations.

[7] As for the grants this is not considered a major obstacle as the CLE on Grant Policy found that only a fraction of grants for research were actually financing research.

Key points

- The synthesis focuses on IFAD's programme and project level interventions which have included innovative technical features for the period 2010 -2018.
- The working definition used for the synthesis is "the introduction of an idea, practice or object that is perceived by an individual or other entity as new or improved. It can involve inputs, products, productive processes, or marketing. It means applying ideas, knowledge or practices that are new to a particular context with the purpose of creating positive change". Some technical innovations might require complementary changes to institutional or social arrangements to facilitate their adoption and magnify their impact.
- The synthesis selected a sample of evaluation reports using a progressive sampling approach, which included initial screening of the available evidence as a first step. The final sample included 57 reports: 25 CSPEs, 22 project evaluations, 3 impact evaluations, and 7 evaluation synthesis reports.
- The synthesis used four standard evaluation criteria to review the technical innovation practices: relevance, effectiveness, impact and sustainability. In addition IFAD specific criteria on scaling up environment and NRM, and Gender were applied.
- The review questions are presented in Annex IV.

II. Corporate processes in support of innovation

A. IFAD's mandate and strategic focus

28. IFAD is the only international financial institution with a specific mandate to reduce rural poverty through investments in agriculture and rural development. It was established as an international financial institution in 1977 to mobilize resources to invest in development opportunities for poor rural people. The Fund works in close collaboration with borrowing country and local communities to design, supervise and assess country-led programmes and projects that support smallholders and poor rural producers.

29. From the outset, IFAD recognized that one of its primary advantages would be its ability to use its resources and institutional capacity to promote the funding and scaling up of activities through strong partnerships with cooperating institutions. Through these partnerships, the Fund expected to be able to leverage its own resources and promote a focus on increased food production and the reduction of rural poverty and hunger within the broader international development architecture. In other words, IFAD understood that it could play a catalytic role in agricultural development. This made IFAD unique as both a specialised UN agency and an international financial institution.[8]

30. Since the mid-1990s, IFAD has made concerted efforts to incorporate innovation into its key policy and strategy documents. The Strategic Framework 1998-2000 identified and highlighted innovative pilot projects and programmes in agricultural and rural development (agricultural production, microcredit, rural infrastructure, self-help groups, and land tenure) as the Fund's "core business". In line with recommendations of the 2002 Evaluation of IFAD's Capacity as a Promoter of Replicable Innovations in Cooperation with other Partners, senior management took decisions to ensure a strategic commitment to innovation supported by attempts to develop a culture of innovation through staff incentives and training.[9]

31. IFAD placed scaling up at the heart of its Strategic Framework 2002-2006 with the objectives of expanding, adapting and supporting successful policies and programmes and capturing knowledge. The Fund expected scaling up to leverage resources and partners in order to deliver greater results for a larger number of poor rural people in a sustainable way.

32. In 2004, IFAD introduced the Initiative for Mainstreaming Innovation (IMI) in an effort to explicitly focus on innovation and mainstream it in IFAD's processes. IMI was directed at building capacity to promote innovation by allocating funds for three types of activities: (i) special funds earmarked for organization-wide activities not appropriate for competitive funding; (ii) competitive funds to be used over a three-year period to finance innovative projects; and (iii) a small pilot funding facility to provide rapid funding for innovative action. The Independent External Evaluation (2005) reinforced the Fund's focus on innovation, and the Strategic Framework 2007-2010 emphasized "innovation, learning and scaling up" as one of the Fund's six principles of engagement. The process of innovation and scaling up was seen as central to the vision of IFAD's role, and all interventions within IFAD's country programmes were expected to be innovative.

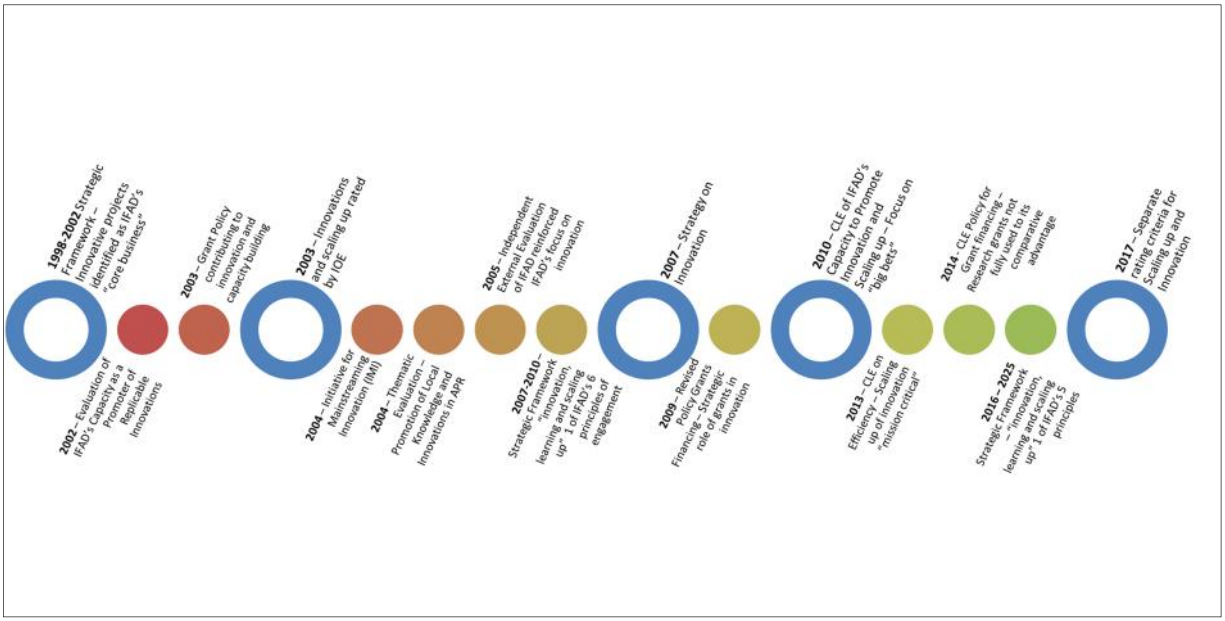
33. IFAD's Strategy on Innovation was developed in 2007. The strategy encourages innovation in practice, focusing on four clusters: i) building capabilities and understanding of challenges requiring innovation; ii) nurturing partnerships and facilitating an innovation network; iii) embedding rigorous innovation processes and the related risk management into IFAD's core business practices and; iv) facilitating a more supportive organisational environment for innovation.

[8] This synthesis has looked at the policies and evaluation findings of partner agencies to draw comparisons with IFAD. A short description and references can be found in Annex III.
[9] IFAD 2018. (Draft) IFAD 40 Years of Investing in the Rural Poor, page 10.

34. The revision of IFAD's Grant Policy in 2009 emphasized the strategic role of grants in innovation and, for the first time, provided an opportunity to involve the private sector in research and the piloting of innovations for replication and scaling up through investment projects. These principles were reaffirmed in the further revision of the policy in 2015.

35. The Strategic Framework 2016-2025 again emphasized the triad of innovation, learning and scaling up as one of five principles for engagement[10] in a way that is "bigger, better and smarter", IFAD aims to broaden successful pro-poor rural development models, widen their geographical coverage and reach larger numbers of people.[11] The Strategic Framework recognizes knowledge management and South-South and Triangular cooperation as key elements for the organization's development effectiveness and IFAD has subsequently developed a Knowledge Management Action Plan (2016-2018)[12] and defined its approach to South-South and Triangular Cooperation.

Figure 1
Time line on innovation in IFAD



Source: Prepared by IOE.

36. IFAD's role can be considered to be that predominantly of a matchmaker, and less as an entrepreneur. In other words, identifying a need, putting forward possible solutions from existing knowledge, sourcing partners for technical support and adaptation, and providing the necessary enabling support to create a conducive environment. This synthesis looks directly at IFAD's achievements in getting new technologies onto farmers' fields and ready for scaling up.

B. Innovation within the 2030 Agenda

37. Given its mandate to eradicate rural poverty and food insecurity, the focus of IFAD's work is on achieving the Sustainable Development Goal (SDG) 1 (eradicating extreme poverty) and SDG 2 (eradicating hunger). However, the interdependent nature of the SDGs means that goal 1 and 2 will not be achieved without contributing to the other SDGs. According to IFAD's Strategic Framework (2016-2025), in addition to SDG 1 and 2, IFAD contributes particularly to SDGs 5 (gender equality), 8 (decent work and economic growth), 10 (reduced inequalities), 13 (climate action) and 15 (life on land). Additionally, through its

[10] The four remaining principles are: targeting; empowerment, gender equality; and partnerships.
[11] IFAD 2016. Strategic Framework 2016-2025, page 20.
[12] Currently under revision.

work to foster inclusive, diversified and productive rural economies – including in the areas of agribusiness, and rural –urban linkages, IFAD's work also contributes to SDG 9 (industry, innovation and infrastructure) and 11 (sustainable cities and communities).

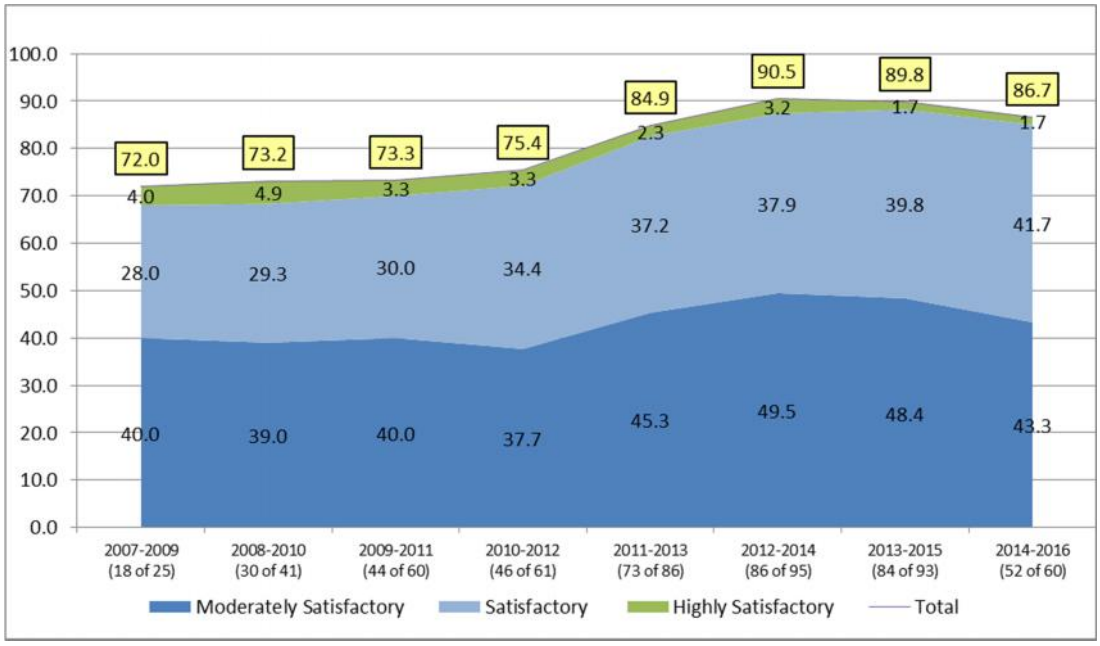
38. The 2030 Agenda recognizes innovation as a cross-cutting element in order to reorient the current unsustainable development trends. The agenda highlights in particular the potential of innovation in developing countries, aimed at fostering sustainable patterns of consumption and production and accelerating the achievement of the SDGs. Recognizing the importance of new technologies to accelerate the achievement of the SDGs, the UN Secretary General has recently developed a Strategy on New Technologies (2018).

C. IFAD Ratings

39. IOE innovation performance ratings. IOE has been rating innovation together with scaling up since 2003 but in 2010 an effort was made to devote deeper attention to assessing scaling up, given its importance in ensuring wider impact on rural poverty. Hence a number of specific questions were added to the IOE Evaluation Manual to better reflect scaling up. As a follow up to the recommendation of the ESR on scaling up IOE started rating innovation and scaling up separately in 2017.

40. As can be seen from the graph below IFAD's contribution to promoting innovation has been improving since 2009 but has slightly deteriorated since 2013 when looking at 3 year averages. It is important to note that this rating reflects both technical and non-technical innovation processes. In fact the majority of statements on innovations refer to the latter.

Figure 2
Innovation – by year of completion[13]
Percentage of projects rated moderately satisfactory or better by three year moving period (PCRV/PPE data)



Source: IOE evaluation database, March 2018.

41. From a regional perspective, the Eastern and Southern Africa Division (ESA) is the only region with good performance in innovation between 2014-2016 and 2013-2015. The Latin America and the Caribbean Division (LAC) and Western and

[13] In conducting trend analysis on the separated criteria, the 2018 ARRI assigns the rating given for the original combined criteria for past evaluations.

Central Africa Division (WCA) showed a double-digit decrease in percentage point for the same period (-11.9 and -14.1 respectively).

D. Recent IFAD evaluations with key innovation messages

42. The 2010 corporate-level evaluation on "IFAD's capacity to promote innovation and scaling up" revealed that the Fund had paid relatively more attention to (and found more success in) innovative solutions in social engineering and institutional arrangements (e.g. promoting participatory approaches to planning and resource allocation) rather than in agricultural practice. Furthermore, despite IFAD providing a fair amount of grant resources for agricultural research to develop innovative low-cost agricultural technologies that could lead to increased productivity and incomes, the result of such research did not easily find their way into investment projects.

43. IFAD's approach to the promotion of innovation was following a broad-based innovation approach, where innovation was pursued in a variety of different fields, without a clear focus on priority areas. While this approach allowed for the harnessing of the creativity and initiative of rural people and local partners, it failed to direct these energies where they were most likely to generate and support innovation. The CLE identified the need for a structured innovation agenda at the corporate level, with a more specific thematic focus. It further identified that the selection of these themes, also known as "big bets", should consider both the areas of agriculture and rural development that could benefit the most from innovative solutions, and those areas where IFAD had already a proven advantage in promoting pro-poor innovations.[14]

44. The Corporate Level Evaluation of Efficiency (2013) highlighted that in order to reach a higher share of projects that were "satisfactory or better", IFAD needed a sharper focus on testing and incubation of creative and innovative technological and institutional solutions to the myriad of problems faced by rural poor in order to become a global centre of excellence for smallholder agriculture.[15]

45. It went on to state that the innovation and scaling up-driven approach would require rethinking about the nature of the projects supported by IFAD and the way IFAD would judge its performance. Moreover, the evaluation found that in a successful country programme, the majority of projects would be those that "replicate, expand, modify, refine and adapt scalable innovations[16] over time with increasing levels of government and third-party financing but at the beginning of the cycle, where prototype testing was called for, there could be a need for smaller, simpler projects based on lighter preparation up front, but with greater support during implementation". This type of project would involve higher risks but also potentially high rewards and would require a cultural shift from risk avoidance to risk management.[17]

46. The 2014 Corporate Level Evaluation on IFAD's Policy for Grant Financing highlighted that IFAD grants were insufficiently used to pilot the implementation of potential innovations that, if successful, could be considered for scaling up in subsequent IFAD supported operations. It went on to state that "a potential source of technological innovation (agricultural research grants) is not fully used to its comparative strengths". In fact the CLE revealed that many research grants were funding micro-projects, where national research and extension agencies supported by IFAD loan-projects could have comparative advantages. Furthermore, there was

[14] IFAD 2010.Corporate Level Evaluation. IFAD's Capacity to Promote Innovation and Scaling up.
[15] IFAD 2013. IFAD's Institutional Efficiency and Efficiency of IFAD-funded Operations, page 15.
[16] The report's use of the term 'innovation' is more generic than the definition of innovation in the IFAD 2007 strategy and the interpretation in this ESR.
[17] Ibid.

also a limit to IFAD's absorption capacity of research results and knowledge further pointing to the need to better establish priorities.[18]

Key points

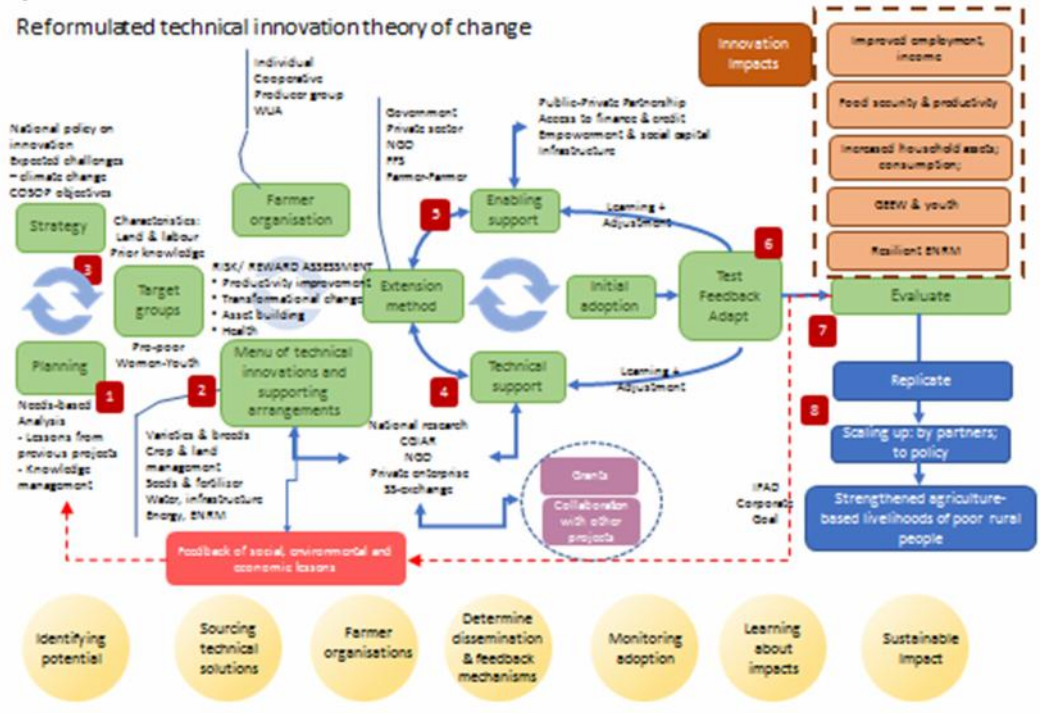
- IFAD has a long history of supporting innovation through its strategic frameworks and other policies (e.g. grants).
- The 2030 Agenda recognizes innovation as a cross-cutting element in order to reorient the current unsustainable development trends. The agenda highlights patterns of consumption and production.
- IOE performance ratings of innovation based on 3 year averages show an improvement since 2009 but a slight deterioration since 2013-2015.
- A key message from several evaluations on innovation and related issues emphasise that IFAD should prioritise and develop a structured innovation agenda at the corporate level with a more specific thematic focus.

III. Analytical framework

A. A revised theory of change

47. The analytical framework for this synthesis is developed around a theory of change and a typology of technical innovations. An initial theory of change was developed in the Approach Paper, derived from IFAD's 2007 Innovation Strategy and informed by IOE's 2002 and 2010 CLEs on capacity to promote innovation and scaling up. The findings in this synthesis have allowed us to reassess that model and put forward a ToC that reflects actual practice in Figure 3.

Figure 3



Source: Prepared by IOE.

48. The original theory reflected the literature on innovation by putting forward a model that envisaged a problem-solving cycle of interaction between farmers' needs and new technical solutions. In fact, technical solutions are rarely new, just new to that context.

[18] IFAD 2014. Corporate Level of Evaluation on IFAD Policy for Grant Financing, page 47.

49. Actual practice is more complicated with three distinct iterative cycles to identify the scope, plan the innovations and their dissemination, and provide a supportive framework. The change process for technical innovation involves a complex interaction of feedback loops, associated with the adjustment of the technical innovation during piloting, adaptation and learning. Whilst the dotted red line and red box highlights the main feedback loop, the blue arrows indicate interaction, learning and adjustment.

50. Interventions must meet farmers' needs but within the framework of national policies and expected challenges such as climate change. The COSOP might guide direction; lessons from previous projects and experience from IFAD's Knowledge Management help inform choice. Targeting is a process of adjustment, taking into account the people IFAD is trying to support, their assets and their existing knowledge. Followed by an assessment of the risks faced by the target group and the nature of change being introduced: to improve productivity; introduce a more transformational change; help build individual or community assets; or contribute to improving health.

51. Dissemination brings together the nature of the technical innovation, the preference or otherwise of working though farmer organisations and the method of extension and dissemination. Many innovations are promoted as part of a combination of practices. During implementation there is likely to be a need for continued technical support, which may require a partnership with a research organisation or the private sector. South-South exchange has fulfilled that role in some instances. Grants and direct collaboration with other projects are a way of sourcing that support. We will see how many innovations are enabled by access to finance and credit; others are dependent on infrastructure; some benefit from social support to empower participants. The timing of all support is important.

52. Far too many innovations are never properly evaluated by IFAD. Few projects report robust evidence for productivity and farm incomes. There are two desirable cycles here. One for rapid feedback during implementation so that technology can be modified and dissemination improved. Secondly, to generate convincing evidence for partners to pick up and scale up. There are examples where the innovation process takes the form of replicating from one setting to another, often before being scaled up by partners or incorporated in policy. But there is little evidence that this process is planned and predetermined. Opportunity appears to play a significant role.

53. Learning plays in important role in an effective process. Information from the economic, social and environmental outcomes is a consideration in the selection of technical innovations and is updated by early results from adoption and periodic evaluation. Evaluations need to assess the three decision cycles in this model: matching potential solutions to target groups; the selected implementation content and modalities; the adoption/adaptation practice and the fine tuning from learning.

54. All theories of change rest on assumptions. These are indicated as numbered red boxes in the diagram and discussed together with the model in Annex VIII.

B. Typology of technical innovation

55. All innovations found in the sample were examined and classified according to the extent to which they were targeted at poorer or better-off farmers[19]; their technical complexity, for which support services were in many cases an essential feature; and the extent to which their implementation required new knowledge through training and human capital development over and above their existing farm practice. This classification, based on available project documentation, informed

[19] Better-off does not imply wealthy farmers or those with high resource endowments. It is used comparatively to indicate less poor farmers who might have access to land or other capital assets that enables them to participate in some technical innovations that poorer farmers would not be able to.

the teams understanding of the nature of change each innovation was enabling and the relationships between technical innovation and process or institutional innovation.

56. A change typology was identified with four parts which are explained in the following paragraphs and illustrated in Table 1 below.

    a. Productivity enhancement
    b. Transformative change
    c. Asset strengthening
    d. Beneficiary health enhancement

57. Productivity enhancement – innovations that improve returns to land, labour and capital by incremental changes to the farm business, including for forestry and fisheries. This category embraces development interventions that improve performance without radical or transformative changes to the system and reflects perhaps the most common examples of agricultural development. They are relatively low risk.

58. Transformative change – innovations that bring a major change to farming system structure and function by introducing new enterprises or radically different ways of farming and post-harvest. Although the techniques might be well known in other settings, the nature of the change means they could be higher risk for the participating households. Some innovations might be productivity enhancing in some settings, but transformative if the beneficiaries have never experienced them before or if their adoption removes a critical resource constraint such as access to land, labour availability, technical knowledge or specialist support.

59. Asset strengthening – innovations that change capital assets and thereby affect the resources available to the family or participating entity (such as a self-help group [SHG]) and perhaps enable productivity change.

60. Beneficiary health enhancing – Innovations aimed at reducing drudgery, both at domestic and production level (e.g. drinking water pitchers, ergonomically designed agricultural tools), and improve beneficiaries' health.

61. It has been argued that poor smallholders have mainly five strategies for escaping poverty which they mix and blend (1) intensification by increased productivity of existing livelihood pattern (2) diversification from new crops, trees, fish, livestock or value adding activities which is represented by transformative change in our typology (3) growth of operated farm or herd size (4) increased off-farm income and (5) exit from farming (larger farmers use the same 5 strategies to increase income). Technical innovations align with one or more of these strategies.[20]

[20] See also Dixon Gulliver Gibbon 2001 Farming Systems and Poverty or Dixon Garrity Boffa et al 2019 Farming Systems and Food Security for Africa: priorities for science and policy under global change.

62.

Table 1
Attributes of Change

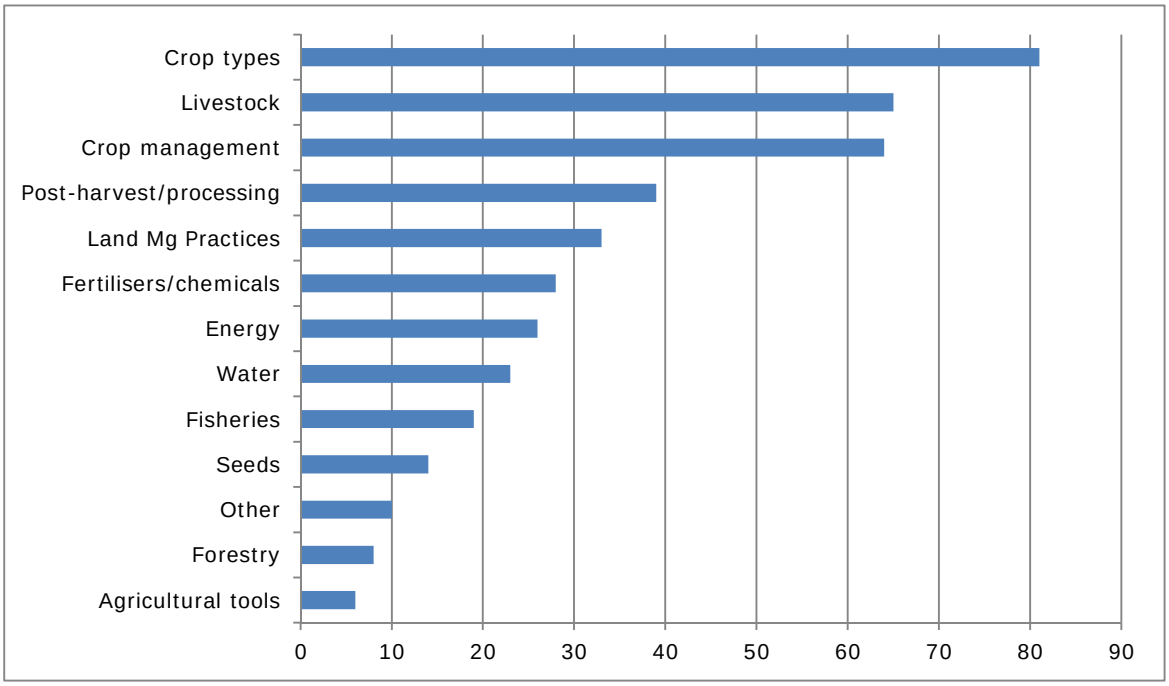
Productivity enhancement	*Transformative change*	*Asset strengthening*	*Health enhancing*
Improved crop varieties	New crop types	Fencing	AWD for reduced arsenic contamination
Organic fertilisers	Bee keeping	Watershed protection	
Fodder preservation and processing	Sericulture	Soil improvement	Ergonomically designed agricultural tools
Water saving techniques	Alternate Wetting and Drying (AWD)	Perennial and tree crop creation	
Improved crop management	Crop processing plants	Fisheries navigation equipment	Light-weight pitchers for drinking water collection
System of rice improvement (SRI)	New product processing	Improved boat building	
Animal vaccination	Previously unexplored value chain activities	Aquaculture ponds	Improved firewood sources
Rice huskers	Solar power	Farm mechanisation	
Home gardening	Biogas	Greenhouses	
Compost preparation	Drip irrigation		
	Rainwater harvesting		

Source: Prepared by IOE.

63. A total of 416 technical innovations were identified through the review[21]. From the analysis, crop types (81), livestock (65), and crop management (64) were the three where most innovations were found (see Figure 4). Figure 5

[21] The ESR used 13 categories of intervention to classify the innovations see Annex V.

Figure 4
Number of interventions per technical innovation



Source: Prepared by IOE.

Key points

- The conceptual framework for this synthesis is captured in a theory of change (ToC) presenting IFAD's pathway to innovation.
- The ESR worked with 13 categories of technical and enabling interventions
- Within the sample of 57 evaluations, the synthesis identified 416 innovative interventions. Most of the innovations were identified for three groupings crop types, livestock and crop management.
- A change framework was identified with four parts: productivity enhancement; transformative change; asset strengthening; health enhancing.

IV. Synthesis findings

64. This chapter presents findings on technical innovation according to the applicable evaluation criteria (relevance, effectiveness, impact, sustainability and scaling up). The focus of the relevance section (A) is on the poverty relevance of the innovations and the relevance of the choice of partners. The effectiveness section (B) describes the types of innovations identified according to groupings of interventions, it reviews the achieved results and analyses some of the key enabling factors. The impact section (C) is structured around five aspects of impact: household incomes and assets; food security and productivity; natural resource management and climate change; gender and youth and human and social capital. In section (D) sustainability of the technical innovations are discussed and the final section (E) reviews the innovations according to the IFAD specific criterion on scaling up.

A. Relevance of innovation strategies

65. This section reviews the relevance of technical innovations according to three evaluation questions: (i) relevance of poverty targeting; (ii) relevance of choice of partners; and (iii) relevance of grants.

Poverty relevance

66. Targeting is one of IFAD's principles of engagement and is central to its mandate of rural poverty reduction. Evidence suggests that strengthening targeting strategies is important for raising overall performance. Targeting is not only defined by the choice of the beneficiaries and achieved by ensuring delivery of benefits, but is also embedded (intentionally or unintentionally) in the choice of the benefits and the underlying assumptions about the context. Table 2 summarises the extent to which different interventions were specifically targeted.

Table 2
Targeting of innovation according to type of innovation

Type of Innovation	***Targeting***				***No. of***	
	None or not known	Better-off	Poor	Women	innovations	
Crop types	67%	12%	19%	1%	81	100%
Livestock	40%	34%	15%	9%	65	100%
Crop management	58%	20%	16%	3%	64	100%
Post-harvest/ processing	67%	10%	3%	18%	39	100%
Land Mg Practices	70%	18%	6%	6%	33	100%
Fertilisers/chemicals	57%	14%	21%	7%	28	100%
Energy	31%	31%	0%	38%	26	100%
Water	61%	13%	13%	13%	23	100%
Fisheries	47%	42%	11%	0%	19	100%
Seeds	57%	7%	36%	0%	14	100%
Other	80%	10%	10%	0%	10	100%
Forestry	51%	25%	25%	0%	8	100%
Agricultural tools	33%	0%	0%	67%	6	100%
Weighted average	56%	20%	14%	9%	416	100%
Number of innovations	233	82	57	37		

Source: prepared by IOE; rows may not sum to 100 per cent owing to rounding.

67. Although with many interventions, the documentation was not sufficiently clear to categorise targeting, the observations do highlight several strong trends:

- Most innovations are not specifically targeted (56 per cent) beyond the choice of location or participating farmers in the project design.
- Among the most frequently implemented innovations, crop types, livestock and crop management, an appreciable proportion were directly targeted at poor farmers.
- Whilst some innovations are clearly only more suitable for better-off farmers (particularly those requiring access to land) overall, innovations are geared towards the 'average' farming household, neither very poor nor better-off.
- Few innovations, less than 10 per cent in most categories, are targeted specifically towards women (and almost none towards youth).
- Statistics on adoption are inconsistent across projects and often missing. But from the available evidence targeting of the poor for crop types and seeds, and of better-off farmers for livestock was associated with good uptake. The nature of innovations for post-harvest/processing, energy and agricultural tools led to some targeting of women and successful adoption.
- Evidence about adoption of targeted land management and fertilisers/chemicals is unclear as those innovations tend to be interlinked with other crop or livestock technologies and not reported separately.

68. Positive examples of technical innovations directly benefiting poor farmers were identified in five cases [01, 04,37,20,57]. In Bangladesh IFAD enhanced practices in freshwater fisheries and aquaculture that improved the culture of small fish (Mola) which was major source of protein for poor men and women [01]. Another project in Bangladesh provided research on farming system technologies, with a particular focus on reducing damage to human health and agricultural contamination from arsenic contamination of rice crops [01].

69. In Sri Lanka the project focus shifted from subsistence agriculture to gradually align itself to changes in the country context and enabled the support of higher profit activities that were of relevance to poor and disadvantaged communities. In particular, the project sharpened its focus on: i) higher value crops and livestock products; ii) linkages to processing and marketing channels within existing value chains (e.g. milk, fruits and vegetable and technology for seed multiplication (potato and onion) [35].

70. The importance of getting targeting right in livestock projects was highlighted [01, 10, 23, 59, 49]. 40 per cent livestock innovations were not specifically targeted and 34 per cent targeted the better-off. Some projects pointed to the relevance of small ruminants and livestock for targeting the poor [10, 37]. In Bangladesh the targeted poor were trained in improved management of poultry and livestock, which contributed to the adoption of improved technologies (e.g. mini hatchery) and practices such as vaccination and deworming [37]. In Gambia poultry business were specifically targeted at young women who traditionally hold at least a few small ruminants but only part of the businesses were profitable [10].

71. In Uganda [23] positive impacts on household incomes were attributed to small livestock support and roads but mainly these were seen for the "not so poor". In Vietnam while animal raising led to income increases, new animal breeds did not particularly address the needs of ethnic minorities despite them being one of the main target groups [59]. In Laos [49] the project should have focused more on small ruminants (poultry and goats) because not all beneficiaries could afford cattle or buffaloes.

72. Lack of access to land can exclude vulnerable groups, and in particular women [05, 09, 12, 42]. In Jordan land ownership was a prerequisite for being eligible for Soil and Water Conservation project subsidies. However, most of the poor (under US$2 per day) were not landowners. The project was therefore

inherently unsuitable for reaching the poor and in particular women and youth who were to be specifically targeted [12]. In Ethiopia affordable irrigation technologies benefited people who owned land, thus leaving out landless people (particularly women) and even potentially creating conflicts with those groups [09]. In Cameroon the production area increased slightly but the extension of crops (irrigated rice and onion) was constrained by access to land, which affected especially women and young people [05].

73. Innovations targeted at indigenous communities need to be tailored to the context [19, 47, 49]. In India improved jhum (shifting culture) farming was relevant as 86 per cent of the total population were tribal and poverty was prevalent among those households which were dependent on jhum and facing increasing marginalisation due to continuous decline in jhum yields [47]. In Laos the trainings and technologies geared towards cattle and pigs were not tailored to the diversity of the geographic areas and the social contexts of the various ethnic minorities who would have preferred goats and poultry. Although women and ethnic minorities were identified for training, language barriers and the limited follow up constrained the internalization and uptake of new practices and benefits accrued largely to better-off farmers and those with prior livestock experience. Although the evaluation reports do not mention it, the question of opportunity cost to the poor for taking part in training and other events can be a significant factor in limiting the attractiveness of innovative technology to poor people.

74. Sometimes self-targeting resulted in exclusion of the intended beneficiaries [43, 45, 49]. In Cambodia livelihood income groups did not always include the poorest families as intended. For example, some criteria such as ‘willingness to use modern agriculture technologies’, ‘possession of some land’ thus being active farmers, de facto excluded the poorest (including the landless) [43]. In DR Congo the self-targeting did not ensure the inclusion of particularly vulnerable groups [45].

B. Partnerships

75. Partnerships are particularly important in three different contexts. Firstly, where research is needed to adapt a variety to suit local conditions, or to develop a variety to tackle a local problem such as salinization or disease. Secondly to establish a process to produce quality seeds. Thirdly, for marketing or processing for sale.

76. Research partnerships mainly supported the introduction of new or improved crops [1, 4, 5, 7, 16, 19, 24, 33, 35, 45, 46, 48] and seed production [35, 45]. The most frequent partners identified were national or governmental research institutes, in charge of developing new crop varieties [5, 7, 16, 19, 35, 45, 48, 54]. In Mozambique [16], improved cassava varieties were introduced in collaboration with the Mozambique Institute for Agricultural Research (IIAM). Similarly, in DR Congo [45], the National Institute for Agricultural Studies and Research (INERA) provided the initial batch of improved crop varieties and healthy cassava cuttings. However, weak capacities of INERA provincial branches combined with late involvement in the project and other factors affected the quality and quantity of seeds provided. In Vietnam [24] IFAD partnered with Can Tho University to develop salt-tolerant rice varieties, in collaboration with agricultural development offices at the district and provincial level.

77. In a number of cases, partnerships involved international research institutes, such as the CGIAR Research Centres working with national partners [1, 4, 15, 19, 33]. In Nigeria [19], IFAD developed a successful partnership with the International Institute of Tropical Agriculture (IITA) and the Nigerian National Root Crops (NNRC), developing higher-yielding and disease-resistant varieties of cassava. In Bangladesh [1], the International Rice Research Institute (IRRI) received two grants supporting the introduction of AWD for

reduced arsenic contamination and climate-resilient rice varieties. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) was involved both in Nigeria [19], for the development of new technologies for dryland agriculture, and in Mali [15], where it provided adapted varieties of sweet sorghum and improved jatropha seeds. In India [33], a partnership with ICRISAT was established to promote the introduction of new crop types. The partnership with ICRISAT and similar organizations did not evolve into a long-term arrangement and was limited to project implementation.

78. Private companies supported in particular cash crops and product processing [7, 15, 23, 25, 35, 48]. In Mali [15], improved jathropa and adapted varieties of sorghum were introduced to feed biofuel production, with the aim of increasing production and farmers' incomes. The cultivation was supported by a partnership with Mali Biocarburant, a biodiesel producer. Similarly, in Uganda [23], the production of oil palm as a cash crop was supported by the private sector for oil palm, considered by IFAD its second-most important partner in the country. Oil palm plantations were also introduced in Cameroon [7], through a tripartite agreement between IFAD's project PAPAKIN, village communities and the private company Huilerie – Plantations – Élevage du Kwilu (HPEK). The involvement of private actors in Laos [48] proved to be key in the promotion of cash crops, such as coffee and asparagus, which in turn contributed to increasing farmers' incomes.

79. The adoption of new and improved animal husbandry techniques as well as of a new beef processing system in Zambia [25] was enabled by a public-private partnership. Similarly, improvements to the dairy farming system were introduced in Sri Lanka [35] through a public-private partnership with private sector companies and governmental departments. Private and state-owned enterprises provided chilling technologies and co-financed the construction of processing and collection centres for agricultural and dairy products, which enhanced linkages between farmers and private firms, interested in entering rural areas to supply the urban demand for dairy products.

Box 2
Partnership with WFP in Rwanda [57]

During the second phase of the Support Project for the Strategic Plan for the Transformation of Agriculture (PAPSTA), marketing support activities were put in place to support innovations in the livestock and agricultural intensification fields. These include a partnership with WFP within the scope of the Purchase for Progress (P4P) framework, allowing rice and maize cooperatives to supply WFP with their surplus production. A second partnership with WFP was established to support soil conservation activities (e.g. digging and maintenance of the anti-erosion ditches), rewarded with food supplies within the Food for work programme. This activity fostered the involvement of the poorest, often landless households, that could not benefit from the livestock distribution scheme.

Grants

80. Seventeen of the evaluations reviewed for this synthesis have reported some contribution from grant funded activities towards technical innovation. Some reporting is inconsistent because regional grants often cover several countries and it is not always possible to identify benefits to any one in particular because they do not link to a loan project. Although evaluation reports do not treat grants in a consistent and detailed way, the diversity of ways in which grants make a valuable contribution to technical innovation can be seen. Seven aspects can be identified.

81. Direct technical development of a potential innovation [12, 14]. In Jordan [12] screening of a large number of forage crops was carried out by the National Centre for Agricultural Research and Extension (NCARE) under a grant to ICBA, and a number of salt-tolerant species and cultivars were selected, although the evaluation criticised weak linkages with the loan projects. Similarly, in Madagascar [14], high-yielding rice varieties were developed through a grant to IRRI.

82. Participatory and pilot initiatives to develop new systems and enterprises [17]. In Nepal [17], a grant supported pilot initiatives to develop new systems. The ICRISAT grant (2001-2008) promoted ''Farmer Participatory Improvement of Grain Legumes in Rainfed Asi" (ICRISAT, 2001-2008). Also within the scope of the Debt Sustainability Framework (DSF), a second grant of US$199,992 was allocated to the Dutch NGO SNV for the implementation of High Value Agriculture Inclusive Business Pilot Project. The pilot in particular focused on organic apple production, as well as vegetable seeds and chiuri.

83. Dissemination and South-South collaboration [14, 17]. In Madagascar [14], a grant to IMAWESA/ICRISAT allowed for SRI to be further promoted by farmers in other countries (Rwanda and Burundi). Similarly, in Nepal [17], a grant supported the development and transfer of technologies for smallholder bamboo and rattan producers from Asia to Africa (INBAR/IDRC, 1996-2000).

84. Value chain development [7, 15, 19]. Grants were used to support value chain across Africa. In Nigeria [19], a grant identified new uses and marketing options beyond the national market to increase competitiveness of the cassava sector in Nigeria. Similarly, in DR Congo [7], a grant was jointly implemented by Africa Rice and INERA to strengthen rice value chains in West and Central Africa. Biofuel chains for the poorest were developed in Mali [15] through a specific grant, aimed at linking the poor to world markets.

85. Grant co-financing [59]. In Vietnam [59] 3PAD was the first project to have mobilized grant co-financing from GEF. The GEF grant implementation was fully integrated within 3PAD. The GEF resources primarily financed technical assistance, training, studies and services in order to supplement the planned 3PAD activities. It financed innovative environmental pilots, community-based forest management and biodiversity conservation planning, environmental training for PMU staff, technical support on environmental aspects of the project, including environmental monitoring, as well as some PMU expenses for operational travel.

86. Knowledge management and dissemination [4, 6, 17]. Two grants were awarded in Nepal [17] to CGIAR Centres and other research institutes. IRRI and CIMMYT developed a "Multistakeholder Programme to accelerate Technology Adoption to Improve Rural Livelihoods in the Rainfed Gangetic Plains", while ICRISAT fostered the "Programme for Harnessing the True Potential of Legumes: Economic and Knowledge Empowerment of Poor Farmers in Rain fed Areas in Asia". By the same token, in Cambodia [4] there are examples of grants reported as facilitating knowledge management and contributing to innovations and improved effectiveness in investment projects. In China [6], PROCASUR strengthened knowledge on innovative solutions using the learning routes methodology in Asia and the Pacific.

87. Energy efficiency [8, 41]. Climate-smart practices, such as photovoltaic energy for pumping, bio-gas and solar dryers have been promoted in the new lands of Egypt [8] through an Adaptation for Smallholder Agriculture Programme grant. Similarly, in Brazil [41] an IFAD grant in the amount of US$0.5 million was used to promote clean energies.

Key points

- Most innovations are not specifically targeted, although there are significant examples where innovations were directed to poorer farmers and communities and to women.
- Whilst some innovations are clearly only more suitable for better-off farmers (particularly those requiring access to land) overall, innovations are geared towards the 'average' farming household, neither very poor nor better-off. Research partnerships (with national and international research centres) mainly supported the introduction of new or improved crops. Partnerships with the CGIAR can catalyse important innovations, but often the partnership is confined to the project duration and does not evolve into long-term partnerships.
- Partnerships with the private sector focus on introduction of cash crops and product processing.
- A third of the evaluations reviewed make reference to grants funded activities towards technical innovation. Grants play an important role in support of technical innovations and were used to deliver a diverse set of activities for technical development, piloting, dissemination and knowledge management. IFAD processes are rarely identified as significant contributory factors to innovation. The importance of how IFAD supports innovations is neglected in most evaluations. Only 21 evaluations commented on the importance of IFAD processes and of these the majority (15) identified complementary grants as the critical feature. Active policy dialogue and technical support during supervisions were both mentioned but only in a few instances. The contribution from wider issues such as fostering partnership working and promoting lessons learning and knowledge management are neglected areas of investigation.

C. Effectiveness of innovations

88. This chapter presents the main findings from the analysis of our sample. Under effectiveness we have analysed the evidence according to the technical interventions identified with a focus on the ones where most evidence was found. With effectiveness we have looked for positive and negative patterns, as well as underlying factors influencing why certain results were achieved or not.

89. There is considerable overlap of innovations per country. Most projects promote multiple innovations, only a few focus on one or two innovations. A little over half of all projects and country evaluations identify between 6 and 10 innovations and three CSPEs each identified more than 15 technical innovations. Multiple innovations bring synergies across the technical innovations, address major elements of farming systems, and reduce portfolio risk.

90. Most innovations occur in packages. Innovations involving crop management and crop types occur together in 51 per cent of all the evaluations and as either one or the other in a further 22 per cent. Innovations involving livestock are typically accompanied by innovations on crops and land management. 21 of the 32 evaluations with livestock innovations also have innovations with crop management, and of the 11, seven were associated with crop type innovations.

91. The following section summarises the innovations highlighted with positive findings in the evaluations, identified according to the technical interventions. It is divided into two parts. First, we treat the most frequently occurring technologies namely crop types (81 innovations), livestock (65 innovations) and crop management (64 innovations). As crop management and crop types are interlinked they are presented in sequenced order. In this first part we discuss dissemination, input supply, credit, infrastructure, private sector and value chain context for the three types. In the second part we describe the less frequently occurring typologies of seeds, post-harvest and processing, land management, fertilisers and chemicals, water and energy. The section ends with a brief overview of three infrequently occurring classes of innovation for fisheries, forestry and agricultural tools.

92. Table 3 summarises the key features found in the sample concerning the extent to which the innovation brought more complex technical change and the demands on new knowledge for adopters.

Table 3

Innovation type	*High-tech Innovation*	*New knowledge*	*No. of innovations*	
Crop types	0%	36%	81	100%
Livestock	25%	57%	65	100%
Crop management	33%	69%	64	100%
Post-harvest/processing	49%	79%	39	100%
Land Mg Practices	3%	42%	33	100%
Fertilizers/chemicals	21%	61%	28	100%
Energy	77%	62%	26	100%
Water	48%	61%	23	100%
Fisheries	68%	79%	19	100%
Seeds	14%	79%	14	100%
Other	20%	70%	10	100%
Forestry	25%	75%	8	100%
Agricultural tools	50%	50%	6	100%
Grand Total	28%	59%	416	100%
Number of innovations	116	244		

Source: Prepared by IOE.

93. For many interventions the documentation was not sufficiently clear to categorise technical complexity and knowledge requirements in detail, but the observations do highlight several strong trends:

- With the exceptions of fisheries innovations which are quite specialised, energy and the small number of agricultural tools, most innovations are found to be of a low technical complexity, which indicates farmers are not being offered risky changes to their farming practices.
- Low input, low tech is often a factor in successful uptake. The sample included both positive and negative examples of uptake of technical innovations. Some common denominators for positive uptake included low-cost, low input, and low tech, accompanied by appropriate extension and enabling factors such as access to water and land.
- Most innovations in almost all categories except crop types and land management have a requirement for new knowledge and skills.

These findings are discussed in the sections below.

Crop Types

94. “Crop types” was the category of intervention with most innovations. In total 81 innovations were found in 30 countries, across IFAD’s five geographical regions. The majority of innovations were related to the introduction of new or improved varieties of locally-grown crops (36). Additionally, 14 innovations referred specifically to the introduction of new or improved varieties of rice (both rice-focused and mixed crop interventions). In 31 instances, the innovations were related to crop diversification, as in the introduction of crops new to the local context.

95. The new or improved local varieties included: roots, bulbs and tubers; tree crops; field crops; fodder crops; biofuels and high value crops and vegetables. For both new and improved locally grown varieties as well as the rice focused interventions

the characteristics of the introduced technologies were the following: culinary or physical characteristics (e.g. fragrance), field performance/production characteristics (e.g. high yielding/short duration), abiotic stress tolerance/climate-smart varieties, biotic stress tolerance.

96. All introductions of new crop varieties, including rice, constituted incremental enhancements to the productivity of locally grown crops as the type of change that was to be engendered in the production systems.

97. For the innovations introduced with the aim of diversifying crop production the range of crop types introduced included: vegetable species, cash crops, field crops, roots and tubers and various perennials. All introductions of new crop types constituted transformational changes, in that they provided new income streams to farmers, diversifying farming systems and incorporating high-value cash crops in several cases.

98. There was little targeting of crop type innovations. Around one in three innovative crop types were specifically targeted to households. Among productivity-enhancing innovations, 16 per cent were directed towards poorer farmers and 8 per cent towards the better-off. For transformative change involving diversification of farming enterprises, 22 per cent were targeted at poorer farmers and 19 per cent at the better-off. Change for the better-off tended to emphasize diversification of production rather than improving varieties. All examples of innovation with crop types were assessed as being of low technical change, but four out of every five transformative innovations required new knowledge among farmers. Productivity-enhancing change was overwhelmingly seen to require little new knowledge for cultivation, but that does not imply that farmers would necessarily be able to achieve the full potential of higher yields or better marketing without additional support.

99. Positive outcomes were reported in 16 cases [01, 04, 05, 07, 08, 10, 11, 12, 16, 19, 23, 39, 46, 47, 54, 59] although some productivity targets were not achieved [22, 08]. In Cameroon, the introduction of short-duration, high yielding cassava and onions (as well as rice) was considered to be effective [05]. In Ghana, a total of 96,413 farmers (exceeding the target by more than 50 per cent) received improved planting materials for high-yielding and disease-resistant cassava, yam, cocoyam and sweet potato and uptake of these varieties was described as massive, with large increases in yields and boosting production and productivity [11]. In Mozambique [38], climate-smart cassava varieties contributed to expanding cassava production and increasing productivity [16]. In Egypt, a shift was accomplished from 3-4 cereal and fodder crops to over 20 field crops, vegetables and fruits with the diversification leading to increased productivity levels, which in turn contributed to a notable influx of new residents into the area [46] which was part of the overall project goal. In India, Napier grass production was adopted beyond the original intended beneficiary group, as it was important in reducing the drudgery of women as well as boosting milk production and household income [47].

100. However, in Tanzania, achievements were below target with regard to the adoption of improved seeds for maize, rice and beans (lower than 85 per cent) as well as corresponding productivity gains [22].

101. Cash crops feature in some innovations [13, 20, 23, 48, 59]. In Kenya the projects' consciously promoted cash crops (e.g. tissue culture bananas, productive pineapple) and cash-yielding animal products (e.g. improved dairy goat)[13]. However, in the case of cash crop development in Rwanda, small landholders were left vulnerable until coffee trees and tea bushes come into production [20].

102. Farmer to farmer approaches was the most prominent mechanism for disseminating technologies. Different farmer to farmer approaches were

promoted in a number of projects [11, 21, 04, 35, 42]. In Ghana [11] technology transfer was promoted through farmers' field fora (an upgraded version of the Farmer Field School concept) and helped generate substantial yield increases for disease resistant roots and tubers [11]. In Cambodia an emphasis was put on group formation and establishing farmer systems improvement (FSI) groups and other farmer to farmer approaches. Whilst this method had some diffusion within individual projects [42] overall, weaknesses in the training and extension approach led to lower than expected adoption of the innovation. In Sri Lanka [35] the Farmer field schools (FFS) approach was used to expose smallholder farmers to new techniques in onion cultivation practices and crop varieties such as turmeric and ginger, ground nuts and fruit trees (e.g. mango, papaya). The FFS approach was highlighted as an enabling factor for promoting the technical innovations but was also critiqued for running the risk of slowing onset of results.

103. Use of national or local extension bureaus was found beneficial but resource constraints and implementation arrangements affected the relationship [06, 36, 21, 54]. In China, partnerships with local agricultural bureaus proved to be very effective instruments for the introduction and dissemination of new products and technologies, often by means of demonstration plots [06]. In Azerbaijan, responsibility for agricultural extension was outsourced to Guba Regional Agricultural Research Centre (GRASC), a well-staffed but under-resourced research and development station of Ministry of Agriculture [36]. In Morocco the partnership with the National Institute for Agricultural Research on activities to support the provincial Agricultural Departments technical service in setting up trial crops was challenging. Difficulties were linked to a lack of control over financial resources by the national institute and ensuring timely allocation of funds [54].

104. Infrastructure, both irrigation and roads, was a crucial enabling factor for introducing technical innovations [23, 43, 58, 54, 48]. Gains in agricultural productivity were driven by adoption of improved rice varieties and increased use of fertilizer, irrigation and cultural practices. The construction of canals for wet season supplementary irrigation in Cambodia encouraged farmers to adopt improved (but more capital-intensive) techniques and thereby boosted productivity further [43]. In Vietnam [58], with project support, the newly paved or retrofitted village roads made a significant contribution to improving market access. This along with other newly-built small-scale infrastructure, such as improved irrigation enabled famers to grow higher-value products including seasonal vegetables, soybeans and new livestock breeds. In Laos [48], better access roads for the coffee produced (cash crop) reduced transaction costs for commercialization and facilitated access to markets.

105. Value chains and Public Private Partnerships play a distinct role in disseminating technologies [23, 48, 21]. In Uganda, the introduction of oil palm as a cash crop, was the first successful example of a major public private partnership in its agricultural sector. Besides introducing a new cash crop to the country, the project's operational model was assessed as a pro-poor innovation because of its built-in mechanism of protecting farmers' interest and supporting an equitable relationship between the small holders and private companies. In that sense, the PPP was an essential element to support the technical innovation. The PPP approach involved central and local governments, private sector partners and farmers organisations. It was a comprehensive approach, addressing also infrastructure constraints (e.g. ferry connection) and it was based on contracts. While time consuming and challenging, once setup they provided a solid foundation for integration and development [23]. In Laos the involvement of the private sector in promotion of cash crops had a direct beneficial effect on income. Some challenges were that crop types were introduced through direct contract farming with a public private partnership approach where private sector companies were

providing inputs such as seeds, fertilisers, extension services and outlets to farmers. This meant that farmers remained dependent on traders for market information, input supply and sales of produce, to the extent that they had to accept prices and in several cases were forced to pay double the price for inputs provided on credit through the farming contract system [48].

106. Understanding markets and buyers is necessary to ensure production can be marketed at a fair price [16, 48, 17]. In Mozambique, climate smart cassava varieties increased production of cassava but as the production increased at a much faster pace than the market could absorb the price of cassava decreased. Whilst the design had identified several market opportunities for the cassava-based products (e.g. chips for animal feed, ethanol, flour supply to mobile processing units linked to the national brewery industry) the farmers were forced to sell their products to a Dutch company which enjoyed a monopoly and paid a low price [16].

Crop management

107. As with the innovations for crop types, innovations in crop management were not introduced in isolation but rather were linked to crop types, seeds, fertilisers and water. Crop management innovations were introduced through 64 interventions in 28 countries, across five regions. The highest number were related to a diverse range of improved crop cultivation techniques, often without details of the crops to which they were applied, but notably for vegetables, fruit trees and forage crops (27), followed by rice cultivation techniques (14), mostly referring to SRI. Due to these innovations being grouped results for the crop management aspect are less frequently reported on compared to other associated innovations such as the crop types and livestock. Also, input supply, credit and infrastructure were not prominent features of the issues raised and are therefore not covered in this section.

108. All innovative crop production methods were aimed at incrementing productivity. 58 per cent of innovations dealing with crop management were not targeted. There are some interesting examples of higher technology innovations such as greenhouse cultivation being targeted towards better-off families but there are few observations to identify a clear trend. Improvements to crop management mostly have quite a high requirement for new knowledge even though two thirds are changes with a low technical complexity.

109. Improved crop cultivation techniques were introduced in 21 countries, across five regions. The range of crops involved included vegetables, roots and tubers, maize and fodder crops. Specific management practices included mulching, seedling nurseries, crop establishment and spacing, timing of planting, and harvesting.

110. Results on the benefits of cultivation were only documented in a few cases [04, 08,15]: e.g., improved cassava production methods in Cambodia [04] were adopted by around 40 per cent of farmers and increasing yields and incomes were noted, to which this activity contributed. In Egypt [08], only 10 per cent of project beneficiaries took up new crop cultivation techniques. In Mali [15], 712 ha of bourgou (hippo grass) plains were regenerated and 1,628 ha re-started.

111. Improved rice cultivation techniques were introduced through 14 interventions. Focus was on SRI (11 projects) and included: transplanting of seedlings, improved variety use, use of compost and soil nutrient management. Other rice production techniques promoted were weed management and crop establishment.

112. Results on improved rice cultivation were mostly positive [33, 42, 47, 57, 42,): several reports described SRI as a successful innovation that was gaining popularity among farmers (33, 42 ,47, 57), leading to notable adoption levels and being a driver of increased productivity and income [33]. In Cambodia [42], SRI was among the technologies with the most successful adoption rates. Yet, other

reports indicated mixed adoption rates for different elements of SRI [4 Cambodia], or low levels of adoption altogether [48], as well as dis-adoption in one case [14]. The main constraint to implementing transplanting in lieu of broadcasting was noted to be the heavy workload this method required, and in one instance the widely spaced planting of single seedlings was found to be inappropriate to local conditions where snails and insects damaged many plants, resulting in empty spots and lower yield.

113. South-South Cooperation was effective for knowledge transfer in the few cases it was reported [20, 52]. In Rwanda, training and study tours were organized to increase knowledge on SRI for project stakeholders and beneficiaries on SRI imported from Madagascar [20]. In Mauritania, exchange visits with households living in adjacent Morocco fostered the introduction of new agricultural techniques into market gardening practices used in oases. Impacts were observed on women's attitudes and social position, culinary recipes based on locally available products, market gardening, income-generating activities and crafts) as well as on diversification of meals and an improvement in the diet of households and children in particular [52].

114. Crop diversification and off-season varieties were taken up in settings where value addition and better linkages to markets were ensured [01, 17, 35, 40, 47]. In Bangladesh [01], new practices for more intensive farming on small plots were enabled by linking to market demand for off-season vegetables and a wider market variety. In Bhutan [40], crop diversification, particularly for vegetables (off season) contributed to increased productivity. Specifically, off-season vegetables, early chilli cultivation, upland paddy, intercropping with citrus and cultivation of organic buckwheat contributed to increasing productivity from the same or smaller land area.

Key points

- IFAD's innovations are stimulating change from traditional staples to cash crops, roots and tubers, vegetables, beverage crops and fruits. The introduction of new crops to diversify production is a transformative change, with a higher risk to growers. These innovations are found in over 30 examples across 17 countries.
- Diversification can benefit the family diet but more often the aim is for cash crops to generate new income. In these cases the links to processing and markets becomes more critical.
- A number of examples have shown how IFAD has been able to support farmers' interests and achieve an equitable relationship between farmers and buyers, but in other instances farmers have been at a disadvantage. Being able to organise farmers and provide access to market information is a vital element of good design.
- Innovations in crop types and crop management were directed broadly towards all farmers; most innovations aimed at increasing productivity; most were low-tech; both classes found farmer to farmer dissemination to be effective.
- Improved crop varieties and some new crop types were effectively targeted at poorer households; neither were technically complex.

Livestock

115. Innovations related to livestock were introduced through 65 interventions in 30 countries, across IFAD's five geographical regions. The majority of innovations were related to livestock breeding (20) which was introduced in 15 countries across 4 regions. Animal health and nutrition (13) and small animal husbandry (7)[22] were other prominent innovations which were implemented in 13 countries across 5 regions. These innovations focused on vaccinations and de-worming, multi-nutrient and mineral blocks and other animal health and cow rearing practices. Under small

[22] [1] Additionally, technologies were identified for bee/silk production (6), general husbandry (6), poultry husbandry (5), housing (30 feeding 93), intensification n (10, Dairy (1)(60, Dairy; feeding; general livestock husbandry; housing intensification and poultry husbandry.

husbandry, innovations included improved management of small ruminants and improved production methods (piggery, goat rearing, duck). All but one of the technologies introduced fall under the cluster on productivity enhancement.

116. Most livestock innovations were targeted, with 15 per cent towards poorer farmers and 9 per cent women. But the main targeting (34 per cent) was towards better-off families. Where information was reported, two thirds of innovations involved a low technical scale of change, such as improved feeding or animal housing with just a third being more complex, mainly dealing with animal health interventions or breeding, especially the use of Artificial Insemination. Many innovations dealt with changes in productivity and required little in the way of new knowledge, but more than half involved farmers in the acquisition of new knowledge. Transformative change more often involved higher technologies where a positive result is more sensitive to factors such as dosage, or the timing of a treatment.

117. Introduction of new breeds and artificial insemination, both higher technology, highlight more negative examples than positive [13, 20, 10, 22, 54, 59, 37, 36]. Kenya and Rwanda stand out as positive examples. In Kenya [13] the introduction of the German Alpine and Toggenburg dairy goat breeds made a big difference to the previous low levels of productivity. In Rwanda [20] the introduction of exotic breeds of dairy cows and artificial insemination increased milk production seven times over since the year 2000.

118. However, in Gambia, Kafos (local village groups) supplied their own female animals as part of their contribution, whilst the project supplied improved male breeds but many farmers reported issues. Some had sold one or more of the rams provided by the project due to aggression and lack of separation of the males from females. This meant that controlled breeding was still not being realised. Introduction of improved cockerels also took place but complete replacement of local varieties was rarely achieved [10]. In Tanzania, achievements were below targets despite inputs being subsidized under a voucher scheme [22]. In Vietnam, new animal breeds were too expensive for poor households [59]. In Bangladesh [37], adoption levels were low.

119. Results on animal health and nutrition are sparse but results on vaccination and deworming are generally positive [04, 10, 12, 37,49, 54,]. In Laos [49], the project complemented the government's own initiative to promote vaccinations. In Cambodia [4], vaccination had the highest adoption rate among a number of innovations. In Bangladesh [37] the project introduced de-worming of cattle with a 28 per cent adoption rate against 16 per cent in the control group. Deworming was one of several higher technology innovations introduced and was adopted together with Artificial Insemination while other technologies were not. Introduction of multi-nutrient and mineral blocks in Gambia [10] improved knowledge and practices but adoption was slow.

120. Training local people was an effective way to deliver decentralized animal health services [20, 43, 46, 49, 58]. In Cambodia [43], using village animal health workers (VAHWs) was a successful approach to privatising extension services in the villages, although the target number of extension events was not achieved. The most frequent services were pig, then cattle/buffalo treatment followed by vaccination of cattle and pigs and important gains in productivity were made (more than 50 per cent for 26 500 farmers). The VAHWs were located where services were required, and thus delivered effectively and efficiently. The advantage of their proximity to service users was that access to knowledge was local, the feedback loop was short, and response was quick. In addition, the use of local people as agricultural service providers built local capacity, grew local leadership, localised agricultural extension services and promoted private sector development. The establishment of VAHWs was particularly successful because

they were working on a fee for service basis. In Vietnam the department of Animal Health trained one village animal health worker for each project village. Access to animal treatments services increased by 562 per cent.

121. Cooperatives and farmer federations were established and used to channel innovations with mostly positive results [20, 21, 33, 35, 41, 54]. In Senegal [21], gathering of pastoralists into pastoral units was used as a channel for introducing livestock management innovations. The pastoral units achieved autonomy and provided essential services to members, defending their interests and promoting the participation of women and youth in community decisions and activities. In Morocco the grass root development associations created for income generating activities did not work as a group and were often characterised by action and strategies for the benefit of individuals [54].

122. The importance of training and provision of veterinary care was a frequent issue [13, 25, 49, 37, 57, 20]. In Kenya [13], it was acknowledged that the improved genetic stock required proper management if it was to demonstrate its potential. All projects therefore had invested in knowledge transfer, awareness-building, training and coaching of farmers, men and women alike. In Rwanda [57] veterinary services were provided for high quality breed livestock (the organisation of veterinary care through para-vets).

123. Innovative distribution schemes had mixed results [57, 50]. In Rwanda [57], a project distributed high-quality breed livestock using a revolving credit-in-kind system, known as Pass on the Gift (POG). This system was organized through community groups and producers' associations, following specific eligibility criteria for selecting beneficiaries based on their physical and financial capacity to establish required facilities (such as forage and cattle sheds). POG schemes for livestock (mainly cows for land holder of more than ½ ha, goats for land holders with less than ½ ha) aimed to establish a solidarity chain in the community. The economic situation of the households that had received a cow significantly improved. The construction of milk collection centres and support to cooperatives in marketing milk greatly improved the cash incomes of the participating households (noting that some markets were more reliable than others). The households that had a too small plot of land to feed a cow (under ½ ha) had received small livestock (goats, pigs, rabbits). The latter group's cash income also improved but not to the same degree as that of the former group. The POG system worked well and is now a well-established practice in Rwanda.

124. In Lesotho [50], a similar system did not work. While the principle was sound, there were problems with the sequencing of training and distribution, and record keeping by farmers, which led to low numbers of additional farmers who would benefit from improved livestock production as a result of the scheme.

125. Livestock innovations were enabled by essential provision of credit in some instances. [37, 58, 35, 54]. In Bangladesh [37], microcredits focused on the livestock and poultry sector and led to the introduction of vaccinations, deworming and mini hatcheries. The credit plus training approach adopted not only gave the targeted poor access to loan funds but also to skill development training improving their knowledge and giving them exposure to improved production technologies and practices, new information and linking them with service providers and markets. In Morocco [54], income generating activities were created through micro credits and included beekeeping, sheep and goat production as well as use of aromatic and medicinal plants. The best results were obtained with livestock production activities (goats and sheep). In Sri Lanka [35], dairy farming innovations were enabled by way of (i) (innovative) self-finance investments, (ii) co-financing by private firms, (iii) revolving beneficiary funds. The establishment of revolving funds by beneficiaries was a crucial factor in sustaining dairy societies.

However, subsidised credit was assessed to be inefficient as it led to credit rationing for profitable pursuits (notably dairy farming).

126. Infrastructure was also an enabling factor for livestock technologies [50, 20, 35, 36]. In Rwanda [20], the distribution of cows was complemented by support for building a stable and planting of fodder grasses and trees. In Sri Lanka [35] dairy farming innovations were enabled by construction of processing and collection centres for produce, including dairy co-financed by the private sector. In Azerbaijan [36] irrigation infrastructure coupled with cattle genetic improvement, bee keeping and agricultural extension led to significant production benefits for small farmers and showed strong potential for meeting the need to improve the food security and income of small farmers.

127. Linkages with private companies fostered value chain development of processing and marketing [35, 25, 49]. The dairy societies [35] empowered farmers to undertake negotiations with the private sector by increasing the confidence of their members, increasing their bargaining position in relation to buying price and conditions (i.e. milk protein and fat content-based pricing). The private sector co-financed equipment and construction of processing and collection centres for agricultural and dairy produce. Many private sector operators in Zambia were showing genuine interest in working with small farmers, and the government had manifested its commitment to bringing on board all players in the agricultural sector, including the private sector and civil society, but the enabling policy environment for public-private partnerships was not fully supportive and there was some level of distrust and lack of effective mechanisms to build good working relationships between private and public sector value chain actors [25].

Key points

- In contrast to crop types and crop management, livestock innovations were more clearly targeted and many of those directed towards the better-off involved higher technical complexity.
- For livestock, the enabling environment was particularly important in respect of the use of cooperative or other farmer organisations, provision of credit, infrastructure and empowerment of local people through training to provide local health services.
- Livestock interventions need comprehensive packages of technical support. The large number of innovations linked to livestock indicates how important this sub-sector is. But the evaluations also show the challenges faced.
- The most common interventions were for improved breeds and breeding. Few have succeeded, unable to take hold due to a variety of reasons including cost and procurement problems. The thriving experience in Rwanda (see case study in Annex II) is an exception.
- Interventions on animal health and productivity have been more successful. A combination of the need for careful targeting of participating farmers, working through cooperatives and farmer federations, links to veterinary support, intensity of the intervention to affect a real genetic change in the population and complementary interventions in nutrition, infrastructure and credit are necessary factors. Village animal health workers in Cambodia illustrate the benefits from a localised service created by training local people.
- Vaccination programmes were often unsustainable [49]. Problems arise from a lack of linkages with public animal health system and livestock providers. It can be hard to improve breeds at scale owing to the number of males needed, a problem faced in Lesotho [50]. More often, livestock improvements were seen as less relevant to poorer households (Vietnam [58]).
- In the few interventions dealing with milk production, links with the private sector provided opportunities for co-finance and partnerships. Apart from small stock and enterprises such as bee keeping, transformative livestock investments were often less appropriate for poorer households
- Issues documented highlight the importance of investing in enabling factors to facilitate technical change and to ensure new introductions are appropriate culturally and for the established diet [33].

128. The following section covers the nine remaining typologies which were less frequent and less standardised.

Seeds

129. Innovations related to seeds were introduced through 14 interventions in 10 countries, across four regions. The main innovations fall under two clusters: certified/quality seeds (production and use) (8) and seed/tuber multiplication (6).

130. Seed multiplication constituted a transformational change, as it provided farmers with a new source of income. Certified/quality seeds were introduced for the following crops: rice, groundnut, cowpea, maize, peanut, mung bean and cassava resistant cultivars. Among the eight innovations identified within this cluster, five were related to the production of certified/quality seeds, which represented a new income stream for the few beneficiaries able to participate, promoting a transformative change. Another three innovations were related to the actual use of certified seeds, which fostered productivity and allowed farmers to sell their products at higher prices. Innovative hydroponic technologies for seed multiplication were introduced for potato, onion, acacia, and hybrid spiny bitter gourd crops.

131. Most examples of improved quality seeds were of low technical complexity and in a few instances were targeted towards poorer families. The more innovative seed multiplication such as hydroponics, was more demanding technically.

132. Adoption levels and outcomes were documented in a limited number of instances. In Bangladesh [38], improved rice seed production was coupled with the Maria model for rice seed preservation, and was employed by 25 534 farmers to store rice seeds. In Mali [15], more than 700 producers were engaged in quality seed production, meeting the local demand. In Sri Lanka [35], eight farmers invested in greenhouses for hydroponics production.

133. However, there were some issues for example in DR Congo [45], where seed recovery, as part of the seed multiplication process, was not effective. This was due to unreliable supply of seeds and delays which affected the innovation outcomes. In Pakistan [56], the multiplication of quality seeds was introduced through a contract grower arrangement. However, collection and grading for re-supply failed. Most seeds went untraced or consumed locally.

134. Partnerships with research institutes were important for availability and quality seed production [07, 39, 21, 35, 19, 15]. Seeds were provided by national research institutes (e.g. Bangladesh Institute of Nuclear Agriculture), which were highly relevant for the adoption of the innovation. However, there were some issues for example in Nigeria [19] where the introduction of certified seeds was constrained by non-availability and high-cost of inputs.

Post-harvest and processing

135. Post-harvest and processing innovations were introduced through 39 interventions in 22 countries, across 5 regions. The majority of innovations identified in this field were clustered as improved methods for post-harvest and processing (23) or tools/equipment (14). Two single innovations were identified as improved management and storage (on farm grain/bean storage). Most of the innovations were productivity enhancing (22) followed by transforming (16). Only one was considered asset enhancing.

136. Interventions were knowledge intensive, with four out of five requiring new knowledge and half being considered to involve higher technical change.

137. Some positive results were reported [10, 14, 20, 22, 25, 48]. For example, in Ghana cassava processing equipment was slowly starting to yield positive results. In Rwanda better prices were obtained from quality improvement in the cultivation

of tea, improved processing techniques and increased blending and packaging within [20]. In Madagascar [14] the importance of introducing improved post production technologies in combination with better irrigation systems were highlighted as a reason for the enhanced rice production.

138. Post-harvest equipment was introduced at very limited scale with subsequent limited effects [5, 7, 40, 54]. In Cameroon [5] the quantity of processing equipment was limited, and the quality was sometimes low. In Congo 40 rice huskers were introduced but outputs were weak and thus their effects were limited [07]. Post-harvest equipment was introduced at limited scale in Bhutan with varying success [40]. In Morocco outputs were more positive but the scale was still very limited. Two crushing units and six fixed threshers were introduced which have helped improve the quality of finished agricultural products, notably olive oil and wheat [54].

139. Support to value chains were the focus of some examples but results with processing equipment are mixed [21, 54, 41]. In Senegal [21], the combination of training and product processing, and a value-chain approach, led to good results. In Morocco [54], the oil extraction equipment for walnuts and aromatic and medicinal plants not only improved the quality of agricultural products but also increased the professionalism of farmers. These are important achievements, but it should be noted that the impact of this machinery and processing equipment did not achieve a substantial increase in beneficiaries' income.

140. Infrastructure was sometimes built without adequate building specifications and was of low quality [23, 25]. In Uganda, the building in which the maize mill and the coffee huller was supposed to be housed was unsuitable (no physical separation of raw material inflows from finished products outflows, inter alia). In Zambia [25], honey cottages among other infrastructure were found to be of poor quality.

Land management

141. 19 instances of innovative land management practices were identified across 17 countries in five regions and mostly relate to soil fertility, and erosion control such as, gully management, infiltration ditches, forage based conservation and live fencing. The introduction of technologies related to land management was always associated with crop or livestock and therefore cross cutting issues are covered as part of the analysis of those sections. A large minority of land management interventions brought a need for new knowledge, such as for pasture and grazing management, and nearly one in five were assessed to be geared more towards better-off farmers owing to land ownership requirements.

142. Few results were reported for soil fertility [07, 08] and erosion control [02, 57]. In Congo, the introduction of the Mukuna velvet bean as a cover plant in the rotation cycle had a beneficial effect on the fertility of savannah soils through the improvement of soil texture through burial which can help limit pressure on gallery forests (7). In Egypt, incomes increased through in part the use of legumes for soil improvement (other reasons were savings of fertilisers and water, and higher productivity of the new crop varieties) [08]. In Rwanda [57], SWC intervention promoted by PAPSTA included a package of activities: constructing full and half terraces, anti-erosion ditches/cut-off drains and soil bunding. In Bolivia, contour tillage, crest infiltration ditches and gully control were complementing traditional soil conservation techniques. But the goal of an area covered by new techniques on plantation, improvement and soil management practices was only partially achieved [02].

Fertilisers and chemicals

143. This synthesis identified 28 instances of innovative fertilisers and chemicals across 15 countries in five regions. Eight fall under the categorisation on fertiliser use efficiency (fertiliser use management tools, introduction of fertilizers e.g. fodder improvement for cows -phosphate fertilisation of fodder), 10 under organic fertilisers (e.g. improved soil fertility)) and 10 on Pest Management/Weed Management including Integrated Pest Management and Integrated Weed Management (e.g. biological plant protection, biological repellent to animals, palm tree management practices. All of the examples fall under the typology of productivity enhancement. Some 21 per cent were more technically advanced; most innovations were low tech but with a high level of new knowledge.

144. Innovative techniques to improve fertiliser efficiency were reported from Bangladesh. In Bangladesh [38], the use of leaf colour charts (LCC) resulted in a reduction in the quantity of urea applied by about 20 per cent as well as an increase in grain yield by 8 per cent. This was due to optimal application. 400 applicator machines were introduced and training was provided to overcome constraints of manual labour-intensive application.

145. All organic fertilisers innovations involved composting and included: a) introduction of new composting techniques e.g. vermicomposting and use of composting and animal manure, and b) promoting improved compost use. Most composting activities involved provision of training and demonstrations [22, 42, 43, 58].

146. Use of Integrated Pest Management and Integrated Weed Management (IPM/IWM) has reduced chemical inputs and lowered costs. IPM/IWM was promoted across different projects [01, 02, 06, 11, 18]. In China [06], the introduction of integrated pest management practices in Ningxia and Shanxi provinces reduced the use of chemicals to a minimum, achieving a reduction in non-point source pollution. In Bangladesh [01], pheromone traps were introduced as part of a package of five low-cost and low-risk technical innovations, as part of a micro-credit project. This simple technology was an environmentally-friendly and low-cost substitute for insecticide, used to reduce pesticide use in vegetable cultivation. By the end of the project, 461 field demonstrations were organized and 28,000 traps were distributed to the beneficiaries with approximately 1,435 farmers using this technology. Farmers reported a 50 per cent saving in costs for insecticide at the same time, production increased by 25 per cent (estimated) In Mozambique [16], a diamond black moth (DBM) biological control technology was piloted and showed promising results in terms of DBM reduction.

Water

147. Water-related innovations were introduced through 23 interventions in 12 countries, across five regions. Most of the innovations were on drip irrigation followed by water harvesting and small-scale irrigation. All except one were associated with innovations for crop management and crop types. The majority of the innovations were productivity enhancing (13). Seven were transformative, two relate to health and one to assets.

148. There is little evidence of any explicit targeting in these interventions. But about half were relatively high tech and most involved new knowledge about water harvesting and management of delivery.

149. Positive results were reported on drip irrigation, water harvesting and small-scale irrigation [01, 08, 09, 12, 16, 41, 46, 47]. In Egypt [46], a combined use of rural finance and extension to promote drip irrigation for field crops and vegetables (e.g. maize, potatoes) and fruit trees (e.g. oranges) was effective. Substantial efforts went into converting moveable sprinklers to fixed sprinkler and drip systems. By project completion 15263,64 ha (65 per cent of the

primary project area) were converted to drip and fixed sprinkler systems. Farmers reported that 90-95 per cent of them had converted to drip irrigation. The technology was relatively low cost and materials seemed to be readily available and the farmers saw an immediate advantage and so were motivated to use it. In Jordan [12] improved water harvesting techniques (specifically the modified Vallerani mechanized system[23]) was introduced to demonstrate improved water-harvesting techniques, cropping systems and instruments in micro-catchments for high fodder shrubs and fruit tree production. The results of the demonstrated improved water harvesting techniques in Jordan were adopted by the Environmental Compensation Unit (ECU) of Jordan, initiated and supported by the United Nation Compensation Committee (UNCC). Higher rates of return for barley were recorded with the improved water harvesting techniques compared with planting barely with traditional pits. Less progress was made in integrating results into policy requirements for the Badia development and restauration [12]. In Ethiopia, affordable small-scale irrigation technology focused on manual pumps and spate irrigation and has resulted in increased production for field crops and vegetables in home gardens [09].

150. In India [47], improved light-weight pitchers for drinking water collection was part of a broader range of drudgery-reduction activities employed to significantly free up women's time. The effectiveness of the light-weight water pitcher vastly exceeded the original expectations of the project. The project "demonstrated" this technology to just over 1,900 household eventually finding that it had been adopted by well over 12,000 households.

Energy

151. Innovations that promoted sustainable energy use were introduced through 26 interventions in 13 countries, across five regions.

152. The main innovations fall under four clusters: biogas technology (9), a combination of biogas and renewable energy sources (2), efficient stoves (8) and renewable energy sources (solar/wind) (7). Most of the technologies introduced promoted a transformative change (17), some technologies were introduced with the aim of reducing firewood use and were thus asset strengthening (8). There were two instances where the technology qualified as drudgery reducing technology fostering health improvements among the beneficiaries.

153. Only 26 out of more than 400 innovations dealt with alternative energy, an indication that these are not seen as mainstream interventions in IFAD. Yet, energy innovations are an area where some visible targeting towards women was evident, especially for energy generation and more efficient stoves. A little under 80 per cent of the innovations were assessed by the ESR as being of higher technical complexity.

154. Use of biogas has the potential to reduce firewood consumption and improve health. Two thirds of the interventions related to biogas reported positive impacts on NRM, fostering adaptation to climate change, reduction of fossil fuels and environmental conservation [01, 09, 10, 41, 57]. In Bangladesh [01] for example, the use of biogas units saved approximately 1.5 – 2 T fuel wood per year. India [33] represents an exception in terms of diffusion of the innovation, as the promotion of biogas had a very limited uptake among farmers, who continued to rely on fuel wood as their primary source of energy. This constrained the forest conservation efforts pursued by the project. In Brazil [41], bio-digesters[24] were introduced in combination with improved stoves as drudgery-reduction technologies, specifically targeting women. A positive impact on women health was

[23] The Vallerani mechanised system consists of a special tractor-pulled plow that automatically constructs water harvesting catchments ideally suited for large-scale reclamation work.
[24] Biogas and bio-digesters are used interchangeably in the sample of evaluations and are therefore discussed together in this section.

registered in Rwanda [57], where the use of bio-digesters represented a solution to the problem of smoke in kitchen without chimneys, when burning firewood. In Ethiopia there was a high uptake of bio-digesters, with the construction of 21 biogas plants (700 per cent compared to the initial target). However, the functioning of these plants relied on the re-use of animal manure. This limited the involvement of female-headed households, who often did not own a big herd and were therefore lacking the manure required [09].

155. While the majority of biogas interventions were introduced at the household level, there are two instances [8, 56] where the biogas technology was introduced in combination with other renewable energy sources both at the household and village level.

156. The introduction of improved stoves impacted positively on women and NRM. The innovation reduced drudgery among women, reduced smoke in the kitchen and fostered better hygiene and living conditions [9, 57]. In the case of Bolivia [02], 56 per cent of the interviewees also reported improved nutrition. The introduction of improved stoves, often coupled with bio-digesters (5 instances), had a positive impact on natural resource management. For example in Vietnam [59], the use of improved stoves reduced firewood consumption by 30 per cent. In Ethiopia energy-saving stoves was coupled with two other technical innovations (solar pumps and home gardening) with the aim of fostering small-scale irrigation. The project introduced 3,581 fuel-efficient stoves, achieving 81 per cent of the initial target, with positive outcomes in terms of climate resilience and drudgery-reduction. The stoves were adapted to the local context and made suitable for preparing injera, the main staple food in the highlands [9].

157. Use of renewable energy sources had limited outreach [10, 33, 07]. Solar pumps in Gambia [10] reported a slow diffusion and the use of solar energy in India [33] registered low outreach, which affected the environmental impacts of the innovation. In DR Congo, solar pumps were not fully adopted nor maintained, given the high operating costs for the beneficiaries, combined with the required maintenance of photovoltaic panels and change of batteries. In this regard, hand pumps proved to be more suitable for the beneficiaries' needs.

158. A number of other technologies were identified in fisheries (19), forestry (8), and agricultural tools (6).

159. Fisheries. Innovations related to fisheries were implemented through 19 interventions in 9 countries, across 4 geographical regions. The technical innovations identified were clustered into three domains: fish cultivation and aquaculture (12), boat construction (4) and fishing equipment (3). Positive results were reported in four countries.

Box 3
Introduction of innovations in artisanal fisheries of Mozambique

In Mozambique [16] despite the successful training of fishermen, the adoption of ice production at markets and navigation equipment was constrained by a delay in the establishment of appropriate financial services (e.g. transfers, credits and incentives), which prevented the beneficiaries from accessing the technologies through credit. In particular, the use of ice as a conservation measure was hampered by the lack of financial instruments to support first investments in cool storage facilities. Beneficiaries, who had not traditionally used ice as a conservation practice, were initially hesitant and had limited funds to invest. Moreover, ice production and storage facilities were dependant on public electricity grids, which were not widely available in remote areas of the coasts. The project contributed to the construction of some grids to supply first sale markets in Zalala, Zambezia [34].

160. Forestry. The ESR identified eight examples of innovations related to forestry across five countries in four regions. Three were of agro forestry, two were on

forest resource harvesting, and two on forest nurseries and tree planting. Three fall within the cluster of transformative and 5 within asset enhancing. The Agro forestry projects covered domestication of new agro-forestry species for food security [5]; diversification of agroforestry parks for sustainable exploitation [15] and sustainable forest protection /intensive mixed agroforestry systems (hedgerows) [59]. Two innovations in Zambia were identified on forest resource harvesting covering non-timber forest products (e.g. mushrooms) and bamboo and rattan production. Examples of forest nurseries and tree planting were identified in Bolivia [2] and Vietnam [24].

161. Agricultural tools. Agricultural tools were introduced through 6 interventions in 4 countries [02, 40, 45, 47], across 3 regions. Two of the technologies introduced targeted productivity enhancement, whereas three of them strengthened the beneficiaries' assets. One tool was specifically introduced to reduce drudgery among women, promoting health improvements. The technologies included both agricultural tools, such as camelid shearing machines and ergonomically designed tools for drudgery reduction [02, 45, 47, 40].

Innovation typology

162. The review of innovations has highlighted the issues of technical change and knowledge. Table 4 summarises the nature of change that is evident in the innovations. Productivity enhancing innovations outweigh transformational change by a factor of two to one and together they account for 85 per cent of all the innovations reviewed. Half of both the productivity and transformational changes are associated with low tech innovations, but 40 per cent of the transformational are high tech, double the proportion for productivity. Changes to farm assets endowment and to family health are associated mainly with more specialised innovations such as land management, forestry, energy and fisheries. They are few in number and their application is specific to their context.

Table 4
Characteristics of innovation

Innovation type	*Productivity*	*Transformation*	*Assets*	*Health*	*%*	*Grand Total*
Crop types	60%	40%	0%	0%	100%	81
Livestock	85%	14%	2%	0%	100%	65
Crop management	86%	5%	9%	0%	100%	64
Post-harvest/processing	56%	41%	3%	0%	100%	39
Land Mg Practices	3%	9%	88%	0%	100%	33
Fertilisers/chemicals	100%	0%	0%	0%	100%	28
Energy	0%	65%	31%	4%	100%	26
Water	57%	30%	4%	9%	100%	23
Fisheries	26%	47%	26%	0%	100%	19
Seeds	29%	71%	0%	0%	100%	14
Other	10%	80%	10%	0%	100%	10
Forestry	0%	38%	63%	0%	100%	8
Agricultural tools	33%	0%	50%	17%	100%	6
Grand Total	235	117	60	4	100%	416

Source: prepared by IOE.

163. The preponderance of productivity change and low technology is a defining feature of IFAD's portfolio. It confirms a logical and practical approach to widespread incremental change which tends to be more inclusive and often less environmentally damaging. It is also logical from an integrated farming systems perspective. Further details are explored in the next chapter.

Key Points

- Most innovations are not targeted but targeted efforts for women have been made with introduction of technologies on energy, water and livestock.
- Most of the technical innovations are in fact low tech and seek to enhance productivity rather than transform the farm. Most innovations focus on changes to productivity through: i) New or improved varieties of locally grown crops; ii) a package of improvements dealing with their management, seeds, use of fertilisers and chemicals and often water suppliers; iii) Livestock health and husbandry. Mostly these present a lower risk to the farmers.
- For the three most common categories (crop type, crop management and livestock) dissemination was fostered to some extent by value chain interventions and links to the private sector. Progress is generally reported as slow, with mixed results. Success has tended to come where there was a package of technical support measures for the enterprise plus training and improved equipment for processing.
- Most innovations require new knowledge and skills which highlights the importance of accompanying support through partnerships. Technical innovations to support value chains need to take account of the whole process from inputs to processing and market. Problems arose when one element was overlooked. In Cambodia [43] crop and livestock production increased but links to markets were not achieved. In Mozambique [16] cassava production expanded faster than the market could absorb. In Nepal [17] income gains from sales of organic apples and vegetable seeds were at risk from overdependence on a single buyer.

D. Impact of innovation

164. In this section we look at the evidence on impact from technical innovation. The analysis is structured under four aspects of impact: (i) household incomes and assets; (ii) food security and productivity; (iii) natural resource management and climate change; and (iv) gender and youth. Each section identifies those types of innovation that have been reported as generating an impact and gives examples of the more successful project and countries.[25]

165. Information reported about the nature of impact varies greatly across projects, with some reporting the results of independent surveys but most quoting results of trials, demonstration plots or the perceptions of farmers. Few cases were found where independent data were reported for specific innovations from farm observations. To simplify our analysis and transform these diverse statements into a common basis, impact was coded wherever a positive result was reported irrespective of the data source, but only where there was a stated or plausible link to the technical innovation. The frequent presence of grouped innovations limited the instances where a direct link could be established, hence the number of innovations with reported impact is much lower than the number of innovations being implemented. This does not imply that many have no impact, just that is cannot be traced. The categories of household income and assets, food security and productivity etc. used in Table 5 follow conventional areas of impact used by IOE. Examination of the success ratio (proportion of innovations with a clearly identified positive outcome) highlights those technical areas where impact has occurred. Table 5 lists the top types of innovation and nature of impact using IOE categorisation.

[25] It should be noted that successful technical innovations sometimes occurred in projects that were not overall successful. Likewise unsuccessful innovations occurred in otherwise successful projects.

Table 5
Innovation types with the highest number of positive statements for innovation impact across countries

Innovation type	*HH incomes and assets*	*Food security & productivity*	*ENRM & climate change*	*Gender*
	No of technical innovations with reported impact *(no. of countries in parentheses)*			
Crop type	**21** *(14)*	**25** *(18)*		
Crop management	**15** *(9)*	**22** *(15)*		
Livestock	**19** *(11)*	**16** *(8)*		**6** *(4)*
Land management		**11** *(9)*	**10** *(9)*	
Water	**4** *(4)*	**12** *(8)*	**5** *(4)*	**3** *(3)*
Post-harvest & processing	**11** *(9)*			
Energy			**8** *(5)*	**9** *(5)*
Seeds	**4** *(3)*	**4** *(4)*		
Fertilizers/chemicals		**8** *(6)*		**3** *(3)*
Forestry			**3** *(3)*	
Fisheries		**4** *(2)*		
Agricultural tools			**1** *(1)*	**2** *(1)*
Other	**2** *(2)*			

Source: prepared by IOE.

166. The table shows clearly that a positive impact on household incomes and assets, and on food security and productivity has been recorded for ten main classes of innovation: seeds, livestock, crop type, post-harvest and processing, crop management, water, land management and fertilizer/chemicals, fisheries and other. Impact on Environmental and natural resource management (ENRM) and climate change, and on gender and youth has been more narrowly identified for seven types of innovation and in a much smaller number of countries. Innovations dealing with fisheries, forestry and agricultural tools are few in number and implemented in only a few countries.

Impact on Household Incomes and Assets

167. In our analysis of the impact of technical innovations we have looked at evidence of impact in terms of improvements to household incomes and assets. Out of our total sample of 416 innovations, 86 (21 per cent) are identified as having had a positive effect. Most of these (66) arise from just four technical areas: crop types, crop management, livestock and post-harvest/ processing.

168. Positive innovation outcomes are inherently uncertain. Examination of the proportion of innovations that result in an identifiable impact reveals that in most countries (86 per cent) less than half of the innovations generate positive outcomes. Only one in five (20 per cent) of all countries have seen an impact on household incomes and assets from more than half of their implemented technical innovations. The proportion of innovations with a positive outcome was the same (22 per cent) for both those assessed as more technically complex and those that were low tech; and slightly higher (24 per cent) for those drawing on existing knowledge than those for which new knowledge was required (20 per cent).

Table 6
Analysis of countries and regions by percentage of innovations for which a positive income result was found

Positive claims/ No. of TI	*No of countries*	*%*	*APR*	*ESA*	*LAC*	*NEN*	*WCA*
0	7	20.0	1	3	2	0	1
1% - 49%	21	60.0	7	6	1	2	5
50% - 100%	7	20.0	2	1	0	2	2
	35	100	10	10	3	4	8

Source: Prepared by IOE.

169. The seven countries with the highest rates of success were Azerbaijan [36], Cameroon [05], China [06], Morocco [01], Nepal [17], Senegal [21] and Uganda [23]. The characteristics of these seven cases where higher levels of reported impact were found have been analysed in more detail.

170. A package of innovations led to increases in income and productivity in Azerbaijan. The introduction of cattle genetic improvement and bee-keeping in particular (in addition to increased supply of irrigation water and investments in agricultural extension services) led to significant production benefits for small farmers and showed strong potential for meeting the need to improve the food security and income of small farmers [36].

171. Improvements to food security, product value addition and the incomes of producers, through increasing productivity came from disease-resistant and high-yielding varieties of rice, cassava and onion, as well as improved techniques for their production and processing, in Cameroon. Cooperatives reported higher yields and higher selling prices, linking these gains in particular to the new crop varieties [5].

172. The introduction of new crop types and varieties through demonstrations was effective overall in China, achieving or exceeding targets and objectives, with a strong impact on household income and food security. For instance, Chinese purple yam introduced to Guangxi was adopted among poorer smallholder farmers, who often achieved transformative increases in income. Similarly, integrated pest management and zero grazing have benefited farmers financially and contributed to sustainability of project benefits [6].

173. An integrated investment geared towards value chain support with new fruit and vegetable crops, livestock improvement, as well as processing units and equipment was effective in Morocco. Some 69 per cent of poor rural households were able to engage in one income-generating activity that boosted their income. Income-generating activities contributed 21 per cent of household income primarily from small ruminant production by women but with some benefits from bee keeping and fruit trees in certain areas [54].

174. Innovative technologies resulted in substantial income increases (75-168 per cent) applied to different legume crops in Nepal. ICRISAT collaborated with the Nepal Agricultural Research Council (and two NGOs) to introduce and test integrated crop management technologies that built synergies among pest, soil and nutrient management practices. Households also reported enhanced incomes from implementing two other introduced innovations, namely organic apple cultivation and production of vegetable seeds, while dependence on a single trader controlling input supply and selling prices proved to be a limitation [17].

175. Impact in Senegal came from a broad base of change. Innovations in Senegal comprised better agricultural and pastoral practices through extension services, the development of varieties and other innovations related to demand-driven, collaborative research, processing of products, and, to a lesser extent, irrigation techniques and adapted SRI. The programme approach up to 2016 was based on consolidation and scaling up of innovations tested in completed or ongoing projects [21].

176. Introduction of oil palm as a transformative cash crop generated major income impacts in Uganda from the employment of farmers on oil palm nucleus farms, as well as improved land rights for smallholders and access to financial services. Also, the introduction of small livestock activities (as well as higher selling prices for farm products owing to the construction or rehabilitation of community roads) was inferred to have effected substantial household income increases, albeit for the “not so poor". Lastly, the introduction of improved crop varieties resistant to common diseases and pests allowed farmers to gradually transform from purely subsistence producers to market-oriented farmers [23].

Key points

- Innovations with successful impact on incomes were part of a broad set of measures, integrated to some extent and improving productivity by building on existing farming practices
- But they often include a new enterprise or form of transformative diversification that provides either new income opportunities or new opportunities for specific members of the household.

Food security and productivity

177. In our analysis of the impact of technical innovations we have looked at evidence of impact in terms of improvements to food security and productivity. Out of our total sample of 416 innovations, 111 (27 per cent) are identified as having had a positive effect, a small number (0.7 per cent) had effects that were detrimental. The data show no difference between those innovations with a high or low technical content and only a slight difference between those requiring new knowledge and those built on existing knowledge.

178. Examination of the proportion of innovations that result in an identifiable impact reveals that in most cases (82.9 per cent) less than half of the innovations generate positive outcomes. Only 17.2 per cent of all countries have seen an impact on food security and productivity from more than half of their implemented technical innovations.

Table 7
Analysis of countries and regions by percentage of innovations for which a positive food security and productivity result was found

Positive claims/ No. of TI	*No of countries*	*%*	*APR*	*ESA*	*LAC*	*NEN*	*WCA*
0	5	14.3	2	3	0	0	0
1% - 49%	24	68.6	8	4	3	3	6
50% - 100%	6	17.2	0	3	0	1	2
	35	100	10	10	3	4	8

Source: Prepared by IOE.

179. The six countries with the highest rates of success feature prominently in the analysis by type of technology Azerbaijan [36], Ethiopia [09], Kenya [13], Mauritania [52], Mozambique [16,34], and Senegal [21]. Two of these featured prominently for impact on incomes as well.

180. The evaluations confirm how benefits arise from combinations of innovations rather than sole initiatives. For example: in Azerbaijan, fodder improvement through varieties, fertiliser and plant spacing; in Senegal, the introduction of improved varieties and production of certified seeds by producer organisations; in Kenya, the underlying driver was a mix of adequate – and available – technology choices, such as improved crop varieties, proven methods of improved soil fertility management and the introduction of better performing breeds of farm animals; in Mauritania oasis development centred on palm trees and vegetable crops with support for water supply, varieties, tree management and technology for crop processing and cooking. It would seem that the key element to success was that these innovations were well planned to build on local potential and existing practices, rather than the inherent quality of technical innovations, but the evaluative evidence is not very clear on this.

181. Quality of data on crop yields is poor. Evaluations in all six cases report improvements to productivity with crop yields mentioned in five cases. None of the evaluations report data from an evaluation survey, estimates appear to come from farmer interviews or project reports. Two projects record benefits from crop diversification but overall there is little analysis about consumption or nutrition or the effect on food shortages.

182. Three of the six evaluations report a specific aim of introducing new technology either in the COSOP strategic objectives or the project objectives. There are also links to enabling factors, with finance and research emerging as the primary factors that create the conditions for successful adoption of the technology. Evaluations in Azerbaijan and Mozambique both identify forms of rural finance, microcredit and innovative financing mechanisms as being a contributory factor.

183. The strength of project links with research institutes is highlighted in Mauritania and Senegal: in Mauritania for pollination of palm trees; and in Senegal the introduction of a demand driven competitive research system. Perhaps the most interesting example is in Mauritania (Oasis Sustainable Development Programme) where a significant enabling innovation was the establishment of a farmer-based extension system through a “South-South” initiative involving exchange visits lasting six months with households living in the oases of adjacent Morocco.

184. The project has successfully introduced diversified vegetable and fruit crops and the training provided by women has had a real and immediate impact (women’s

attitudes and social position, culinary recipes based on locally available products, market gardening, income-generating activities and crafts). This impact has also been reflected in health benefits from the diversification of meals and an improvement in the diet of households and children in particular [52].

185. Additional examples are evident of impact on both incomes and food security. Among 18 innovative technologies implemented through 5 projects in the Gambia [10], the introduction of cassava and sweet potato and enhanced vegetable production were found to have a lasting positive impact on household food security and generation of marketable surplus.

186. In Ghana, most innovations were not technical but financial or institutional. Ten innovations have been identified across 9 projects. There was no clearly defined strategy for technical innovations. But a country-specific grant, "Sustainable Up-scaling of Seed Yam and Cassava Production Systems for Small-Scale Growers in Ghana" (funded by the EU Food Facility), as a response to severely escalating food prices in 2008, sought to strengthen and modernize production of cassava and yam through disease-resistant planting material to enable smallholder farmers to increase their production and open up income generating business and employment opportunities for rural families. It was successful, with new technologies being developed and disseminated through the project [11].

187. The underlying driver of agricultural productivity was a mix of adequate – and available – technology choices in Kenya [13]. Productivity has improved on small farms in the last five years, with average yield of maize increasing from 1.5 to 3 tonnes per hectare. The innovations introduced included improved crop varieties, proven methods of improved soil fertility management and the introduction of better performing breeds of farm animals. Intense awareness-building, training and coaching, and the building up of social capital by farmers, including women, were crucial additions for the observed impact, with potential for replication.

188. Water control linked with SRI has shown strong results. Madagascar is an example where improved water control and SRI was taken up in two projects. According to one self-assessment report [2], the combined effect of hydro-agricultural developments (4,330 ha or 206 percent of the forecast) and the adoption of intensive or improved rice systems through farmer field schools has led to a productivity increase in rice yields (from 500 kilograms to 3 tonnes per hectare in some cases). In another project [3] self-assessment report, a significant increase in production is observed for all major crops through water control, introduction of improved seeds and adoption of SRI/ SRA. Indeed, the yields have evolved significantly compared to the situation before the project: three times for rice and almost doubled for beans, peanuts and lentils. The evaluation indicates that crop intensification had been good and research was available on the matter. But given that they lacked strategies for conservation and integrated watershed management, the negative impact of technical innovations for NRM increases within a context of increasing risk of drought and soil erosion. Furthermore, the CSPE identified that IFAD-supported projects do not have sufficient funds to deal with basin management and environmental protection.

189. The experience of Lesotho Sustainable Agriculture and Natural Resource Management Programme is interesting. A small number of innovative technologies were promoted within a wider programme of agricultural development: practices to prevent land degradation (including biological and structural measures); pasture reseeding for better quality grazing areas; genetically improved rams and bucks; new fruit and vegetable varieties; and Introduction of beekeeping. The PPA field observations identified strong, but only anecdotal, evidence that household food security has benefited from programme activities, particularly fruit trees, crops, vegetables, poultry, pigs and sheep and goats.

Key points

- In the same way as for impact on incomes, successful innovations were part of a package of measures, integrated to some extent and building on existing farming practices.
- Several of these results also reflect a declared intervention strategy to promote new technology and integration of technical change with enabling financial services.
- Also important is the incorporation of research linkages to support the technology.
- In some instances, food security is clearly linked to improving household diet, with a positive impact on women and children.

Impact on ENRM and Climate Change

190. Only a small proportion of innovations (15 per cent) were identified as having had a positive effect on ENRM and Climate change; a small number (5 per cent) had effects that were detrimental. A higher proportion of positive outcomes were reported for those innovations with a high technical content (16 per cent) than those with a low content (12 per cent). A slightly higher proportion (14 per cent) was found in those requiring new knowledge than those drawing on existing knowledge (12 per cent). The Evaluation Synthesis on Environment (2016) pointed out that environmental risks were often overlooked or that they had not been assessed or taken into account. This points to a risk for IFAD that poverty is reduced and incomes raised at continuing costs to the environment.

Table 8
Analysis of countries and regions by percentage of innovations for which a positive ENRM result was found

Positive claims/ No. of TI	*No of countries*	*%*	*APR*	*ESA*	*LAC*	*NEN*	*WCA*
0	12	34.3	4	4	0	3	1
1% - 49%	22	62.9	6	5	3	1	7
50% - 100%	1	2.9	0	1	0	0	0
	35	**100**	**10**	**10**	**3**	**4**	**8**

Source: Prepared by IOE.

191. Only one country [Ethiopia, 09] out of the sample has seen an impact on ENRM and climate change from at least half of its implemented technical innovations. To understand why there are so few, we have looked at those countries with a lower success rate.

192. The many different innovations identified that have some positive impacts on NRM can be grouped under three general clusters: (i) alternative energy sources, (ii) introduction of species and technologies that were more compatible with climate change, and (iii) soil and water conservation measures.

193. The introduction of biogas technology, improved stoves and alternative energy sources had positive impacts on ENRM. Specifically, the use of biogas technologies reduced pressure from deforestation and limited soil erosion; the promotion of improved cooking stoves further reduced wood consumption.

194. In Ethiopia, beneficial impact has arisen from the introduction of more efficient wood burning stoves and new biogas plants, adapted for injera preparation (the main staple food in the highland region of the country). In Bangladesh [1], biogas units contributed to reducing fuel wood consumption by 1.5-2 tonnes per year. In Ghana [11], waste from cassava processing was used to produce energy, reducing environmental pollution derived from cyanide-rich cassava effluents.

195. The introduction of improved stoves in Rwanda [57] reduced the use of firewood by more than 30 per cent if compared with traditional open stoves. The use of biogas technologies for cooking and lighting further contributed to relieve the pressure on natural resources. Environmentally-friendly alternatives were introduced in Senegal [21] for the processing of néré, cajú and karité. Improved bakery ovens and néré steamers contributed to the reduction of energy consumed in the processing process.

Box 4
A post-harvest environmental innovation

> In Mali [15], chorkor ovens were introduced for smoking of fish. This technique developed in the 1980s in Ghana and then in Senegal for smoking fish, which allows a reduction in the quantity of wood used due to the reduced smoking time. The installation of chorkor kilns and dryers is a success since the process of fish smoking has been difficult to improve due to the manpower necessary for handling and maintenance. But there is no evidence of improvements to productivity or incomes from this innovation.

196. Several innovations were promoted as adaptation measures to climate change. These include water harvesting structures in response to drought [18], pasture management techniques [21], pasture reseeding [50], crop varieties adapted to the local environment [5,18,52,59], crop rotation and other climate resistant practices, including shade-cloth greenhouses and crop calendars [4,16,21,55].

197. In Mauritania [52], negative effects of climate change in the oases have been mitigated by the introduction of different palm tree varieties, combined with efficient water management. In Cambodia [4], crop calendars and crop diversification helped farmers in coping with the effects of climate change. Similarly, the introduction of sea beans (Mukuna) in DR Congo [7] as a cover crop in the rotation cycle contributed to increase the fertility of savannah soils and limit pressure on gallery forests.

198. Soil and water conservation measures. The main innovations under this cluster include a number of interventions aimed at reducing soil erosion, such as tree planting [5, 20, 41, 42, 55, 57], planting of fruit trees [43], planting of fodder trees as hedgerows [57], and establishment of nurseries [41]. Reduced use of fertilisers, use of composting and farmyard manure as well as mulching reported impacts on soil fertility [4, 18, 46, 55]. The interventions often included water conservation measures, such as drip irrigation [4, 18, 46, 55], which resulted in important water savings.

199. Drip irrigation, water harvesting and new crop species and varieties were identified as having positive impacts on the environment in Nicaragua [55]. A wide range of environmentally-friendly innovations were introduced. In Egypt [8], innovative farming systems generated environmental benefits, reaching 20-30 per cent savings in fertilizer use and 7 to 19 per cent savings in water use.

200. Conservation farming and promotion of non-timber forest products were found to have some impact among seven innovative technologies in Zambia [25]. Planting of trees on slopes in Vietnam [59] was promoted to mitigate soil erosion and improving water infiltration, further reducing the risk of flooding.

201. Conservation practices that would support the best use of local species and regenerate vegetation, preventing soil erosion were introduced in Brazil [41]. Planting of seedlings and reforestation contributed to reduce deforestation, which was a major concern for beneficiaries. In Rwanda [57], SWC measures were adopted in combination with planting of fodder trees, contributing to the reduction of soil erosion and loss of valuable soil. Soil water retention capacity was also improved through mulching of fields, while planting of nitrogen-

fixing trees as hedgerows and application of manure enhanced soil fertility. In Cameroon [5], contour planting was introduced in combination with the use of attack-resistant varieties and organic fertilizers to improve soil water retention.

202. Livestock resilience at pasture was increased by the introduction of fodder grass in the land use system in Vietnam [59]. Similarly, in India [47], Napier grass production for fodder had a significant impact on the environment, contributing to reduce over-grazing in communal areas and damage to common property resources in daily collection of fodder. In China [6], the introduction of zero-grazing livestock production reduced pressure on natural pastures.

203. In Lesotho [50], the programme implemented several measures to reclaim degraded areas, rehabilitate pastures and graze lands, and promote conservation agriculture. Positive impacts were reported in terms of increased soil fertility, reduced soil erosion and increased awareness among beneficiaries on natural resource and environmental protection. A more efficient use of natural resources was also achieved through the integrated approach promoted by the project. Pasture regeneration was also promoted along other interventions in Mali [15], within the scope of Bourgou plains regeneration. The construction of stone barriers and half-moons was aiming at fostering water infiltration and soil conservation.

204. Balancing the positive benefits of technical innovations with actual or potential damaging environmental and natural resource is challenging, as several examples show. In Egypt modern irrigation systems have been introduced without adequate concerns over the longer-term potential for salination. Drip irrigation, which requires precise and timely implementation, has been introduced in locations where supplies are uncertain and crops have subsequently shown signs of water stress [46]. Irrigation in oases in Mauritania [52] is expanding but the locations have slow recharge rates and there is a need for more monitoring to manage the system.

205. Evidence from China indicates a concern that productivity improvements have involved more intensive use of inorganic fertilisers and pesticides with a negative impact on human health. Similarly in Madagascar, effective crop intensification took place without a strategy for conservation and integrated watershed management leading to concerns about increase in drought and soil erosion. The regeneration of flood plains in Mali was successful but the resulting increase in grazing herds has brought new pressures for which further remedial actions are needed.

Box 5
Understanding the setting is important to achieve net benefits

> Drip irrigation and conversion of open (canals) to closed (pipes) systems has led to reduced water loss due to evaporation, and this will have had a positive impact on climate change resilience. However, such impacts will have been relatively small compared to upstream water supply reliability, affected by: (i) climate change; (ii) upstream use by riparian countries in the Nile basin; and (iii) irrigation system management (efficiency, distribution, reliability).
> Egypt, West Noubaria Rural Development Project (PPE)

206. Processing of cassava has helped farmers achieve a higher value in Cameroon [5] and Ghana [11], but dealing safely with the effluent is a cause for concern. Projects in the same two countries together with DRC [7] and Laos [49] have intensified cropping and introduced modern varieties, which have put indigenous crops under pressure and have reduced biodiversity or soil fertility and contributed to deforestation.

207. Introduction of improved breeds or processing technology have expanded grazing numbers in Bolivia [2] and Vietnam [59], bringing overgrazing with the potential for soil erosion. Lastly, solar power and biogas was

introduced in Jharkhand-Chhattisgarh, India [47] as a step towards forest protection and climate change adaptation, but uptake was limited and stalled when the project finished, leaving the forests as the main source of fuel.

Key points

- Only 15 per cent of the technical innovations were identified as having had a positive effect on ENRM and Climate change; a small number (5 per cent) had effects that were detrimental.
- Where they have been adopted, alternative energy sources have demonstrated real impact. But biogas has substantial limitations in terms of access to raw materials, demands on labour and a suitable climate, so is likely to be at best a niche technology. In contrast, improved stoves have widespread application.
- Transformative innovations have evident potential to help adaptation to climate change. The few examples in this synthesis merit further exploration and analysis.
- The larger category of improvements to assets through soil and water conservation reflects longstanding historical interventions to contain soil erosion and harvest water.
- Negative outcomes feature more prominently in terms of actual or potential environmental damage and indicate the need for careful monitoring of otherwise successful interventions.

Impact on gender[26] empowerment and equality

208. Out of a total of 416 innovations identified, 33 (7.9 per cent) reported a positive impact on gender equality and women empowerment, while a small number (0.9 per cent) reported a negative impact. A slightly higher proportion of high tech innovations reported positive outcomes (10 per cent) than for low tech (8 per cent). Positive outcomes were reported in 9 per cent of innovations drawing on existing knowledge and 8 per cent for new knowledge.

209. Out of the entire sample, only one country, Ethiopia, reported an impact on gender from more than half of its implemented technical innovations. A lower success rate (25-49 per cent) was identified in Bolivia, Brazil, India and Nigeria.

Table 9
Analysis of countries and regions by percentage of innovations for which a positive Gender and Youth result was found

Gender claims/ No. of TI	*No of countries*	*%*	*APR*	*ESA*	*LAC*	*NEN*	*WCA*
0	24	68.6	6	8	1	4	5
1% - 49%	10	28.5	4	1	2	0	3
50% - 100%	1	2.9	0	1	0	0	0
	35	100	10	10	3	4	8

Source: Prepared by IOE.

210. The following section has been organised according to the three main objectives of the IFAD Policy on Gender: i) Promote economic empowerment to enable rural women and men to have equal opportunity to participate in, and benefit from, profitable economic activities: ii) Enable women and men to have equal voice and influence in rural institutions and organisations; and iii) Achieve a more equitable balance in workloads and in the sharing of economic and social benefits.

211. Promote economic empowerment. The analysis identified a number of cases where access to technological improvements and productive assets enhanced gender equality and women empowerment.

[26] Impacts on youth were reported only with reference to beekeeping [19] in Nigeria. According to the evaluation document, bee-keeping, in conjunction with other livestock interventions, attracted young people, generating a life-changing impact through increased incomes. The innovation also fostered employment opportunities, which further contributed to the reduction of youth migration.

212. Home gardens was reported as beneficial to rural women, contributing to improved food security and living standards, but also to increased income through sale at markets. A number of technical innovations were introduced in relation to home gardens, including water-saving techniques and cisterns [41], production of fruit [41] and vegetable crops [2]. In Bolivia, home gardens were introduced in combination with other innovative activities, such as production of compost, improved stoves and greater care of livestock, targeting specifically women, with the aim of increasing their income and their families' nutritional status. In Brazil [41], backyard gardens were promoted as an income-generating activity for female beneficiaries, who gained access to and control over household income for the first time. In Ethiopia [9], home gardens reported similar impacts, benefiting specifically landless women.

213. Fruit and cassava processing was introduced in Brazil [41] and saw an active participation of women, who benefited from increased income. The integration in value chains through processing was also reported in Nigeria [19], where the project promoted cassava processing into flour for bread, mainly a female activity (95 per cent of the beneficiaries were women).

214. Reducing time poverty and drudgery for women was conceived as a precondition for improving health, increasing productivity and fostering their involvement in society. The aim of several technical innovations was to reduce time poverty and drudgery among women. This implied acting on the root causes of such phenomena, both at the productive and household level (e.g. reducing domestic workload and time spent on household chores).

215. As rural household chores performed by women often involve fuel collection and food processing and preparation (IFAD, 2016), eco-efficient stoves and biogas digesters were introduced as labour-saving technologies in a number of countries [3, 9, 47, 57]. In the case of Rwanda [57], the introduction of improved stoves and domestic bio-digesters had a positive impact on women health, mitigating the issue of smoke in the kitchens, caused by the absence of chimneys and use of firewood. Similarly, in Ethiopia [9], the introduction of improved stoves reduced women's workload, while also improving living and hygienic conditions. However, biogas technology reportedly did not benefit female beneficiaries, who often lacked the necessary livestock and manure.

216. Fodder crops cultivations were introduced to reduce the time spent by women in collecting fodder. In Laos [49], forages and feed crop (e.g. cassava) were planted to reduce time spent in collecting and preparing pig feed. The PPE indicates that time dedicated to collecting and preparing pig food was reduced to 1.2 hours a day, in comparison with more than 2 hours before the adoption of fodder crops. The innovation was supported by extensions services in the form of technical training. In India [47], Napier grass was introduced to prevent women from collecting natural grass from the forest and reduced the time spent by women in collecting fodder by 60 per cent.

217. Water-related innovations showed one of the highest success ratios in terms of gender impact. As women are often responsible for water collection, their workload was reduced by the introduction of irrigation and drainage systems (specifically drip and valve irrigation)[52]. In India [47], heavy metal pitchers for water collection were replaced by light-weight pitchers, reducing water collection time by 30 per cent. The improved pitcher weighs only 1 kg, instead of the 5 kg bronze pitcher, and contains more water (17 litres against 15 litres). All women interviewed during the PPE reported that the pitcher was more comfortable to carry, therefore reducing time and labour, with positive effects on their health.

218. Adapted agricultural tools were introduced in India [47] in combination with other drudgery-reduction interventions, including vermicomposting and the above-mentioned water pitchers, Napier grass and improved firewood sources. These

technologies reduced the daily amount of time spent on household chores by five hours.

219. The ouricoury processing machine helped to reduce the workload among women, adapting machinery that was previously used for livestock feed. This technology allowed women to decrease the painful manual work, of breaking the fruit with two stones, while also improving the quality of the product [3].

220. Drudgery reduction was not achieved in the case of Vietnam [59], where a number of female beneficiaries highlighted that the introduction of cash crops, such as canna, were actually increasing their workload (as harvest happens in winter, at the same time with rice harvesting). As a consequence, not all of them felt they had enough time available to participate in project activities.

221. In a limited number of cases technical innovations fostered women's involvement in the household decision-making process and contributed to the achievement of a higher societal status. Women benefited from the pass-on scheme for livestock implemented in Rwanda [20]. The introduction of improved breeds through this solidarity chain improved incomes and living standards, which in turn affected the social status of beneficiaries. As women became donors of heifers, their self-confidence increased and allowed them to participate in the community decision-making discussions. It should be noted, however, that the distribution of livestock required a contribution from the beneficiaries. This represented a constraint for the most vulnerable women-headed households, who could not afford to pay this contribution (IFAD, 2009, Mid-term review).

222. In Bangladesh [37], the project introduced vaccination for poultry and livestock. The trained poultry vaccinators were all women. The provision of such technical training, together with micro-credit, generated an important impact on household-level gender relations and helped expand the role of women inside and outside the home. Women benefited from increased mobility, improved participation in family decision-making and greater control over revenues from project activities.

223. Similarly, the introduction of improved seed preservation techniques (Maria model for rice) and the use of pheromone traps in Bangladesh [38] had the double effect of reducing expenditures for fertilisers and seeds, while enhancing incomes. As women acquired and adopted these new technologies, they gained an increased status both at the household and at the community level.

224. In Ethiopia [9], small-scale irrigation allowed women to increase their incomes and pitch their voices in the communities. However, land ownership constrained women participation as it is not common for the wives of farmers to own the land in their own name.

Key points

Despite the small number of reported impacts, a wide range of beneficial changes were observed:

- less than 10 per cent of technical innovations in most categories are targeted specifically towards women (and almost none towards youth).
- the wider discussion of GEEW aspects in evaluations often fails to link impact to innovation.
- economic empowerment associated with tools and opportunities to process crop and animal products and secure higher value, and some improvement and diversity of diet from new crops;
- skills training to operate specialist equipment, sometimes combined with providing a village-based service to other farmers is recognised as bringing increased economic participation and self-esteem;
- reduction of labour through access to improved water supplies, more efficient provision of fodder and reduced need for firewood associated with improved stoves.

Impact on human and social capital

225. Looking more widely than direct benefits already reported, the synthesis explored evidence about the impact of technical innovations on human and social capital. These aspects are rarely a central focus of interest during CSPE and PPE so well documented examples are not common. But some interesting findings do emerge. Although numbers are small, some 8 per cent of positive findings were associated with low tech innovations, compared with 3 per cent for high tech.

226. Social and productive groups not only enable innovations to take hold, but can also strengthen social cohesion and self-reliance. In Nicaragua [18] the project intervention strategy with its participatory approach and links to academic research generated important processes of social mobilization and knowledge sharing among the men and women beneficiaries, towards the common good. In Morocco [54] technical innovations aimed at fostering an incipient value-chain approach. They encompassed the introduction of new crop types, livestock improvement, as well as processing units and equipment. The oil extraction equipment for walnuts and aromatic and medicinal plants, procured jointly with other projects, has not only improved the quality of agricultural products but increased the professionalism of farmers, despite some setbacks in market access. In Cameroon [5] the programme focused a value chain approach on sectors with strong economic potential (cassava, onion and rice). The human and social capital of the target groups has increased through numerous technical training courses and support for different forms of community and producer organization. Additionally, the successful experience with farmer field schools has been capitalized into a manual that appears to have been widely disseminated.

227. Not all groups are sustainable. In Zambia [25], the project helped to transform the organizational capacities of the target communities through sensitization, community mobilization and group formation (which did not exist at the time). Although the formation of these local institutions empowered some of the communities to register their groups as legal entities, these groups became dysfunctional after the project ended.

228. In Mozambique [16], support to cassava production in partnership with the Mozambique Institute for Agricultural Research (IIAM) and the Alliance for Green Revolution in Africa (AGRA) helped stimulate the registration of land use and utilization rights achieving 3,923 against a target of 750.

229. In Nepal [17], one of four countries to participate in a regional grant to ICRISAT for the improvement of grain legumes in rainfed systems, the results have led the Nepal Agricultural Research Council to develop a document on vision and strategies to improve grain legume production for livelihoods, food security and poverty alleviation in the country. Even more promising, in the DRC [7] lessons from two projects focusing mainly on improving access to improved seeds and setting up local seed production systems involving farmers' organizations and public research and monitoring institutions have been instrumental in the elaboration of a national strategy for seed development and the preparation of a Seed Law which is awaiting promulgation.

Key points

The few examples illustrate potential in several ways:

- To enhance social capital and self-reliance by a combination of technical training, exposure to markets and an appreciation of production and processing quality and standards;
- Stimulating institutional change sometimes in recognition of people's rights, or to establish a legal framework such as for supply of quality seeds.

E. Sustainability

230. Three main factors were identified as affecting the sustainability of technical innovations: (i) government support; (ii) technical and financial viability, including availability of supply, required maintenance and related costs; (iii) environmental resilience, with a specific focus on post-project risks.[27]

Government support

231. The role of national governments in supporting technical innovations long-term was identified as key in a number of evaluations [01, 14, 19, 20, 33, 37, 54, 59]. Specifically, they can play a role in sourcing of specialist inputs and continuing financing after project closure.

232. In Bangladesh [01], line departments (DAE and Fisheries) were expected to continue the provision of technology for crop intensification, poultry production and rice improvement, in partnership with national and international research institutes. Within the Microfinance and Technical Support Project, implemented in Bangladesh [37], the sustainability of livestock vaccination for poultry and large ruminants was dependent on adequate supply of vaccines from the Department of Livestock Services.

233. Lack of governmental ownership in Rwanda [20] hampered the sustainability of watershed protection interventions. The institutions created to temporarily manage the watersheds (Local Watershed Management and Supervision Committee – CLG) were found to duplicate the functions usually attributed to local administrative bodies, rather than enhancing the process of developing the capacity of local governments. In India [33], the sustainability of livestock production improvement required stronger linkages with line departments, which was not promoted by the project. In Morocco [54], the government indirectly affected the sustainability of livestock interventions by drastically reducing public subsidies for animal feed and vaccination.

Technical and financial viability

234. Affordability of innovations is imperative. In a number of cases, the sustainability of technical innovations was linked to their technical and financial viability [01, 02, 05, 06, 10, 11, 14, 16, 34, 37, 38, 45, 48, 52, 56, 57]. Low specification items, local manufacture and minimal maintenance all help keep costs down.

235. In Gambia [10], the financial viability of an integrated poultry-aquaculture scheme was assured by the low-cost poultry housing, made of cheap and locally-available materials. Similarly, local production of mineral licks ensured a supply stream for multi-nutrient licks and mineral blocks as well as additional income for traditional village group farms. In Bangladesh [37], locally-available inputs, combined with low levels of investments contributed to the replication and adoption by non-targeted households of mini-hatcheries.

236. In Madagascar [14], SRI and improved rice cropping techniques were considered potentially sustainable because of low maintenance and operation costs required. Similarly, in Bolivia [2], the sustainability of the innovations introduced was attributed to low maintenance costs, both in terms of financial investment (for home gardens, improved stoves, improved livestock management and potato cultivation) and labour (for tilling the soil on contours and composting).

237. On the contrary, the cost of shade-cloth houses in Mozambique [16] prevented it from becoming a viable investment for the beneficiaries. Also the sustainability of alternative fishing equipment was constrained by its limited availability (for sale only in large urban centres), which resulted in increased costs for fishermen [34].

[27] In addition to these three factors, Annex X also covers enabling factors and their sustainability in relation to technical innovations.

In DR Congo [45], solar pumps were not maintained because of the high operating costs and the required change of batteries and maintenance of photovoltaic panels, which represented a constraint to farmers, who preferred hand pumps.

238. In Pakistan [56], the introduction of improved seeds was not supported by a sustainability strategy, which left farmers dependent on the Programme and Department of Agriculture for the provision of inputs. Similarly, in Rwanda [57], the lack of planting material constrained the impact of hedging, limiting its long-term sustainability.

Environmental resilience

239. Some innovations enhance environmental sustainability; others can be at risk from the environment. Environmental sustainability of technical innovation was reported in a few instances [02, 14, 38, 46, 51, and 54]. In Bangladesh [38], for example simple and low-cost innovations were introduced (urea super granule, pheromone traps, leaf-colour charts and improved rice varieties), which contributed to the reduced use of agro-chemicals, fostering environmental sustainability.

240. Even where the innovation is workable the context can undermine sustainability. Despite good technical and financial viability, the sustainability of SRI and rice system improvements in Madagascar [14] could be hampered by floods and soil erosion. Similarly, in Egypt [46], the sustainability of drip irrigation was undermined by the increasing water scarcity affecting the region. In Morocco [54], the introduction of sardi stud rams for genetic improvement successfully contributed to the intensification of livestock production. However, the sustainability of such benefits could be constrained by the effects of drought.

241. In Malawi [51], the environmental sustainability of improved techniques for maize cultivation was hindered by soil degradation. The focus on mono-cropping, promoted by Government policy, was not deemed suitable to maintain soil fertility, further reducing the resilience of the agro-ecosystem.

Key points

- Identifying the right partner in government and ensuring the right institutional set up is key to continued government support.
- Affordability and availability of the technology in the local area as well as low operation and maintenance costs both in terms of finance and labour determines the sustainability of innovations after project closure.
- While some innovations promoted were environmentally sustainable more were at risk from the environment or were in danger of damaging the environment (e.g. floods and soil erosion, water scarcity, drought, soil fertility).

F. Scaling up

242. In IFAD the most recent definition of scaling up (IFAD 2015) refers to: i) ‘expanding, adapting and supporting successful policies, programmes and knowledge so that they can leverage resources and partners to deliver larger results for a greater number of rural poor in a sustainable way; and ii) scaling up results does not mean transforming small IFAD projects into larger projects. Instead, IFAD interventions focus on how successful local initiatives will sustainably leverage policy changes, additional resources and learning to bring the results to scale. In reality many projects and subsequent evaluations document replication of innovations from one IFAD project to a second phase. For this reason replication is included in this analysis. Replication is a positive step in the dissemination of innovations and is akin to extended testing and may be a precursor to scaling up.

243. The Evaluation Synthesis on Scaling Up (2016) highlights a number of characteristics that facilitates scaling up. Among them are focused and well-

conceived project designs and evidence on project outcomes and impact. However, M&E is a weak aspect of most projects. Weak M&E coupled with the chronic problem of slow implementation pace during the first three to four years results in limited evidence on what works, what could be scaled up and in what conditions until the late stages of the project cycle. The report also notes that that the issue of scalability has not been acknowledged forcefully (i.e. certain interventions may present economies or diseconomies of scale; they may be successful or cost effective only at a certain size, and other complementary interventions may need to be introduced as the size changes).[28]

244. Scaling-up of technical innovations introduced in IFAD-financed projects was undertaken in 13 countries, mostly in the APR, ESA and WCA regions (four countries in each region), and to a lesser extent in LAC and in the Near East, North Africa and Europe (NEN) (one country in each region).Three aspects were considered for the purposes of this evaluation synthesis, and the results presented below are sectioned accordingly: (i) Replication of technologies in follow-up or subsequent IFAD-financed projects; (ii) "appropriation by partners", referring to scaling up of innovations by IFAD's partner organizations or governments; (iii) "practice to policy", which captures the incorporation of technical innovations into government policies. In addition, this section also covers cases of (iv) "spontaneous adoption", denoting the voluntary, self-motivated uptake by non-beneficiary farmers of innovations by way of observation and peer-to-peer learning and knowledge transfer. A further sub-section describes several cases of missed opportunities for scaling up innovative technologies and practices, as assessed in the respective evaluation reports.

Replication

245. Replication was the scaling-up modality most frequently encountered, covering a number of innovations across seven countries [1, 4, 9, 12, 14, 19, 57].

246. In Bangladesh, portable biogas units were trialled successfully in one project and were piloted in a subsequent IFAD-financed project based on the results achieved (re-using effluent from livestock, estimated savings in use of fuel wood of 1.5-2 tonnes per year were achieved) [1]. The same evaluation report further stated, in general terms, that several other agricultural technologies trialled within projects were later expanded to many parts of the country; but the technologies were not detailed further [1]. In Ethiopia, biogas was replicated in a follow-up IFAD project which had national coverage. The follow-up project also replicated other innovative approaches, such as community-based natural resources management, land certification and participatory forest management [09].

247. Replication of pheromone traps and livestock vaccinations, introduced in Bangladesh [37, 38] through the local NGO PKSF, was reported in a subsequent IFAD project in Bangladesh (FEDEC). Through its micro-enterprise loans, FEDEC launched 42 sub-projects, which provided technical services to a larger number of farmers, including both the promotion of pheromone traps and livestock vaccination (IFAD, 2017 – Occasional Paper 18).

248. The introduction and/or subsequent replication of technical innovations was sometimes fostered by grants [4, 12, 14, 19]. For example, in Jordan, improved water-harvesting techniques (developed under a grant with the International Centre for Agricultural Research in the Dry Areas were replicated in a subsequent IFAD-financed project [12]. Similarly, an IFAD grant to WorldFish in Bangladesh [1] fostered the productivity and use of "mola" fisheries. A follow-up

[28] For example the ESR highlights that research and extension activities generating and disseminating new varieties of cassava that were resistant to the mosaic virus in West Africa were successful. They were funded initially by IFAD and CGIAR, but other multilateral and bilateral donors provided additional support. However extension activities resulted in significant surplus production. In the absence of improved processing technology, one of the downsides of this success was diminishing farm-gate prices of cassava in several countries.

large grant was approved in 2017, in support of the 'nutrition-sensitive fish food systems pillar' of WorldFish, to expand the experience gained in Bangladesh to Cambodia, Myanmar, Thailand and Zambia (IFAD, 2018).

249. In East and Southern Africa, a grant to the IFADAFRICA network enabled knowledge exchange between Madagascar and other countries, in that the system of rice intensification was transferred from Madagascar to Rwandan rice growers, who, in turn, trained rice farmers in Burundi [14].

250. In Nigeria, the positive experience gained with introducing cassava processing (into flour) was further supported by a number of subsequent grants: (i) a regional grant led by the Natural Resources Institute aimed to improve the performance of the cassava industry by way of further research and dissemination of innovative practices for cassava processors that were to be taken up by IFAD programmes in the WCA region; (ii) a grant to the International Institute of Tropical Agriculture aimed to increase cassava-based household incomes, contributed to employment creation and the reduction in wheat import expenditure by transforming cassava roots into high-quality edible flour; (iii) a grant supported the government's flagship programme to develop the cassava bread subsector, coordinated by the trade and agriculture ministries, inter alia by providing training to bakers, caterers, and extension and research staff on high-quality cassava flour [19].

Appropriation by partners

251. Scaling up in the form of appropriation by partner organizations and governments was reported in four countries [1, 5, 9, 12].

252. In Bangladesh, sand-based mini hatcheries for poultry were introduced in one project and subsequently disseminated to a larger area through partner NGOs of a financial institution founded by the Government, which was one of the main implementing agencies for the project. Spontaneous adoption of mini hatcheries by non-beneficiary farmers was also documented [1].

253. In Jordan, results from grant-supported research, specifically the identification of salt-tolerant varieties of fodder crops and improved water-harvesting techniques, were disseminated in a few cases by programmes supported by the government and international donors. By the same token, soil and water conservation investments were replicated in a few areas from government resources; notwithstanding, it was noted that their expansion to a larger national programme would have required a more concerted effort in the initial project and, more importantly, in the scaling up to other projects [12].

254. In Cameroon, a follow-on project entirely funded by the government continued to promote the multiplication of quality cassava cuttings and selected varieties [5].

255. In Ethiopia, affordable, small-scale irrigation technologies were scaled up by a multi-donor programme led by the World Bank [9].

Missed opportunities

256. Missed opportunities to consistently and systematically replicate a number of promising technical innovations in later generations of projects or in new target areas came to the fore in Egypt; these included the successful approach to irrigation and drainage development together with effective environmental monitoring, the introduction of solar power and integrated environmentally-sound farming systems [8].

257. In Senegal, lack of financial resources was identified as a major hindrance to scaling up innovations, despite the potential political will. There was also little success in advocating for partnerships and securing support from co-financers; poor coordination and limited mediation capacity on the part of the agriculture ministry and this was considered pivotal in this regard [21]. Similarly, in Brazil, it was found that wider partnerships with a range of federal government agencies (in

addition to the strong existing partnerships with the agriculture and planning ministries) were an important factor to be considered for future scaling-up efforts as such agencies possess a national perspective and are therefore well-placed to identify successful innovations in individual states and scale them up in others through national policies and programmes [3].

Practice to policy

258. National extension programmes were found to be primary actors driving the acquisition of innovations at the policy level. Policy-level scaling up was reported in four countries [12, 16, 20, 57, 59].

259. In Jordan, technological, institutional and policy approaches for improved water-harvesting and crops-rangeland-livestock integration, which had been tested in two regional grants co-financed by IFAD, contributed to the design of a restoration programme for the Jordanian steppe. However, progress with policy up-take of the results was limited, specifically for improved water harvesting techniques [12].

260. In Mozambique, innovative biological control of diamondback moth was integrated in national programmes and standards and scaled up through the national agricultural extension service; this pest management approach had been introduced through a successful collaboration between IFAD-funded regional grants and a project supporting the government's National Programme for Agricultural Extension. Adoption of this technology was causally linked to the enhancement of produce quality and productivity [16].

261. In Rwanda, while individual projects helped to promote emerging agricultural innovations, the long-term challenge for scaling up such innovations was to find an institutional approach that would fit into the decentralization process and local government structures [20]. One of the innovative practices successfully adopted institutionally was hedge planting of fodder crops on bunds for soil conservation, which was taken up by the national agricultural extension service, along with other innovative technical packages [57]. An interview with the former country programme manager for Rwanda confirmed that the policy engagement element of the project was very strong and that the positive results obtained with bunding and hedge planting resulted in a policy change away from the previous labour and resource-intensive terracing policy of the government.

262. In Vietnam, no less than six innovative technical packages tested under an IFAD-financed project were officially recognised and included in the provincial public extension programme: these included the system of rice intensification, compacted fertilizers, high-quality rice varieties, improved compost, pig feed processed from cassava and the introduction of diversified fodder-grass species [59]. The latter refers mainly to Elephant grass, which registered high levels of adoption by farmers and widespread diffusion (exceeding the target by 14 per cent).

Spontaneous adoption

263. Spontaneous adoption was driven by a combination of different factors, including evidence of benefits to farmers, peer-to-peer learning, demonstrations and affordability. Evidence was documented in six countries [7, 8, 16, 45, 48, 57] across Africa and Asia.

264. In Mozambique, the introduction of the use of ice on board artisanal fishing boats appeared to have been spontaneously adopted more widely (presumably by fisher folk that were not project beneficiaries), which was causally linked to the enhancement of the quality of the catch [16].

265. In the DR Congo, the use of improved crop varieties has spread also to non-beneficiary farmers, by peer-to-peer learning. By the same token, following the installation of rice huskers by a project, many other farmers procured their own husking machines (with a dramatic increase of huskers from 5 to 300 in a five-year

period in one location alone), and many private entrepreneurs invested in rice processing and particularly husking; this was attributed to the large expansion of the rice production area driven by the project, as well as the profitability of husking [7, 45]. Similarly, peer-to-peer learning was identified as a driver for scaling up innovations in Rwanda. Neighbouring farmers even beyond the watershed borders adopted several technical innovations introduced by the project within the first three years of project implementation (2006-2009), namely hedge planting of fodder crops on bunds for soil conservation, multiplication of crop seeds and improved cultivation and propagation of fodder grasses [57].

266. In Ethiopia, in some project locations evidence was noted of improved technologies being spontaneously taken up by farmers in surrounding areas as a result of demonstration activities, with the potential of extending income and food security benefits to communities beyond the project [8].

267. In India [47], light-weight water pitchers and Napier grass production were both adopted beyond the original intended audience. The pitchers were demonstrated to 1,900 HH and adopted by 12,000 households. Adoption of the pitchers was particularly enhanced by the farmer self-help groups and federations selling them on the market. The success of these innovations was attributed mainly to their low cost: Napier grass tufts were generally given away for free by households that had already established the grass, and the plastic pitcher was a popular cost-saving replacement for the commonly-used metal pitcher.

Key points

- Replication was the most frequent way of disseminating innovations and was often assisted by grants. The case studies show that where innovations have worked it is often where they are replicated in a succession of projects over a long period.
- In a few instances missed opportunities were identified where promising technical innovations were neither replicated nor scaled up seemingly because of loss of interest or the occurrence of new priorities.
- In a few cases national extension programmes were driving the innovations to the policy level.
- Spontaneous adoption took place in a number of cases and reaffirmed the viability of the innovations introduced. In many cases the adoption was driven by peer to peer learning and demonstrations.

V. Emerging good practices and lessons learned

268. This ESR identified a change typology with four parts (productivity enhancement, transformative change, asset strengthening and beneficiary health enhancement). The two most important changes were productivity enhancing and transformative which made up 56 per cent and 28 per cent of the sample respectively.

269. The distinction between productivity enhancing innovations and transformative innovations is important. Productivity enhancing innovations are those that improve returns to land, labour and capital by incremental changes to the farm business, including forestry and fisheries. Transformative change, on the other hand includes innovations that bring a major change to farming system structure and function by introducing new enterprises or radically different ways of farming and post-harvest technologies. Transformative innovations are considered higher risk and usually require broader packages of support to be successful.

270. The section below discusses selected productivity and transformative practices using the typology developed for the Synthesis and IFAD's model as explained in the theory of change. Both types of practices are important to IFAD but each type requires specific accompanying support and involves different levels of risk and targeting.

Productivity enhancing practices

271. Introduction of fertiliser and pest management requires a package of support to work. This includes enhanced efficiency of fertiliser use and adoption of organic products, and tackling pests and weeds through integrated methods. Improved use of fertiliser and IPM/IWM bring quick and visible returns from lower costs or improved yields. A successful practice is linking field demonstrations with access to microcredit. A less common practice is to introduce applicator machines to overcome labour constraints.

272. The system of rice improvement (SRI) is beneficial for supporting innovations in rice production. SRI is not a fixed package but a combination of practices, chosen to meet the needs of the context. It can include: transplanting of seedlings, improved variety use, use of compost and soil nutrient management, weed management and crop establishment. SRI has been popularised across three regions, APR, ESA and WCA.

273. Introduction of improved or quality seeds requires a systemic and comprehensive approach. Interventions need to ensure there is an appropriate framework for guarantees of quality, continuity of partnership with research institutions to provide foundation material, arrangements for contracting or authorising outgrowers and a procedure for collection, grading and distribution.

Transformative practices

274. The introduction of new crops helps to diversify production but exposes farmers to new risks. Diversification can benefit the family diet but more often the aim is for cash crops to generate new income. In the latter case links to processing and markets are critical. Being able to organise farmers and provide access to market information is critical for safeguarding farmers' interests and achieving an equitable relationship between farmers and buyers in many cases.

275. Improved use of water requires low cost technology and materials that are readily available. Drip and sprinkler irrigation improve efficiency; small scale irrigation (SSI) with manual pumps and spate irrigation can transform crop options as can water harvesting in micro catchments for fodder shrubs and fruit trees.

276. Innovations for soil and water conservation and climate change adaptation are labour intensive and generate little extra income, but they can also reduce production costs and enhance food security Introducing new plants and trees provides additional sources of grazing or fodder and can reduce soil

erosion combined with nitrogen-fixing varieties and composting they improve soil structure and fertility. Water harvesting and water infiltration can extend growing seasons and enable crop diversity.

277. Alternative sources of energy have a potential to transform the household's energy efficiency and have significant health benefits by reducing drudgery and smoke in the kitchens. Bio-digesters help dispose of waste products and reduce wood consumption but has substantial limitations in terms of access to raw materials, demands on labour and a suitable climate; so is likely to be at best a niche technology.

Lessons learned

278. A collective set of technical innovations, such as SRI, provides a simple focus for project design, even though the component parts can, and should vary, according to local needs. Introducing collective sets of technical innovations for rainfed field crops, vegetables, livestock and others facilitates project design, implementation support and learning.

279. Technical innovation to promote value chain development needs careful preparation. Plans to add value by increasing production to create a marketable surplus either through improved productivity or by transforming farm enterprises and processing need to take account of markets: provision of inputs, sale outlets, buyer concentration, farmer negotiating power, and consumer demands, while avoiding over-dependency. With new products these can be hard to determine in advance.

280. Environmental damage can arise from innovations supporting both diversification (new crops) and asset growth (livestock numbers) as well as productivity. Productivity improvements can stimulate more intensive use of inorganic fertilisers and pesticides and overgrazing by livestock. Poorly planned water use brings the potential for salinization; and some processing, such as for cassava, generates effluent that has to be controlled to prevent environmental damage.

281. Effective partnerships are essential for input supply, technical advice, group development, dissemination and marketing. Innovations can bring extensive demands for support from government agencies, research institutes, NGOs and private sector entities. Critical functions such as seed supply are difficult to establish. Negotiating shared objectives, resource availability, priority actions and supportive policies with partners is challenging.

282. Managing successful innovation demands transdisciplinary skills. Understanding the physical and social context, how best to engage and work with partners, the most effective mode of delivery and how to organize participating farmers brings a need for skills that can outweigh the technical aspects of the innovation.

283. The simpler the innovation the greater the chance of it being sustained. Low cost, low tech innovations with short input supply and marketing chains, local manufacture and minimal maintenance are most viable. Some apparently simple technical innovations can be more complex to manage and sustain. Sustainability is less certain where government ownership is in doubt, partnership support is narrowly tied to projects, and technology is dependent on scientific support. Functioning local organisations and strong market connections all help sustain relationships and manage risks.

284. Scale has to be considered when introducing innovations. Some innovations only show their benefits when implemented at scale. Others such as post-harvest and processing equipment and machinery can be difficult to manage at scale.

VI. Conclusions and recommendations

A. Conclusions

285. Technical innovation, defined as the introduction of a process or product that is new to the context, is mainstreamed in IFAD and examples can be found in all aspects of the portfolio. According to this definition the majority of project interventions are innovative. Most technical innovations aim to enhance productivity and offer low-cost, low-tech marginal improvements in cropping practice and animal health. They are classic interventions in agricultural development that are low risks and well suited to the needs of many farmers. Most innovations are of low technical complexity and are designed to bring incremental changes to the farm business.

286. A smaller number of innovations are transformative. Transformative innovations are more risky and they carry a higher level of high-tech change. They can be more disruptive, with the potential for higher rewards but require higher investments in resources and knowledge. The distinction between productivity and transformation is important if IFAD wants to promote substantial changes in income and food security. Innovations of a transformational nature are needed to tackle the root causes of hunger and malnutrition within the Agenda 2030.

287. The majority of technical innovations are not targeted to specific groups. Most technical innovations are geared towards the 'average' farming household in any location, neither very poor nor better-off. There are some exceptions for livestock and some other innovations that are more suitable for farmers with access to land and finance.

288. Accompanying support and partnerships are essential for introducing innovations that require new knowledge and skills. IFAD is well positioned to provide this type of support as it is seen as a strength of IFAD's approach across the portfolio. IFAD usually has a facilitating role, linking the mode of dissemination, the implementing partners and the enabling environment. Grant-funded projects are the most frequent mechanism for research and technical development, but they are often not systematically linked with practical application and adaptation.

289. Impact tends to come from a package of innovation measures, not a single element. Innovation is inherently uncertain, some technologies take time to get established. These results might well be a good reflection on the projects; after all, income is a function of more factors than just the innovation. A positive impact on household incomes was found in 20 percent of all projects only. A higher proportion (27 per cent) sees improvements to food security and productivity.

290. Many innovations related to agricultural practices are potentially significant for NRM and climate change mitigation but the associated risks need to be carefully managed. Some technical innovations had positive impacts on the Environment and NRM and CC, for example drip irrigation, green manure; others can have negative unforeseen longer-term consequences, for example irrigation, cassava processing.

291. IFAD is dealing with a very assorted portfolio with few repeat examples of many innovations. A small number of specific technical innovations have been replicated in many locations. Otherwise there is an extensive range of other innovations that respond to local context and needs. The challenge to scaling up comes from innovations being so many and various, that there are few simple messages about what works where and for whom.

B. Recommendations

292. Recommendation 1: Enhance focus on transformative practices within IFAD's approach to technical innovation while continuing to promote low risk improvements to productivity for the majority of poor smallholder

farmers. IFAD should recognise and reward such innovative efforts that are transformational but more risky. A working environment that rewards risk taking is at odds with a view that successful adoption is the only satisfactory outcome. A clearer distinction between the more routine productivity enhancement and less common transformational innovations would help to understand and manage the change that is being promoted and better target the innovations. Some interventions move on from being part of agriculture's natural cycle of learning and advancement to a more transformative change. Project design would need to anticipate the point when innovations become transformative and plan for dissemination and enabling support. Scaling up needs to be mainstreamed in project design to maximise impact and return to innovation.

293. Recommendation 2: Systematically monitor, evaluate and learn from innovations. Too many innovations are underreported and learning is lost. This applies to both loans and grants. There is no systematic framework to evaluate innovation in project and country evaluations. Simple measures, such as using adoption rates in a uniform and consistent manner, can be very revealing. There is a need to both address relatively simple questions about adoption rates but also to address why innovations worked or did not work in the specific context. There is also a need to better document when different packages of innovation have worked. Evaluation needs to understand the adoption/adaptation process and how the enabling support functioned. More challenging innovations might benefit from a counterfactual model to demonstrate outcomes. Narrow focus on impact avoids the more practical questions about why an innovation works in some settings for some participants and not for others.

294. Recommendation 3: Use the forthcoming CLE to explore IFAD's readiness to promote transformative innovations. This synthesis has highlighted the distinction between productivity enhancement and transformative change. A deeper exploration of the extent to which IFAD as an organisation is set up to actively support transformative innovations should be undertaken by IOE. This would include an assessment of the risk culture in the organisation.

Senior Independent Advisor's Report

Introduction

1. The terms of reference (tor) for the Evaluation Synthesis were to: (a) identify technical innovation practices and lessons learned about the potential for success and scaling up that can inform future IFAD interventions; and (b) identify key factors enabling (or hindering) innovation, within the limitations of the available evaluative evidence. Standard evaluation key questions were addressed, including relevance, effectiveness, impact, sustainability and scalability, as well as partnerships and specific IFAD criteria.

2. The Independent Adviser was requested to assess the soundness of the analysis, the key emerging issues and the recommendations of the evaluation synthesis. In particular, the main tasks of the Adviser were to: (i) review the draft final evaluation synthesis report and provide written comments and suggestions for improvements; and (ii) review the final evaluation synthesis report and prepare a brief report (as follows) commenting on the analytical framework, the structure and storyline, the description of context, the quality of analysis and the conclusions and recommendations.

3. For the better part of a century the importance of innovation in economic growth has been recognized; and of agricultural technical innovations, e.g., new crop varieties and livestock feeding practices, for agricultural and rural development. This recognition led to in-depth studies of technical and institutional innovations in agriculture, including their variety, complementarities, systems context, pathways to impacts and linkages to scaling. For more than two decades IFAD strategies, plans and evaluations have emphasised innovation -- and more recently scaling – in the project portfolio. Consequently, this evaluation synthesis of technical innovation is very timely, and will contribute to further internal assessments of innovation.

Analytical framework

4. The usual approach to synthesis has been followed, namely: review of literature and relevant IFAD reports; systematic screening of evaluation reports to select a functional set for the synthesis, from which target innovation practices and a working typology were identified; and comparative analysis of innovation practices and assessment against IOE evaluation criteria (relevance, effectiveness, efficiency, impact and sustainability). The approach was complemented by case studies and interviews with IFAD staff.

5. The chosen time frame of 2010-2018 is appropriate, from which 57 evaluations were selected from the 106 such products available over the time frame. The composition of the evaluations is interesting: 25 Country Strategy Programme Evaluations, 22 Project Performance Evaluations (PPE/PPA), 3 Impact Evaluations (IE), and 7 Evaluation Synthesis Reports (ESR). Helpfully, more than 30 of evaluations contain primary synthesis, notably the country strategy evaluations and the evaluation syntheses – in this sense this evaluation synthesis can be considered a meta-synthesis. Unfortunately, only 3 impact evaluations could be included in this meta-synthesis. Although the mixed composition of the sample products limits quantitative analysis, the assessments of this meta-synthesis are underpinned by a wealth of evaluative evidence which lends credibility to the conclusions and recommendations. Given the predominance of text in the evidence base, the choice of the Nvivo software for analysis is endorsed.

6. One of the particular challenges in this evaluation synthesis is a practical definition of technical innovation. Many narratives around agricultural innovation were founded in technical innovation, e.g., improved varieties, management practices or other research products, and developed further in relation to institutional innovations. However, the interaction between technical and institutional innovation has frequently been overlooked in the literature and project design. This evaluation

synthesis has proposed a workable definition of technical innovation in Box 1, whilst clearly recognising the enabling role of many institutional innovations. The categories and examples of technical innovation presented in Annex V (adapted from 3ie experience) are adequate, although there would be minor aspects which could be improved, such as the separation of some related categories (e.g., seeds and crops) and the lack of attention to integrated technical innovations (e.g., crop-livestock integration). Not surprisingly, of the 416 identified technical innovations which were grouped into 13 categories, about half comprised crop type, crop management or livestock innovation categories.

7. The functional typology of technical innovations is generally acceptable (viz, productivity enhancement; transformative change; asset strengthening; and beneficiary health enhancement) and the exemplars in Table 2 are useful and relevant to IFAD. Additional exemplars under Beneficiary health would include pesticide spray practices, aflatoxin control in groundnuts and maize and disaster preparedness – and perhaps zero tillage cropping to reduce the labour burden of field preparation by women. However, it would be a mistake to make too much of the typology, because of inter-linkages across the functional types and the phasing of farm development, e.g., 'incremental' productivity enhancement of staples is often an entry point to asset growth and 'transformative' crop and livestock diversification (i.e., major changes to system structure and function). Second, whilst history tends to record long term successful development as 'transformative', in project and short term investment cycles on the ground such changes are far more nuanced.

8. Highlights of the history and scope of thinking on innovation are reflected in the Annex, although in no sense should this be considered a review of the wealth of literature on technical innovations and innovation systems. Embedded in the theory of change Annex is an important classification of technical innovations, viz: (a) 'sole' or standalone technical innovation; (b) technical innovation supported by essential process and institutional innovation for effectiveness of the technical innovation; or (c) technical innovation associated with optional complementary process and institutional innovation which magnifies or accelerates impact of the technical innovation.

9. Another strength of the evaluation synthesis framework is the theory of change. For the purposes of this evaluation synthesis, the theory neatly distinguishes technical innovations from enabling innovations in the context of investment projects, reflecting the phases of identification of scope, planning, dissemination and follow-up support. If the framework were to be further developed for future studies based on broader TOR and more detailed data, there would be value in (a) unbundling the extension function to reflect public, private, NGO and farmer group actors and (b) recognising that the adoption process includes elements of innovation trial, take up in fields, adaptation to fit the farm household system (labour and cash availability and risk and consumption preferences) as farmers learn of the performance of the technology, and some disadoption or replacement by alternate technologies.

Structure and storyline

10. The structure is logical and sound. The overall storyline is relatively straightforward, although with some complexity in relation to the typical bundling in many projects of technical innovation with complementary enabling, often institutional, innovations – and the associated challenges in relation to attribution. The corporate context is detailed (and the timeline Figure is compelling), and the analytical framework is appropriate and effective. The richness of the findings, albeit largely based on qualitative evaluative evidence, is striking – well-structured by the evaluation research questions, and with excellent cross-referencing to the sources. The lessons are fairly compact, and have concentrated on the facts – in some places there would be opportunities to draw out implications for project design and implementation, recognising the complexities of farming systems and institutional landscapes on the

ground. The conclusions flow logically, and the conclusions and recommendations are strongly focused.

Context

11. The main body of the report focuses on the IFAD corporate context (paras 31-49) supplemented by Annexes III and IX. As noted elsewhere in these comments, innovation has attracted attention for almost a century and is a core theme of many public services and businesses. The fundamental role of agricultural technical innovation, whether from research or from farmers, in agricultural and rural development and in poverty reduction is well recognised. The report contains a detailed account of IFAD policies, strategies and plans related to innovation and scaling which provide the corporate context for this evaluation synthesis of technical innovation.

Quality of the analysis

12. The analysis is found in the rich Synthesis of findings chapter (paras 65-269) and the short ensuing chapter Emerging best practices, contributing practices and lessons learned (paras 270-283). Without doubt the analysis is sound and of value to IFAD management. In fact the team has extracted many relevant findings and lessons given the challenges of the focus on technical innovation alone and the practical limitations of evaluative data availability and quality. There are lessons for IFAD in relation to quality of the underlying evaluative data, not only in relation to M&E and reporting, but it is also possible that the increased attention to social and institutional innovations (cf technical innovations) in recent IFAD policy, while understandable and appropriate, might have distracted project management and evaluations from ensuring clarity on the reporting of the underlying technical innovations. Some particular themes worth further exploration in follow-up studies are discussed briefly in ensuing paragraphs.

13. Under-development is characterized by scarcity of technical knowledge in the context of weak institutions and governance. While occasionally the separate implementation of technical or institutional innovations can be successful, a majority of smallholder agricultural development projects require specific bundles or combinations of synergistic technical and institutional innovation at each stage of implementation, from diagnosis to follow-up scaling, in order to generate the best rates of return. A simple example would be the contrast between: improved varieties of open pollinated legume crops and the complementary institutional innovations for community seed multiplication, quality and distribution; and hybrid maize seed and the institutional innovations for seed multiplication, marketing and financing by the private sector. Of course, systematic project review and adaptive management foster appropriate adjustments during project life. Direct investment in capacity for local innovation systems also generates high pay-offs through the ongoing generation of new innovations, including technical, in project areas.

14. Inclusivity of marginal groups, notably youth, and gender empowerment are essential themes in modern sustainable rural development. It is surprising that the evaluation evidence lacked sound information on these aspects. Clearly improved stoves and water management directly impacted (positively) women; however, it is likely that poor rural women also benefited significantly from many crop type, crop management and livestock innovations – but the data was scarce and the evidence was thin. Similarly, the lack of information on the participation of and impact on youth is surprising.

15. In development discourses today the term sustainability is used with two completely different meanings. In this evaluation synthesis and in some research organisations, the term means the continued use of the technical innovation by the target population. However, the more common meaning, deriving from the Bruntland report and the Rio Summit, is the stability and continuation of socio-ecologic systems, with economic, environmental and social indicators, after the technical

innovation is adopted. In relation to the latter (broader) meaning, the synthesis could have placed more emphasis on the contrast and often conflict between intensification and livelihood improvement on one hand, and environmental outcomes and sustainability on the other hand. The negative trade-offs between economic development and the environment have been emphasised by many UN and national strategic documents. Nevertheless, recent (impressive) gains in household food security and poverty reduction have been achieved at significant cost to underlying agricultural resources, namely aquifers, soil health and agrobiodiversity.

16. The resilience of the farm household systems of the poor is of critical relevance to enduring rural poverty reduction, and could have been discussed in greater depth. Increased resilience is required with particular reference to climate variability and market volatility, but also the risk of a slide back into poverty (from ill-health, droughts, price collapse, etc.). An important aspect is foresight knowledge including scenarios of climatic, economic and industry conditions.

17. The selection and management or partnerships is core to the effectiveness, impact, sustainability and scalability of technical innovations – with wider relevance than training. The key issues are not only sectoral balance (research, or business) but also the selection of individual partners with appropriate human and financial capacity, aligned objectives and the trust of communities. It could be argued that IFAD plays an important role as broker and also as entrepreneur in partnership formation and management – and success in these aspects underpins effectiveness, impact and scalability of technical innovations. The selection of partners also determines the plausible pathways to impact for technical innovations (private sector, public extension, etc.) and, in this connection, the best modality and likely success of scaling.

Conclusions and recommendations

18. The evaluation synthesis conclusions and recommendations are relevant and important, and are supported by the evidence and analysis found especially in the rich synthesis of findings and the short lessons learned chapters.

19. The ten Conclusions on technical innovation in IFAD projects are valid and supported by the evaluative evidence. The mainstreaming of innovation, and in particular technical innovation, in IFAD is a major achievement. To a large degree, the diversity of 416 technical innovations across 13 categories (crop types, crop management and livestock accounted for half) simply reflects a ‘demand-driven’ approach reflecting the varied needs of farmers in different farming systems and institutional contexts across the 80 countries in this study – and as such diversity of technical innovations is not an issue of itself. Fostering local adaptation of technical innovations through functional research linkages could add value to the dissemination and scaling aspects of many projects. The evidence that productivity enhancing technical innovations (low complexity, low risk, adoptable by a spectrum of farm types) reduce poverty in many different farming systems should be viewed as an IFAD success (reflecting ‘IFAD’s strengths and purpose’). Moreover, such productivity enhancement of existing farm enterprises frequently leads to diversification, i.e., transformation. Indeed, productivity enhancement of staples to ensure household food security is often a pre-condition for effective diversification and transformation. Therefore, there is a phasing opportunity, for initial investments on productivity enhancement to be followed by transformative technical innovations in subsequent investment streams. Clearly the limited impact on gender empowerment (except for stoves and water), natural resource management (except for SWC) and climate resilience is a matter of some concern (and so too youth) and merits further investigation in an integrated technical and institutional innovation context. Overall, this analysis shows that IFAD faces the risk of successful productivity enhancement (intensification) and transformation (diversification) achieved at significant cost to the environment (see earlier remarks). Another

significant conclusion from the evidence is the effectiveness of combined technical innovations, pointing to the importance of integration in design and implementation. The unevenness of M&E data is clear from the analysis, and also the lack of attention during design to foresight and scaling is a concern.

20. Recommendation 1 (para 300) on 'enhancing' transformative practices (while continuing to promote low risk innovations for productivity enhancement) is endorsed on the understanding that the proposed 'enhancement' of transformative practices recognises the synergies and sequencing between farming systems productivity enhancement (intensification) and transformation (diversification). Moreover, the synergies between different types of technical innovations for transformation (e.g., crop-livestock integration) need to be better understood and incorporated into investment designs for transformation.

21. Recommendation 2 (para 301) on systematically monitoring, evaluating and learning is fully supported. High payoffs to investment in stronger MLE would be expected not only for future evaluations, but also to strengthen adaptive management of project implementation. One could add that the scope of the MLE should include the pathways to impact, beyond the technical innovations, adoption and outcomes alone; and to embrace the economic, environmental and social spheres of sustainability. Moreover, stronger foci on inclusivity (especially gender), sustainable resource management and climate resilience would be advantageous. The management of risk at all levels (technical innovations, farm management, project implementation, corporate management) merits attention.

22. Recommendation 3 (para 302) is clear -- the planned CLE could obviously benefit greatly from the well-documented evidence base and the analysis of this evaluation synthesis. The findings of the evaluation synthesis suggest close examination of six critical themes about innovation in the IFAD portfolio, viz: inclusivity (including gender and youth); linkage of low risk productivity enhancements (intensification) with farming system transformation (diversification); integration (of technical and institutional innovations, and of farming system components); sustainable resource management (avoiding environmental costs); dynamics (of farm and rural development); and risk management at all stages of the project cycle.

Summary

23. In summary, given the narrow focus on innovations of a technical nature and the limited availability of quantitative evaluative data at project level, the team has done an excellent analysis and identified important lessons for IFAD and partners. The evaluation synthesis benefited from a good range of existing evaluative products. The report also represents a solid foundation for follow-up studies on innovation in agricultural and rural development in general and in the IFAD project portfolio in particular.

Case studies

COUNTRY	India
PROJECT NAME	Livelihoods Improvement Project in the Himalayas
IMPLEMENTATION PERIOD	2003-2013
PROJECT TYPE	Credit and financial services

1. Context. Over the last decade, India has experienced a rapid growth, joining the ranks of Middle-Income Countries (MICs) in 2007. However, a third of the world's poor continue to live in India, where pockets of deep poverty have formed due to uneven growth across the country. Population growth has further increased the pressure on natural resources to meet the domestic and global demand for food. In this context, the Indian agricultural sector shows resilience to natural shocks and market volatility, also as a result of favourable investments and technological uptake. Leveraging technology has been a key driver of sustainable agriculture in the country over recent years: according to the GII (2017), India has consistently outperformed on innovation relative to its GDP per capita.

2. With the objective of achieving a sustainable and inclusive agricultural growth, India is currently supporting innovation through policy support and institutional development. India's present public policy with regard to agriculture is focused on encouraging innovation and entrepreneurship, fostering the growth of an ecosystem for technology and digital innovation. This process aims at providing access to new technologies for farmers, with a focus on marginalized rural poor, targeted by national development schemes.

3. Project. The Livelihood Improvement Project for the Himalayas (LIPH) was designed to target vulnerable groups of the Himalayan region. Population growth in an area dependent on subsistence agriculture weakened the self-sufficient system of mountain communities, resulting in natural resources depletion and unsustainable farming systems. Moreover, traditional practices usually performed by women and older people, were gradually abandoned, as agricultural tasks required an increased number of labourers.

4. The primary objective of the project was to improve the livelihoods of vulnerable groups in a sustainable fashion through the promotion of livelihoods opportunities and the strengthening of concerned institutions. The project was implemented in five districts of the states of Meghalaya and Uttarakhand. The main target consisted of groups that fell either below or just above the poverty line, reaching approximately 72,000 households in over 1730 villages.

5. The two states where implementation took place, Meghalaya and Uttarakhand present very different environmental and socio-cultural conditions. Uttarakhand, located in the western Himalayas, is mostly covered by hills and mountains, which leaves limited space for agriculture. However, 80 percent of the hill population relies on rain-fed agriculture for its livelihood. The monsoon climate further increases soil erosion and degradation, affecting the overall productivity. The state of Meghalaya, on the contrary, is situated on a vast plateau in the eastern Himalaya. Approximately 80 per cent of the largely tribal population depends on agriculture, which is mainly performed by women with limited use of modern techniques and low productivity. A large portion of the cultivated area is under "shifting cultivation" (jhum) for the production of horticulture crops and spices, which are then marketed in the plains or in the neighbouring region of Assam.

6. Innovation. Several innovations were introduced in Meghalaya and Uttarakhand states: solar lanterns, improved stoves, SRI, polyhouse cultivation, jhum system improvements, organic production, Napier grass, vermicomposting, motorized

wheat threshers, power tillers and chaff cutters, ergonomically designed agricultural tools, fibre weaving from nettles, organic repellent and light-weight pitchers for drinking water collection.

7. The use of ICT further enabled technical innovations: the 2015 India CPE witnessed instances of ICT use in the Uttarakhand segment, fostering the creation of a web-based “federation help line” for women’s self-help groups (SHG) on federation governance issues. All the communication materials were uploaded on Google docs, and used by the project staff to share and analyse the work; sms-based communication between SHG on cultivation techniques, climate, market rates of various crops, government schemes, in collaboration with the Department of Telecommunication.

8. Detailed information is available on a limited number of initiatives:

   a) Organic production practices (adoption[29]);
   b) Napier grass (adoption);
   c) Vermicomposting (adoption);
   d) Light-weight pitchers (adaptation of metal water pitchers);
   e) Solar lanterns (adoption).

9. Identification. Technical innovations have been identified within the three main areas of intervention and innovation presented in the 2001 COSOP for India. These include promoting women’s empowerment and representation in local government’s bodies, access to common property resources and natural resource management and non-farm enterprise development. The 2001 COSOP further recognized the establishment of SHGs as platforms for poverty reduction and development. The SHGs would be the recipients of new technologies, made available in a number of different sectors, further contributing to capitalizing the time saved by women and enabling their empowerment.

10. Pre-inception Report. For Meghalaya, technical innovations were mainly directed towards the introduction of new farming practices and crop varieties, supported by extensive training and people mobilization. The need for this intervention stemmed from the wide employment of jhum practices in the region, responsible for soil degradation, observed during a pre-inception study and field mission. The need to support natural resource management in tribal areas was also included in the 2001 COSOP as a primary area of intervention.

11. Strategy. While the innovations implemented did not require complementary inputs in terms of increased resources, they were strongly complemented by various empowerment and extension activities. This is especially true for farmers following the "shifting cultivation", experiencing soil depletion and pest infestation, who were trained in vermicomposting and other IPM practices. The formation of Self-Help Groups and Cluster Level Federations, supported by the project, further enabled the adoption and diffusion of innovative technologies (e.g. solar lanterns and Napier grass) through the organization of demonstrations and increased access to credit.

12. Adoption. Adoption was encouraged by the local context. Solar lanterns, for example, provided a solution to the erratic supply of electricity in Uttarakhand. Their adoption allowed local families to save on the cost of electricity and kerosene, while providing them with good intensity light.

13. The introduction of technical innovations encountered several barriers. The Meghalaya Joint Review Report reported a few constraints in implementing organic production techniques in Tehri district, including the availability of inputs at village level; lack of fodder to sustain cattle for milk and produce the manure required for

[29] The nature of the innovations varied, including adoption from another setting, adaptation of an already existing technology and also the creation of new elements.

organic farming; distribution of free chemical fertilisers and pesticides by DoA and cross-contamination of organic plots; lack of knowledge on organic certification process; lack of training facilities near villages; and lack of grading, packing and transport.

14. The introduction of Napier grass was constrained by initial reluctance of beneficiaries: villagers believed that local grasses were more suitable for their cattle and Napier grass would have reduced milk yields. Moreover, they were convinced that Napier grass would have taken a long time to grow, representing an additional burden for the households.

15. Diffusion. The project was successful in introducing new drudgery-reduction tools and practices. The Napier grass achieved the highest level of adoption (151 per cent), followed by vermicomposting (49 per cent). However, the choice of implementing the project in two non-contiguous states might have limited the opportunities of cross-learning and technical transfer.

16. A number of technical innovations were not adopted because of either high start-up costs or insufficient return on investment. Insufficient technical support was also among the main reasons for limited uptake. Given the low replication rates, demonstrations were therefore considered an ineffective mechanism for introducing sustainable technologies. In Uttarakhand especially, multiple demonstrations in the same villages were not efficient and replication of demonstrations was less than satisfactory.

17. Poverty relevance. The introduction of innovative production methods, tools and crops, complemented by household drudgery-reduction initiatives significantly reduced women's workload and time poverty. Solar lanterns, introduced to provide poor households with a stable source of energy, proved to be both cost-effective and pro-poor. Also, the fact that poverty was prevalent among those households which were dependent on jhum and facing increasing marginalisation due to the continuous decline in jhum yields suggests that the programme efforts for improving "shifting cultivation" methods were relevant for poverty reduction.

18. In Uttarakhand, some SHGs turned the new technologies into a business opportunity, benefiting other women as well. This is the case of water pitchers and solar lanterns that reduced the time and energy spent on household chores, but were also promoted and sold by SHGs to other women in the area. Likewise, the labelling and organic certification for example were very relevant, as they transformed traditional crops or medicinal plants produced for self-consumption to be sold to the local markets in important income generating activities.

19. Despite the project's efforts to engage the poorest households, the project failed to include the poorest rural groups in Uttarakhand, who were under-represented in the SHGs. In Meghalaya, the primary target group were marginalized women and rural households, prioritizing the poorest and mid-poor strata of population. However, during the implementation phase, the focus was more towards better-off households, who had been covered to the extent of 91 per cent. The poorer categories had a limited coverage of 32 and 35 percent.

20. Cost-effectiveness. Relying on solar power, the adoption of solar lanterns provided households with more light than electricity and kerosene. Lanterns were also cheaper to operate than traditional energy sources and cheaper than more complicated solar home systems, which were affordable only for well-off households. Napier grass cultivation was introduced as fodder, it had no cost attached, required little water and its tufts were given away for free by households with an established cultivation.

21. Outcomes. The primary outcomes of the technical innovations presented above were improved productivity in terms of increased yield and incomes as well as increased household gender equality and women's empowerment. According to the

Annual Outcome Survey carried out in 2011, 60 per cent of project group members reported increased crop yields, compared to only 25 per cent in the control group. There was a significant positive change in the use of improved agricultural inputs such as seeds, organic pesticides/fertilizers and new crop varieties, and evidence of improved agricultural practices. Paddy cultivation using the SRI technique has significantly raised the productivity of rice in the Meghalaya state.

22. The adoption of improved methods for organic crop production, including soil and water conservation and appropriate pest control techniques, substantially contributed to increased yields – up to double in some cases. Improved income is also attributable to the introduction of small poly houses, where seedlings and off-season vegetables were produced and marketed by the federations.

23. Time saving. The reduction of domestic workload allowed women to engage in other activities and build their social capital. The employment of motorized wheat threshers reduced the threshing time by 96 percent, Napier grass production reduced the time spent by women in collecting fodder by 60 percent and the light-weight water pitcher reduced water-collection time by 30 percent. As a result, the overall time spent by women on household chores was reduced by five hours a day.

24. Sustainability. Provided that repairs and maintenance can be done locally, the labour-saving technologies and their enabling effect on women's empowerment are likely to have been sustainable. Despite their inefficiency, demonstrations are likely to have influenced people to a certain extent, as trainers and lead farmers will continue to serve the communities over the long term. Their services have also started to be compensated with a fee, which further enhances the sustainability of the system benefitting both the local area and the dissemination process. However, the relatively low level of replication of demonstrations and limited support offered by financial institutions hampers the sustainability of skills and knowledge transfer in select locations.

25. Scaling up. A number of initiatives introduced by the project were spontaneously adopted beyond project premises. The main example was the light weight water pitcher, which was demonstrated to 1,900 households and adopted by 12,000 households. SHGs and federations further enhanced its adoption by selling the pitcher on the market. Napier grass was also another innovation that exceeded the expectations and reached beyond its intended audience. The reason behind the success of Napier grass and the lightweight pitcher is attributable to their low-cost.

26. Other technologies often required additional investment, and with few income-earning opportunities for women, the opportunity cost of their time was virtually zero. Therefore, even if a considerable amount of time is saved, households place almost no value on women's time and are so unwilling to invest in labour saving tools. As a result, these interventions were not so widely adopted, although sometimes popular in specific places. These include: smokeless stoves (since bottled gas and, more recently, electricity have become more popular for cooking), chaff cutters (human powered, an electric version would reduce the work required), cattle troughs (expensive, but popular in some places), and farm equipment such a threshers and ploughs.

COUNTRY	Brazil
PROJECT NAME	Rural Communities Development Project in the Poorest Areas of the State of Bahia
IMPLEMENTATION PERIOD	2006-2014
PROJECT TYPE	Rural Development

27. Context. Brazil is the largest country in South America, with a population of approximately 209.3 million in 2017[30]. The World Bank classifies Brazil as an upper-middle income country with a GNI (gross national income) of US$8,580 per capita.[31]

28. Compared to other developing countries, Brazil has a relatively well-developed innovation system, with several universities well placed in the world rankings and a growing role in world knowledge production. Policies and institutions play a key role in supporting this process. In the past, the agricultural sector in Brazil benefitted from successful policies aimed at enhancing the country's innovation system. As a result, the country established a broad R&D system, comprising a diverse set of institutions, with the advantage of having a close relation to farmers. This allowed Brazilian agriculture to benefit from a wide range of technological innovations in the fields of genetic engineering, soil improvement and correction, plant and animal breeding, livestock technologies, among others.

29. Despite the innovative component of its agricultural sector, Brazil presents high levels of income inequalities and poverty with a higher prevalence in rural areas[32] .

30. Project. The Rural Communities Development Project in the Poorest Areas of the State of Bahia, also known as Gente de Valor, targeted 29 municipalities in the semi-arid zones in the Northeast of Brazil. This semi-arid area is commonly known as the Sertão, characterized by stunted and sparse vegetation, which constitutes the caatinga biome. The project's development goal was to reduce poverty, especially extreme poverty levels, of semi-arid communities of the State of Bahia.

31. Innovation. The project introduced 13 technical innovations, clustered into three main categories. Agricultural and livestock related innovations included the implementation of agro-ecological techniques, water-saving productive home gardens, soil conservation practices (mixed cropping), improved management of small ruminants in fundo de pasto, and apiculture. Processing innovations included desalinization plants in Brazil plum processing units, equipment for fodder processing, innovative harvesting techniques aimed at reducing tree damage, Sisal manufacturing, and processing plants for Brazil plum, Ouricoury Palm, cassava and honey. Environmentally-sustainable techniques included plantation of native tree seedlings for conservation, sustainable extractive practices, eco-efficient stoves and bio-digesters.

32. Detailed information is available on productive home gardens, agro-ecological practices, processing plants, eco-stoves and bio-digesters.

33. Identification. Gente de Valor was conceived as a consolidation of a previous IFAD-funded project in Brazil, called PROGAVIAO. The main aim was to expand PROGAVIAO's approach to other municipalities in the State of Bahia, characterized by similar baseline conditions to the ones of the previous intervention. The Terminal Evaluation Mission for the PROGAVIAO project highlighted the project's

[30] World Bank Databank: https://data.worldbank.org/indicator/SI.POV.DDAY?locations=BR
[31] World Bank Databank: https://data.worldbank.org/indicator/SI.POV.DDAY?locations=BR
[32] UNDP MDG Country Report, Brazil 2014: http://www.undp.org/content/dam/undp/library/MDG/english/MDG%20Country%20Reports/Brazil/140523_relatorioodm.pdf.

strategy in addressing critical infrastructure issues that have a key impact on rural development and livelihoods. An example is ensuring water security for residents and livestock, an issue addressed by Gente de Valor through the establishment of water-saving productive home gardens.

34. The introduction of bio-digesters and eco-efficient stoves, aimed at reducing energy consumption relying on the use of firewood and manure, was finalized only after the Mid-Term Review. It was included in the project through a grant, which was initially intended to support castor bean production and transformation.

35. Strategy. The majority of innovations, aimed at supporting productive activities, required the construction of infrastructures that allowed increased access to water, as scarcity of water was a structural condition of the area of intervention, the semi-arid Sertao region.

36. In 2008, as one of its first activities, the project started to build water tanks (for human consumption and horticultural production), as well as water reservoirs for livestock consumption. This allowed for the subsequent implementation of productive home gardens and agro-ecological trials. The project also recovered eight dams and built one. The stored water was destined for animal consumption, fish farming and irrigation of small vegetable plots.

37. One of the components of Gente de Valor was dedicated to the development of human and social capital in the targeted communities. The project offered training and support in organizational, managerial and technical capacities, combined with a dedicated strategy to include women and young people. This enabled the adoption and diffusion of innovations in the productive component. The creation of GIs (Groups of Interest), small sub-groups with a stated interest on a specific priority action, supported the definition of intervention projects promoted by Gente de Valor. GIs also supported the adoption and diffusion of several technical innovations, such as productive home gardens, agro-ecological techniques, apiculture, fruit and cassava processing, nurseries, eco-stoves and bio-digesters. Processing represented a major part of the GIs (16 per cent of the total): processing of fruit (usually native species, such as Brazilian plum, Ouricoury palm and cashew) and to a lesser extent the processing of cassava constituted one of the main priorities of beneficiaries.

38. Adoption. A package of agro-ecological techniques was tested on dedicated plots. However, the implementation and management of these trials revealed some difficulties, as these trials mainly followed a standardized format, therefore reducing their experimentation potential. The stated objective of this intervention was to compare traditional practices and new practices testing different varieties, fertilization, new spacing, and production costs. However, in the plots visited by the MTR team, several agro-ecological practices had not been used, including the association of crops and the use of local organic matter. Also, the physical management aspects of the soil were not worked[33].

39. In the case of cassava, the project financed plot preparation and fencing, also providing different local varieties, from other regions and from EMBRAPA. However, in the plots visited by the mission team, it was observed that manioc was the only cultivation, with the soil totally uncovered and employing an imported non-synthetic fertilizer, with relatively high cost.

40. Several varieties of forage plants were experimented with (sweet and giant palm, sorghum, mandacaru without spines, leucena, forage watermelon) using several techniques (e.g. spacing, fertilization). The objective of these trials was to monitor the yield, its adaptation and costs, in view of their future employment as fodder. This represented a possibility for improving the rearing of small animals (mainly

[33] It should be noted that this is only relative to the gardens visited by the MTR mission team, whereas there are examples of more successful organic trials (IFAD. 2010. Gente de Valor Mid-Term Review. p. 45).

sheep and goats) and cattle for milk production. Given the fact that animal husbandry is a source of savings and income in the region, the farmers showed a great interest in these trials.

41. Adoption was fostered by context-relevance of the innovations promoted. Droughts are cyclical events affecting local production and soil conditions, mitigated by conservation practices implemented by Gente de Valor. However, the adoption of a number of innovations was constrained by several factors. The processing plants for cassava, Brazilian plum and honey required sanitary and environmental authorizations, which were indispensable before the start of their construction. The release of such concessions delayed the completion of the physical works as well as of all the activities required for the proper functioning of these units. Delays were also reported for the delivery of eco-efficient stoves.

42. Access to land also represented a barrier to the implementation of productive home gardens. According to Register of Domicile and Cadastre of Rural Property, 41.7 per cent of the 693 surveyed properties were less than 5 ha, of which 23.2 per cent were less than 2 ha. In a semi-arid environment, this amount of land provides only limited support to the livelihoods of rural families. In the case of some suburbs targeted by the project, some beneficiaries did not have enough land to build a cistern. The associations also had difficulties in finding a suitable area for the nurseries.

43. Diffusion. According to the PCR, 6,245 farmers adopted the water cisterns for water storage. 4,893 farmers benefited from the productive home gardens, introducing their produce in to their diets. 22 productive units were implemented over the course of the project. However, the construction of cassava processing units was very expensive. As a result, the project could not meet the demand for processing units, which resulted in limited uptake of the innovation. In some cases, this further affected the planting of cassava, which diminished due to a lack of accessible processing units.

44. Poverty-relevance. There is clear evidence that the Project works with the poorest. There is no questioning of the success in this prioritization. This is particularly relevant since policies and projects to combat poverty often struggle to reach this segment, which in general does not have structured forms of organization and is difficult to identify and access for planners and managers. Also, the fact that the innovations were very-well adapted to the local conditions reinforces their poverty relevance. Specifically, ouricoury palm processing machines were relatively small size and low-cost, and could be easily taken from family to family, towed by a motorcycle. Apiculture only required a small investment and a relatively small amount of individual labour to generate income, which made it a pro-poor intervention.

45. Cost-effectiveness. Productive home gardens appeared to have high benefit/cost ratios. Productive home gardens rely on two 5000 l cisterns for irrigation. The relatively small size of the cistern, a cost-saving feature, enabled a significant number of households to be served. However, it did not allow for the irrigation of important areas of vegetables (less than 50 m2), even when combined with water-saving cultivation techniques. Therefore, the MTR reports that the produce from the productive gardens were mainly destined for self-consumption. As for small ruminants rearing, the costs of introducing improved raising practices for a herd of 30 heads is estimated at BRL 2,094 (US$687) per household on average, while annual net profits increased from US$981 to US$3,267, meaning that within a year of operations, costs could be recovered and exceeded. Apiculture and ouricoury processing machines were indicated as cost-effective.

46. Outcomes. The principal areas of impact of the innovations were increased household assets in terms of consumption (increased food security), increased knowledge and behaviour, and resilient environmental and NR sustainability.

47. Soil conservation and water-saving practices had an impact on the sustainability of the local ecosystem, further strengthening the resilience of family production establishments. Productive home gardens enhanced the availability and diversity in the household food basket by adding new types of vegetables (e.g. lettuce, beetroot, cabbage, onion) and fruits (e.g. orange, lemon, and mango). Communities assisted by the project reported better availability of fruits and vegetables in their diet, either through consumption of their own produce or because small earnings from the home gardens were directed to purchase higher-quality food. Product diversification was also achieved through the cultivation of seedlings within nurseries, which were then sold in the neighbouring communities, allowing the beneficiaries to strengthen production, preserve biodiversity and raise their incomes.

48. The involvement of women in home gardens and through that in vegetable farming, fruit and cassava processing and handicrafts allowed them to have access to and control over part of the household income for the first. They were also involved in bee-keeping and goat-raising, which were previously considered men's responsibility. The project adapted some investments to women's needs, including the construction of potable water tanks close to their houses and the eco-efficient stoves and bio-digesters for drudgery-reduction.

49. Sustainability. The initiatives conducted in the focus area on selected value chains were implemented in the last phase of the project. Their sustainability depends on the continuity of follow-up work and investments. Productive home gardens and ecological techniques introduced important changes in the form of resource use by families with positive impacts for physical and financial health, which are likely to be sustainable. While these initiatives had shown good chances of economic viability, they still required financial support and technical assistance for consolidation in order to produce a significant increase in income per family.

50. The sustainability of ouricoury coquinho-breaking machines is supported by the local availability of inputs and repair services.

51. Scaling up. The Government of Bahia provided support to the project's activities from the beginning. The State government showed great interest in the innovations and approach introduced by Gente de Valor and their potential to be upscaled to other municipalities of the State of Bahia. However, the lack of adequate monitoring, systematization and documentation of such innovations and best practices hampered scaling up as well as contribution to public policies and programmes.

52. Lessons. Adaptation to the local context and support to enabling factors were key elements of the innovations promoted.

53. The poorest groups are often hard to reach, as they are often spread across large areas lacking any structured organization. The creation of Associations and GIs allowed the project to empower these groups and foster the adoption of innovations targeted to the poorest themselves.

54. The specific agro-ecologic conditions of the area of intervention, the semi-arid Sertao, required preliminary initiatives aimed at ensuring water access. Innovations were therefore implemented thanks to this previous preparation work.

COUNTRY	Rwanda
PROJECT NAME	Support Project for the Strategic Plan for the Transformation of Agriculture
IMPLEMENTATION PERIOD	2006-2013
PROJECT TYPE	Agricultural Development

55. Context. Rwanda is a landlocked country located in Sub-Saharan Africa, with a growing population of approximately 12 million in 2016[34] and the highest population density of the continent. Over the last 15 years, the economy of the country has continued to grow at a sustained pace, fostering poverty reduction from 59 per cent in 2001 to 39 per cent in 2014[35]. At the same time, Rwanda reported an outstanding record as innovation achiever, figuring among the six Sub-Saharan economies listed as innovation achievers at least five times in the previous six years.

56. The agricultural sector is still a key component of the economy of the country, contributing to 30.9 per cent of the total GDP in 2017. However, Rwandan agriculture is mainly characterized by small production units, reflecting the issue of land availability and the relative pressure exerted by the growing population on the country's national resources. Poverty still has a high prevalence in rural areas (43 per cent), especially among households with limited landholding, who obtain more than half of their income working on other people's farms (76 per cent).

57. Project. The Support Project for the Strategic Plan for the Transformation of Agriculture (PSTA) was initiated in 2005, with the overall objective to "contribute to the poverty reduction process in Rwanda by providing concentrated and collaborative implementation support to the PSTA, which aims to transform the current practice of subsistence farming into market-oriented agriculture, increasing opportunities for growing cash crops, while ensuring food security and preserving the existing resource base".

58. The project targeted the poorest segment of the rural population, focusing specifically on women-headed households, youth, families affected by HIV and civil war. It further aimed at covering the broader needs of farmers' associations and their federations, as well as the administrative and coordinating central, provincial and district bodies in charge of agriculture and the implementation of local development plans.

59. Innovation. PAPSTA was designed with two technical components. The first component was dedicated to building institutional support, foster capacity-building of the agricultural sector and strengthening rural community organizations. The second component of the project aimed at improving agricultural and livestock production through specific pilot actions, articulated in five subcomponents:

- Watershed protection and hedging (piloting soil and water conservation practices);
- Integration of livestock into agricultural systems (introduction of high-quality breed livestock);
- Marshland development and rice production (SRI);
- Research and development to support agricultural intensification (improved rice varieties and soil conservation practices);
- Replication mechanisms for pilot actions (mainly of a financial nature).[36]

[34] World Bank Data. Available at: https://data.worldbank.org/country/rwanda
[35] Ibid.
[36] IFAD. 2005. Report and Recommendation of the President. p. 7.

60. Eight technical innovations were identified: hedge planting of fodder trees and grasses on bunds for soil conservation (bocage), optimal use of organic manure in combination with fertilisers or lime and natural phosphate to improve paddy soil fertility, rainwater harvesting for hillside small-scale irrigation, new rice varieties, seed multiplication (corn, bean, soy, potato, manioc), SRI, introduction of high-quality breed livestock, biogas digesters.

61. Detailed information is available on the new technologies for soil protection, and specifically the system of bocage (hedging), the introduction of SRI, the genetic improvement of livestock through artificial insemination and seed multiplication.

62. Identification. IFAD's strategy in Rwanda, as documented in the 2007 COSOP, builds fully upon government strategies for the transformation of the agricultural sector.

63. The main policy of reference was the national Strategic Plan for the Transformation of Agriculture (PSTA), a component of Rwanda's policy for poverty eradication, which emphasized poverty reduction, devolution of power to decentralized administration, empowerment and capacity-building at all levels. The PSTA provided the basis for selecting the technical innovations introduced by the Support Project for the Transformation of Agriculture (PAPSTA). This project was designed collectively by different stakeholders (donors, beneficiaries, government) with the aim of supporting the Ministry of Agriculture (MINAGRI) in managing and implementing the four priority action programmes of the PSTA.

64. Strategy. The introduction of innovations often required the provision of complementary services. The distribution of pure-breed and cross-breed cows as well as the replacement of local cows with artificial insemination required the establishment of a professional veterinary system. The project design envisioned the creation of a private veterinary system at the district level, supplying medicines for the prevention and control of livestock disease. The veterinary system had an animal health insurance scheme attached. The scheme followed a basic principle, requesting the payment of 1,000-2,000 francs per farmer to constitute the initial fund from which the cooperative reimbursed 50 per cent of veterinary costs incurred by contributing farmers[37]. During the second phase of the project, together with a pregnant heifer, beneficiaries were provided with a batch of acaricide products to administer preventive treatments against tick-borne diseases.

65. Since its pilot phase, SRI reported increased incomes. However, in order to achieve its full potential, SRI required a specific technological package. Specific mention is made to the water management component. Seed multiplication required complementary inputs in terms of manure and phytosanitary products, for which sale counters were established.

66. Community-level capacity building. The replication of successful innovations was enabled by a strong institutional support, established in Component 1 of PAPSTA. The activities under this component were intended to build the capacity of decentralized stakeholders to implement project activities and share the knowledge required to replicate pilot actions.

67. PAPSTA established community innovation centres at the sector level, responsible for knowledge transfer and the scaling up of successful pilot actions, and a new system of extension services based on FFS. This system built on a partnership among farmers, extension services and agricultural research centres. The establishment of FFS enabled the involvement of beneficiaries in deciding which technologies were better performing and worth diffusing.

[37] The lack of a financial analysis to support the design of the insurance schemes posed a high risk that they were not viable overtime (IFAD, 2013, p. 22).

68. IFAD also supported the replication of pilot innovations through the provision of two investment funds to enable farmers or farmers' groups to access the necessary financial resources for replication. At design phase, special attention was given to youth and women's access to these funds.

69. During the second phase of the project, marketing support activities were put in place to support innovations in the livestock and agricultural intensification fields. These include the establishment of milk distribution centres[38], the distribution of mobile phones to access the Agricultural Market Price Information System (which provides information on prices for agricultural commodity chains within the main markets in Rwanda) and a partnership with WFP within the scope of the Purchase for Progress (P4P) framework, allowing rice and maize cooperatives to supply WFP with their surplus production.

70. Adoption. The main innovations piloted within the watershed management cluster were adopted in response to the widespread soil degradation, affecting the areas of intervention. The project put in place an integrated system of innovation, where measures against soil erosion were the entry point to support improved livestock and agricultural production. The introduction of livestock was fostered to solve the issue of lack of manure, to be used for agricultural intensification, further supporting food security.

71. Livestock activities have been well-implemented and well-received by the families. Three years after implementation, livestock insemination and distribution activities showed good performance statistics. However, the mortality of local small stock (30 per cent) was a problem. The MTR suggested that more attention had to be paid to the sourcing of local animals.

72. For the areas of Bugesera and Nyanza, plants transplanted had to face a severe period of drought, that significantly reduced their recovery rate (55 per cent). This caused a loss of plants for approximately US$130,000. Also, the type of forage shrubs employed for animal feeding and soil fixation were not suitable to the high-altitude areas of Gakenke, Ngororero and Nyamagabe. This constrained the availability of fodder in those areas and reduced the quantity of milk produced. The transportation of plants grown in family nurseries in the lower areas represented a limitation, considering that the plants were usually transplanted further uphill.

73. SRI adoption was constrained by poor water management (due to the fact that the rehabilitation activities of marshlands had not started at the time of the MTR) and cooperatives' disorganization. The cooperatives did not have enough funding to purchase the inputs within the required deadlines. Beneficiaries also had issues with the basic production equipment and post-harvest infrastructure. Another big challenge for rice producers was to plant at the right time (normally in January and August). In fact, if planting was late, up to 50 per cent of production could be lost. Adjustment to the planting calendar was however difficult because of the previous rice crop.

74. Seed multiplication was constrained by the absence of storage warehouses and drying areas, necessary for farmers to certify their seeds. This infrastructure was built in the districts of Kibaza and Rwabutazi from rice producers' cooperatives during the second phase of the project.

75. Incentives. The project distributed high-quality breed livestock using a revolving credit-in-kind system, known as POG. This system was organized through community groups and producers' associations, following specific eligibility criteria for selecting beneficiaries based on their physical and financial capacity to establish required facilities (such as forage and cattle sheds). Subsidies were provided for the construction of stalls and for initial inputs.

[38] In line with the government policies and in response to the increased milk production, PAPSTA established six milk distribution centres on the basis of a matching grant (IFAD, 2009, p. 48).

76. Since fodder cultivation, like hedges and other soil conservation activities, required a large amount of work, agroforestry plants (plantes agro forestrier et herbes fixatrices) were provided for free to the farmers. This was important also because access to fodder increased the chances of eligibility for the POG scheme.

77. Diffusion. The pilot actions and technical innovations were initially implemented in six selected pilot watersheds in six districts, representing major agro-ecological zones of the country. After the MTR in 2009, five additional areas were selected for replication.

78. As early as October 2008, the SRI and living hedges (fodder plants) were already replicated outside the pilot zones by the beneficiaries themselves.

79. The Project Completion Report reported data on the diffusion of innovations under component 1 of PAPASTA, at the end of the project: 44,180 ha of degraded land were hedged and protected against erosion (443 per cent compared to initial target); 32,950,456 agro-forestry trees were produced and transplanted, equivalent to 92 per cent of project target. The operations were done through private and household nurseries (12.95 million agro-forestry trees produced in private nurseries and 20 million agro-forestry trees produced in household nurseries). However, 2,998,245 forestry seedlings were distributed representing only 31 per cent of the 9,696,000 forestry seedlings that were planned to cover 606 ha; 683 ha layouts of progressive terraces were established (105 per cent).

80. At the end of the project, a total of 3,750 dairy cows were distributed to vulnerable households, exceeding the initial target by 285 per cent (increasing demand from beneficiaries and the Government). Similarly, a total of 7,580 small ruminants and 909 pigs were distributed, exceeding the initial prevision of 3,600 animals. The distribution of pigs was not done in some watersheds due to religious beliefs or restrictive measures adopted in response to the outbreak of contagious diseases (peste porcine). Artificial insemination reached 8,257 cows (with 50 per cent to 70 per cent success rate) against the 3,000 foreseen. This was a direct consequence of the increased number of cows distributed and farmers' awareness on advantages related to genetic improvement in terms of increased milk production.

81. SRI, initially piloted on two marshlands, reported high adoption rates. Success factors include mobilization and training of rice farmers, savings on the quantity of water and seeds employed and high yields (despite the lack of a water management system). SRI was extended to new marshlands in the second phase of the project, reaching a total of 10,100 farmers trained by FFS.

Poverty-relevance

82. While the integration of hedging with terracing has been successfully targeted to the most vulnerable, by virtue of the project design, most project investments were accessible only to land-owning households.

83. Livestock distribution, for example, was restricted to households that owned a minimum amount of land – reportedly 0.6 ha for goats and 0.8 ha for a cow. According to the baseline study, 46 per cent of the households in the area of intervention have less than 0.55 ha. The option for beneficiaries to either obtain a cow or small animals, depending on their land, fodder and labour availability, allowed the participation of poorer households with limited land availability. However, the attached cost of materials and labour constrained the participation of the targeted poor, especially women and orphans, who could not afford to pay their share of the contribution.

84. Involvement in soil conservation activities (e.g. digging and maintenance of the anti-erosion ditches) was rewarded with food supplies from the WFP within the food for work programme. This activity fostered the involvement of the poorest, often landless households, which could not benefit from the POG scheme.

85. Cost-effectiveness. The MTR assessed the cost-effectiveness of pilot activities according to different farm models, combining cows or small stock with crops cultivation on three different agro-ecological zones (half of it being fodder). The analysis shows a significant increase in the annual income for households (from 19 per cent to 68 per cent). The most profitable models are the ones that included cows, due to milk sales and increased availability of manure. However, AI has a high up-front cost. The MTR suggested that if the government wanted to extend this practice to other areas it is important to provide it at an affordable price to farmers.

86. The improved rice varieties, made available from the research component, allowed farmers to save on water and labour. In comparison with the traditional varieties, the rice obtained was also sold at a higher price (+15 to 20 per cent). On the contrary, the cost of rice production under SRI was higher than the cost of production using traditional techniques. In fact, SRI required a large amount of work in terms of labour, weeding and transplanting, paddy threshing and drying.

87. Outcomes. The main outcomes generated by watershed protection (terracing and hedging) and marshland development activities were improved soil productivity, resulting into higher yields and income. According to the beneficiaries interviewed, the increased incomes allowed them to purchase household items and other physical assets.

88. The implementation of soil conservation activities resulted in the control of soil erosion, resulting in environmental resilience and NR sustainability. Increased food production was generated by SRI implementation and improved rice varieties that produced higher yields. On a targeted area of about 12,000 ha, the increase in production resulting from SRI adoption was 4000 t per season. Increased income was also reported from the introduction of nurseries (net profit of US$400,000 through the sale of plants).

89. Benefits. From a preliminary analysis, the yield in t/ha for crops on average doubled with the project interventions. Milk production increased from 1.6 to 10.6 litres per cow following the introduction of cross-breed cows. Households increased meat consumption from 28 per cent to 45 per cent and daily vegetable consumption from 47 per cent to 75 per cent. The number of farmers in associations tripled; farmers who were not members of associations/organizations fell from 48 per cent to 15 per cent. However, the lack of a proper functioning M&E system constrained the ability of the project to assess the effectiveness of the pilot activities on the target group. Beneficiaries of cow distribution reported an average sale of 5 l of milk per day, which translates into a monthly revenue of approximately 20,000 FRW. From a nutritional point of view, milk family consumption varies from 2 to 5 litres per day in households that did not consume any milk before the project.

90. Sustainability. In 2009 the project re-adjusted its strategy for the next 4 years. One of the main priorities was to ensure the sustainability of the successful innovations introduced by PAPSTA. This was realized involving MINAGRI, the local administration and farmers' organizations, supporting their progressive taking charge of the initiatives. In the first five pilot zones, the private service providers were gradually disengaged.

91. The establishment of family plant nurseries allowed farmers to continue growing their own forage shrubs even after the end of the project. The establishment of progressive terraces that incorporate fodder hedges had the potential to be sustained, as the maintenance required was relatively low and the use of hedges as fodder for the animals provided an incentive for the farmers. However, further extension of the terraces required additional external funding. Also, fodder cultivation might be threatened during dry season.

92. The sustainability of livestock distribution is linked to the POG system. If the discipline is maintained within the communities in passing on the animals and if diseases do not erode the number of animals, the process should ensure the sustainability of the initiative. The sustainability of the livestock interventions also relied on the formation of breeding cooperatives, who managed the sale of vet supplies and livestock food. The discontinuity of subsidies supporting the construction of stalls might also represent a challenge for the sustainability of the livestock intervention, especially since the POG system for materials did not widespread across all project districts.

93. The sustainability of the SRI was linked to the ability of producers' cooperative to restructure themselves after the end of the project and become independent, relying on increased revenues.

94. Scaling up. SRI and fodder cultivation spontaneously spread out of the pilot zones during the first three year of implementation. The testing and implementation of the various innovations promoted by the project led to the publication of a number of standard technical packages that are currently used by the national extension service and other development partners all over the country.

95. Scaling up was a design feature of the project, that enabled local districts to take charge of project initiatives and incorporate them into their planning process. However, the scaling up strategy did not contain a thorough analysis of the human and financial resources of the district, which are fundamental to ensure a medium/long-term sustainability.

96. A few innovations from PAPSTA were replicated in KWAMP, a subsequent IFAD project concentrated in one district (Kirehe). As far as technical innovations are concerned, SRI, bocage, and seed multiplication were replicated with slight changes, incorporating lessons learned from PAPSTA. SRI, for example, was adapted to the new project and did not include water management. Higher investments in dams compensated for the missing water component from the adapted SRI package. Participatory approaches and enabling factors, such as the animal health insurance scheme, the in-kind revolving credit system (POG) for livestock distribution and the establishment of CCIs and CLGs, were also replicated in KWAMP.

97. Lessons. A specific component of the project was dedicated to piloting innovations aimed at fighting soil degradation. The project adopted an integrated approach, called "Bassin Versant" (watershed area), combining soil protection measures (entry point for agricultural intensification), livestock distribution and agricultural intensification. Beneficiaries were motivated in performing soil protection activities so that they could access forage shrubs and become eligible for the POG scheme, receiving improved-breed livestock, which would in turn increase the availability of manure for agricultural intensification activities. The direct association of watershed protection activities with farmers' production activities with an income-generating potential fosters the participation of a large number of beneficiaries.

COUNTRY	Bangladesh
PROJECT NAME	Microfinance for Marginal and Small Farmers Project
IMPLEMENTATION PERIOD	2004-2010
PROJECT TYPE	Credit and financial services

98. Context. Bangladesh is one of the fastest-growing countries worldwide. Over the last seven years, the annual GDP growth rate has averaged 6 per cent-7 per cent and it is expected to exceed 7 per cent per year for the next five years. Despite promising developments in the field of innovation and poverty reduction, Bangladesh has high rates poverty (24.3 per cent of its population living below national poverty lines), with approximately 25 million people living below the extreme poverty line of US$1.90 per day. While only 4.3 per cent of the urban population lives in poverty, rural areas show a higher rates of poor population, reaching 35.2 per cent.[39]

99. In Bangladesh, the microcredit sector is well-established, relying on non-governmental organizations acting as MFIs and channelling funds to the landless poor. However, this system has not catered adequately for smallholder farmers (also known as "small" and "marginal" farmers), who also had limited access to credit for agricultural purposes from banks.

100. Project. The Microfinance for Marginal and Small Farmers project was conceived to introduce an innovative approach to deliver financial services to small and marginal farmers, in partnership with Palli Karma-Sahayak Foundation (PKSF), and the apex organization in the country, by providing funds to MFIs. Launched in 2005, MFMSP covered 14 districts in north-west and north-central Bangladesh over a period of six years, with the goal “to provide improved livelihoods to 210,000 poor small and marginal farmer households”.

101. Innovation. The microcredit component was complemented by the introduction of five new crop-related technologies: leaf colour chart and super urea granules for efficient fertiliser use in rice production, pheromone traps for reduced use of pesticides in vegetable cultivation, AWD for rice production, and the Maria model for seed production and preservation.

102. Identification. The identification of technical innovations was made through the assessment of farmers’ groups’ priorities during the implementation phase of the project. More in general, the need for crop-related technical innovations aimed at increasing agricultural productivity stemmed from the National Agricultural Strategy for Bangladesh (NAP),[40] in line with IFAD Strategic Framework for Poverty Reduction and Regional Poverty Strategy for Asia.

103. The introduction of LCC and USG was linked to a shortage in the availability of urea, a fertilizer, which in turn limited agricultural production. This shortage was the result of a government policy, made worse by illegal exports of urea out of Bangladesh.

104. Strategy. A partnership with the Bangladesh Rice Research Institute (BRRI) supported interventions in paddy and provided residential training at the BRRI Training Centre for eight batches of Technical Officers (TO) and Assistant Technical Officers (ATO).

105. Technical support was provided in the form of farmers’ group technical trainings, demonstrations and field visits by the Department of Agricultural Extension (DAE).

[39] World Bank Data. Available at: https://data.worldbank.org/indicator/SI.POV.NAHC?locations=BD&view=chart
[40] D) increasing agricultural productivity (both land and labour) through a combination of research output, improved support services, capital investment, increased input application, better land use and more efficient input use. This will both ensure food security and release land for diversified crops (IFAD, 2003, p. 7).

Follow-up training was performed by Technical Officers (TOs) and Associate Technical Officers (ATOs), hired by the POs through project funding. From interviews with beneficiaries, it appeared that the DAE's training models were not developed assessing specific farmers' needs[41] and trainings were mainly conducted in the form of classroom teaching. ATOs and TOs provided more practical and on-the-field training during weekly meetings.

106. Adoption. Investigations in the field by the MTR mission highlighted several factors influencing adoption. For example, seed preservation (for which MST is used) and vegetable cultivation (for which pheromone trap is used) are typically performed by women, who reported higher rates of adoption after training. LCC had been demonstrated in almost all groups and was popular among farmers. However, adoption was constrained by the lack of availability of charts.

107. Delays in the supply of LCC further slowed their distribution to the farmers, which only took place in the fourth year of the project. Also, an average of 2/3 charts were provided to groups of farmers, which constrained their usage. Many farmers could not read properly and were therefore not able to read the instructions on the back of the chart.

108. Not all technologies could be employed in all target areas. AWD, for example, was relevant mainly in areas prone to flooding and not where deep tube wells were used. The spread of USG was constrained by the fact that it was relevant mainly in clay-like soils. The adoption of USG was further constrained by two factors. First, USG was not widely available, as it had to be produced from standard prills of urea (small pellets) using a special briquetting machine, which was not popular in Bangladesh. This issue was solved in 2007/2008, when a national programme provided briquetting machines. Second, the application of USG in the field manually was very labour intensive. In relation to this, the project introduced 400 applicator machines to project POs.

109. Despite the promotion of IPM by the DAE, pesticide sales suggest that farmers continued to use increasing amounts of insecticide. This seems to be linked to the limited efficacy of pheromone traps in controlling the stem borer, the most serious pest affecting rice cultivation.

110. Diffusion. Given the demonstrated positive impact on net income and interest by farmers, the introduction of new technologies was successful. In general, most respondents who received training (over 90 per cent for all technologies) found the technology useful. Adoption rates varied between 50 per cent (for AWD) and 77 per cent (for MST) of the respondents. Regarding specific agricultural technologies, many beneficiaries who received training reported having disseminated the technologies to others.

111. According to POs' progress report, it was found that around 29,815 farmers of 25 POs had used LCC by June 2011. Training on USG was provided to 9,514 beneficiaries and 890 demonstrations were organized for farmers. As of June 2011, around 47,228 farmers from 25 POs had used the technology.

112. The project, in collaboration with Rural Development Academy (RDA) and Bangladesh Rice Research Institute (BRRI), distributed 32,600 porous pipes to the beneficiaries. By June 2011, 10,302 farmers had used the porous pipe for irrigation purposes and 271 demonstrations had been made. However, AWD uptake remained low. This technology is only really suitable in areas dependent on pumped water, while it is not really useful in low lying areas where water is raised

[41] "Training needs assessment has also proved problematic in so far as farmers are often unable to identify their training needs in the absence of knowledge about new technologies. However the alternative of simply using a standard pre-conceived training module risks teaching farmers what they already know or what is not relevant. Ideally the Technical Officers of the POs should themselves be made aware of promising new technologies and then in discussions with beneficiary groups assess what training the farmers need" (IFAD, 2008, Annex I p. 39).

by more traditional means. The main problem however is that farmers usually pay pump owners a fixed price for water for a season, and there is little incentive for pump owners to pass on any 'savings'. At present therefore the technology is largely restricted to farmers who own their own pumps and can benefit from savings.

113. By June 2011, the project had arranged training on Maria model for 41,947 beneficiaries and 811 demonstrations on seed production and preservation following the Maria Model; a total of 24,534 farmers of 25 POs stored rice seed using this technology. 28,000 pheromone traps had been distributed to the beneficiaries and 461 demonstrations organized in the field using the pheromone trap; around 1,435 farmers reportedly used the technology.

114. Poverty-relevance. LCC was easy-to-use and inexpensive. This diagnostic tool was used for efficient urea application in rice fields by monitoring the relative greenness of a rice leaf. Using this tool, farmers could easily top dress the needed amount of urea, comparing rice leaf colour with LCC colour strips. This helped to avoid overuse of fertilizers and thus reduced the cost of urea for farmers.

115. Cost-effectiveness. USG contributed to a reduction in the amount of urea needed by 30 per cent and to an increase in yield by 10 per cent. According to the 10 POs surveyed by the PKSF, the use of USG generated a saving in urea up to 40 per cent in comparison with traditional prills. This represent a cost saving of Tk 1350/ha. At a time when urea supply was limited and the price had increased, the use of USG appeared to be a cost-effective measure.

116. Pheromone traps were described as a low-cost and environmentally-friendly insecticide. It was observed that farmers who used the pheromone trap in their eggplant plots to control fruit and shoot borer, and in cucurbits to control fruit fly, saved up to 50 per cent in costs for insecticide and increased production by approximately 25 per cent for the same area of land. LCC was a labour-intensive practice, that required frequent visits to the field, which increased the labour costs by Tk 500/ha approximately. Nevertheless, the implementation of such practice reported yield increase (5-10 per cent) and savings on urea (20 per cent). Farmers reported a slight yield increase and a small saving, deriving from less water usage. PKSF survey indicates that the number of irrigations during the boro season can be reduced from 18-20 to 10-14 when using PP. This in turn means that about 40 per cent less water is needed on average and that farmers can reduce the amount of diesel required for pumping on average by 15 litres a season, resulting in substantial cost savings (Tk 7,300/ha).

117. Outcomes. Most of the adopters reported yield increases and reduction in production costs to varying degrees. As per the PCR, the use of LCC could lead to a 5-8 per cent yield increase, the USG to a 10 per cent yield increase, AWD to a 4 per cent grain yield increase and the pheromone trap to a modest yield increase. As the majority of priority technologies for rice production were predominantly intended for home consumption, the increase in yields positively affected food security.

118. Overall the project had a positive impact on natural resources and the environment. The two fertilizer-related technologies that were promoted, USG and LCC, contributed to the reduction in use of urea fertilizer by farmers, while pheromone traps served to reduce the use of chemical insecticides. AWD technology reduced excess groundwater pumping. Further, short-duration rice varieties were introduced as an adaptation measure to climate change (delayed rain season).

119. Female beneficiaries reported the acquisition of new skills, such as improved rice seed preservation (MST) and the use of pheromone traps for aubergine and

cucurbits cultivation, which reduced expenditures and enhanced income, raising their status in the household and community.

120. Sustainability. All five technologies introduced by the project were simple and low-cost, presenting good potential for continuous adoption by farmers and increase in returns, but sustainability requires some follow-up. These innovations are environmentally sustainable, contributing to the reduced use of agrochemicals.

121. Two issues require specific attention. First, the group-based approach at the basis of the microcredit system could be compromised by high dropout rates, mainly influenced by “graduation” of some borrowers from microcredit, and lack of project activities attached to the funding. Second, the, technical support and training by NGO-MFIs might not be sustained without project funding. If not properly tackled, these issues might affect the sustainability of the five technologies.

122. The sustainability of USG is also linked to the availability of applicators. While they were distributed for free by the project, their cost is relatively high. Moreover, these machines need frequent repairs, for which a repair system should be put in place to ensure the sustainability of the technology. Local production of applicators seems however a promising factor in terms of future sustainability and diffusion of the innovation.

123. Scaling up. There are clear indications that most of the technologies promoted will continue to be used by beneficiaries, and that the use of these technologies was already spreading spontaneously. As indicated, many more pheromone traps were being used by beneficiaries than were originally distributed, and there were signs that farmers were increasingly using USG.

124. Replication of pheromone traps was reported in subsequent IFAD projects in Bangladesh. Despite the main focus was on scaling up the innovative microcredit component, MFMSFP was followed by another IFAD project (FEDEC) implemented by PKSF. Through its micro-enterprise loans, FEDEC launched 42 sub-projects, which provided technical services to farmers. These included both the promotion of pheromone traps and livestock vaccination, introduced in an earlier IFAD project in Bangladesh (MFTSP).

125. Lessons. The incorporation of agricultural expertise, through the appointment of TOs and ATOs, proved to be an effective way of providing farmers with technical knowledge. ATOs and TOs main function has been catalytic in that they have helped farmers understand the details of technologies they were already aware of, rather than teaching them about the overall technology from scratch. This raises the possibility in future projects of minimising the amount of formal training and focusing on providing access to technical expertise on an ad hoc basis.

126. The project has demonstrated quite clearly that it is better to focus on the promotion of as limited number of technologies rather than a wide range of technologies. This was not fully recognised at the design stage that allowed for a wide range of technologies to be promoted based on the perceived needs of farmers at different locations. This demand- driven approach did not appear very successful and during implementation it was decided to limit the number of technologies promoted and this appears to have been successful. Also, the most successful technologies, in terms of adoption rates, tend to be simple, to have a low cost, and or, to be cost-effective for farmers.

Approaches to innovation by other IFIs

1. The analysis in this synthesis took a twin track approach to benchmarking IFAD's performance and the external validity of the findings by comparing (a) project level performance; and (b) innovation practices.

2. IFAD's strategy for innovation, with an embedded systematic process, capacity building for staff and working in partnerships is closely mirrored by the approaches taken by other major development partners including the World Bank,[42] Asian Development Bank (AsDB)[43] and African Development Bank (AfDB).[44] The other Rome-based agencies, the World Food Programme[45] and the Food and Agriculture Organization of the United Nations share comparable approaches.[46] Also, the UN Innovation Network spans 11 funds and programmes promoting an approach characterised by three pillars: building an architecture to promote innovation; activating partnerships and building an innovation ecosystem; and creating a culture of innovation. IFAD has recently become a member of this network.

3. Of note for this synthesis are the differing emphases on technology. The World Bank characterises innovation as bringing new products, new processes, and new forms of organization into economic use without any specific consideration of technology. AsDB's Guiding Principles for their Strategy 2030 highlight promoting innovative technology and sees the adoption of advanced technologies as integral to agricultural productivity and food security. AfDB strategy for 2016-25, Feed Africa, recognises the importance of contextually appropriate technology, but sees the technology challenge as being one of dissemination rather than innovation.

4. Importantly, the definition of innovation adopted by IFAD and refined in this report is widely shared. A key feature being that innovation is about change that is new to the context, irrespective of whether it is new in nearby localities, elsewhere in the country, or the world.

5. It is not possible to make direct comparisons about project performance with respect to innovation. No partner agencies have such a comprehensive performance rating system as that employed by IFAD, so there are no direct comparators of project or country programme performance as regards innovation from completion reports and similar portfolio reviews.

6. Evaluation reports from partners do offer insight and comparisons with the findings in this synthesis, although none have been found that focus specifically on technology. One study from the World Bank[47] and two from the Asian Development Bank[48] have findings that echo the analysis in this synthesis, although their remit was multi-sectoral and wider than technical innovation. The 2013 World Bank Group Support for Innovation and Entrepreneurship study found in a comparison between innovative projects rated as successful or unsuccessful, that the main

[42] The Innovation Policy Platform (IPP), developed by the World Bank Group and the Organisation for Economic Co-operation and Development (OECD), is a web-based interactive space that provides easy access to knowledge, learning resources, indicators and communities of practice on the design, implementation, and evaluation of innovation policies.
[43] AsDB 2009 Operational Plan for Sustainable Food security in Asia and the Pacific makes reference to innovation. Innovation features: as an output indicator under enhanced knowledge and technology; as part of support to agricultural research; and for strengthening staff skills. 2017 the Bank Established a High Level Technology Fund that addresses the challenge of innovation. And Innovative technology is presented as part of the Vision, Value addition and guiding principles in the Strategy 2030 published in 2018.
[44] Feed Africa - Strategy for Agricultural Transformation in Africa 2016-2025 embraces innovation, although the challenge with technology is presented as one of dissemination rather than innovation.
[45] WFP Innovation Accelerator, established in August 2015.
[46] Tropical Agriculture Platform – a multilateral facilitation mechanism with the aim to foster better coherence and greater impact of capacity development for agricultural innovation systems in tropical countries.
[47] World Bank Group Support for Innovation and Entrepreneurship. IEG September 2013
[48] AsDB 2013 Learning lessons Agricultural Value Chains for Development; AsDB 2018 Thematic Evaluation Support for Small and Medium-Sized Enterprises, 2005–2017: Business Environment, Access to Finance, Value Chains, and Women in Business.

factors were overly complex design, inadequate risk assessment, poor supervision and inadequate performance by the borrower. Lessons from an AsDB 2012 study into Support for Agricultural Value Chain Development argued that value chains need continuous inputs for innovation and technology to raise productivity, reduce costs, and stay competitive. In the context of value chains, the study distinguished between innovation as a continuous process that can involve stakeholders at any point in the chain to improve production, product quality, and marketing processes and technology, which is either imported as a turnkey package or is the output of research and development. That distinction is potentially significant in the context of the UN Secretary General's Strategy on New Technologies and highlights a tension in global interpretations about the relationships between technical, social and institutional change. The study also argued for integrating research into project designs rather than as standalone objectives.

7. An AsDB thematic analysis into support for SME's argued that improving access to finance was not sufficient without other support dealing with capacity constraints including a wider use of technology and innovation.

Benchmarking information

"Where does IFAD stand in relation to partner and comparator agencies?"

	Policy and strategy
World Bank	2012 Agricultural Innovation Systems. An investment sourcebook. 7 modules about the agricultural innovation system approach with principles of analysis and action. Definition is in line with IFAD and our ESR: Innovation is the process by which individuals or organizations master and implement the design and production of goods and services that are new to them, irrespective of whether they are new to their competitors, their country, or the world. An innovation system is a network of organizations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organization into economic use, together with the institutions and policies that affect their behaviour and performance.
African Development Bank	Feed Africa - Strategy for Agricultural Transformation in Africa 2016-2025. Refs to innovative finance and extension models; link to gender and crosscutting issues page 35; More generally, development of context appropriate agricultural technologies and their distribution. (P16) [Strategy sees the issue as being *dissemination* of technology; innovation not referenced much] See Ax IV Fig 20
Asian Development Bank	*2009 Operational Plan for Sustainable Food security in Asia and the Pacific makes reference to innovation.* Some references to innovation: as an output indicator under enhanced knowledge and technology; as part of support to agricultural research; strengthening staff skills; *2017 Establishment of a High Level Technology Fund that addresses the challenge of innovation* *2018 Strategy 2030* Innovative technology is part of the Vision, Value addition and guiding principles (see page 10 Fig 5) Strong links to agricultural production, food security and value chains. Quote Para v page vi v. Promoting rural development and food security. ADB will support efforts to improve market connectivity and agricultural value chain linkages. It will help DMCs increase agricultural productivity and food security by boosting farm and nonfarm incomes, promoting the adoption of advanced technologies and climate-smart agricultural practices, and supporting the improvement of natural resource management standards. It will also help DMCs enhance food safety. *DMC Developing member country*
	Regular performance reporting
World Bank	*Innovation is not included as part of the ICR review methodology, on which the annual results and Performance of the World Bank Group is based. The ICRR Guidelines do note that a reviewer can invoke innovation as grounds to propose a field assessment of an ICR.*

	No comparative statistics for IFAD.
Asian Development Bank	No references to innovation as part of the APPR. Technology is referenced but (2017) only with regard to ICT. The 2017 Development Effectiveness Review references innovation in the context of SDG9, but not with regard to the agriculture sector. The 2010 sector synthesis of Post-Completion Evaluations for agriculture and NR does not provide any analysis related to innovation. Agricultural productivity growth is identified as a key element of interventions with a lesson that projects should have suitable improved technologies. *No comparative statistics for IFAD.*
African Development Bank	PCR and PPER guidelines include innovative projects as a criterion for selection; but there is nothing about innovation in the reviews themselves The 2013 results management framework has minor references to innovation, but mostly concerned with how the Bank operates. The Bank's Feed Africa strategy (see below) has one area of support to enhance agricultural productivity by using modern technologies and references 'Level 2' indicators for number of people trained to use improved technology. *No comparative statistics for IFAD.*
UN	Three UNIN members integrate innovation into their integrated results and resources frameworks at the level of outputs/outcomes and into concrete indicators: UNDP; UNHCR; UNICEF *UNDP (Integrated results and resources Framework 2014-2017)* **Output 7.6**: Innovations enabled or development solutions, partnerships and other collaborative arrangements **Indicator 7.6.1:** Number of new public-private partnership mechanisms that provide innovative solutions for development **Indicator 7.6.2:** Number of pilot and demonstration projects initiated or scaled up by national partners (e.g. expanded, replicated, adapted or sustained) also indicators 1.1.3 (productive technology); (Data available for 2014-2017) The UNDP Results Oriented Annual Report, completed by all country offices, features a section on innovation. Similarly, UNICEF country offices report through the Country Office Annual Report, which features two innovation-related questions. The information is not specific to agriculture. **In some instances, innovation is incorporated into integrated results and resources frameworks, but not operationalized in indicators.** The 2016-2021 Unified Budget, Results and Accountability Framework,[53] the Joint Programme instrument operationalizing the UNAIDS Strategy (On the Fast-Track to end AIDS) features Output 7.3, formulated as: "technological, service delivery and health innovations fostered." The narrative of this output points explicitly at the promotion of innovation in HIV service delivery, including mobile health, eHealth and telehealth. The UNFPA Integrated Results Framework 2014-2017 includes an output under organizational effectiveness and efficiency formulated as "increased adaptability through innovation, partnership and communication." There are no specific indicators on innovation associated to this output. The UN Women Integrated Results Framework 2014-2017 does not include any outcomes, outputs or indicators explicitly related to innovation. (Ref: Formative Evaluation of the UNFPA Innovation Initiative, 2017. Page 29)
World Bank	***Evaluation*** World Bank Group Support for Innovation and Entrepreneurship September 2013 Tables of analysis Data from World Bank, IFC and MIGA project databases between FY00 and FY11 to identify both closed and active projects focused on innovation and entrepreneurship. World Bank sector and theme codes, however, do not use innovation, entrepreneurship, or related terms to report on Bank activities. Nor does IFC or MIGA have a system that officially records or tracks innovation. Thus, IEG adopted an alternative approach to identify relevant projects and activities (appendix B). (page 17) [*Project selection was by a combination of key word search and direct inspection of development objectives and components with necessary variations between the three agencies*.]

Table D.2. Lending on Innovation Component by Income Category

Income category	Lending for innovation components (US$ millions)	No. of projects	Average lending per pr (US$ millions)
Lower	1,352	48	28
Lower-	708	36	20

middle			
Upper-middle	1,711	22	78
Total	3,771	106	36

Source: World Bank.
Note: n = 106. Thirteen projects' lending related to innovation and entrepreneurship was not identifiable. These were all active projects.

Table D.3. World Bank Project Component Lending by Region

	Closed			Active		
	Lending for innovation components (US$ millions)	**No. of projects**	**Average lending per project (US$ millions)**	**Lending for innovation components (US$ millions)**	**No. of projects**	**Average lending p project (millions)**
AFR	223	19	12	843	21	38
EAP	293	6	49	143	2	71
ECA	199	8	25	193	5	39
LAC	612	24	26	954	10	95
Other	196	7	28	115	3	38

Source: World Bank.
Note: AFR = Africa Region; EAP = East Asia and Pacific Region; ECA = Europe and Central Asia Region; LAC = Latin America and the Caribbean Region. n = 106. Thirteen projects' lending related to innovation and entrepreneurship was not identifiable. These were all active projects.

Table D.4. World Bank Project Component Lending by Sector

	Closed			Active		
	Lending for innovation components (US$ millions)	**No. of Projects**	**Average Lending per Project (US$ millions)**	**Lending for innovation components (US$ millions)**	**No. of Projects**	**Average Lending p Project (U millions)**
ARD	520	21	25	444	11	40
ED	590	7	84	376	6	63
FPD	330	28	12	1,096	18	61
Other	83	8	10	332	7	47

Source: World Bank.
Note: ARD = Agriculture Sector; ED = Education Sector; FPD = Finance and Private Sector Development Sector*:* n = 106. Thirteen projects' lending related to innovation and entrepreneurship was not identifiable. These were all active projects.

Chapter 4

CHAPTER 4
PORTFOLIO PERFORMANCE OF WORLD BANK GROUP SUPPORT FOR INNOVATION AND ENTREPRENEURSHIP

Table 4.1. Factors Associated with Project Performance in World Bank Projects

	Projects with		Projects with	
	Unsatisfactory outcomes		Satisfactory outcomes	
Performance Issue	Number	%	Number	%
Inadequate supervision	8	62	5	10
Overly complex design	6	46	14	27
Lack of stakeholder involvement	1	8	2	4
Inadequate technical design	10	77	20	39
Inadequate risk assessment	3	23	3	6
Inadequate M&E framework, poor data quality/indicators	10	77	31	61
Inadequate skill mix of bank team	3	23	0	-

Inadequate borrower performance	11	85	9	18	4:1
Implementation disrupted by a crisis	4	31	8	16	2:1
Number of projects	13		51		

Source: IEG.
Note: M&E = monitoring and evaluation.
a. This is a ratio of percent unsatisfactory to percent satisfactory outcome.

The main problems with project performance were associated with the Bank's role, irrespective of whether projects achieved their objectives. The issues were with project design (complex design, unrealistic targets, inadequate M&E) and quality of supervision. On the borrower side, problems were caused by inadequate performance of government and implementing agencies and implementation delays. (Potential comparison with IFAD results)
A number of interesting features emerged from this analysis. On design, inadequate technical design appears almost as often in successful projects as in unsuccessful ones. As many projects with inadequate M&E fail as those that succeed. On implementation, problems occurred on both the Bank and borrower side. Also, all projects were affected by implementation problems. Setbacks occurred not only in projects that did not achieve their development outcomes but also in projects that successfully achieved them.

Support by the Bank has a much broader coverage than for IFAD. Analysis in five countries selected for the study (Brazil, China, Chile, and Kenya) shows that while by far the greatest investment was in strengthening entrepreneurial capabilities, other innovations covered support to public R&D, Financing schemes, and fostering linkages. (See text pages 57, 58 et seq)

Asian Development Bank

Support for Small and Medium-Sized Enterprises, 2005–2017: Business Environment, Access to Finance, Value Chains, and Women in Business,
The analysis identifies a lack of capacity to innovate. SME's include agricultural processing and businesses, but there is no specific analysis for the sector.
'ADB's operations in access to finance focused mainly on addressing the supply-side issue of lack of SME access to finance. There were no operations to address demand-side issues such as the capacity constraints of SMEs. The lack of capacity and skilled workforce, the limited use of technology and innovation, and the lack of access to product markets were key issues that were not addressed by ADB's operations.' (Linked document F, para 53)
2013 Validation Report for the Indonesia Poor Farmer's Income Improvement through Innovation Project. PCR Rated as Highly Successful (validation downgraded to Successful)

Evaluation Knowledge Study

October 2012

Support for Agricultural Value Chain Development

and

June 2013 Learning lessons Agricultural Value Chains for Development

Emphasis on innovation and technology

Other analysis

World Bank

The Innovation Paradox 2017

Analysis about why developing countries do less innovation than advanced countries, despite its critical role in modern growth theory and how countries achieve prosperity.

Innovation is defined (in business terminology): 'It primarily involves the process of adoption of existing technologies, the process of copying or imitating attributes from other products, or the adoption of new managerial and organizational practices or business models from other companies.'

Good Innovation Policy Design Checklist (Box 6.2, page 118)
The project management and innovation literatures identify the following key dimensions of good innovation policy design (RIME). These are evaluated in the PER review process.
1. Rationale:

- Is there a documented market or system failure to be addressed?
- Is there a clear statement of goals, beneficiaries, and measurable outcomes?
- How will the proposed solution interact with the rest of the policy mix?
- Does the proposed solution take into account how local context may make an alternative policy more efficient?
- Does the measure consider the relative strengths of the public and private

	sectors? ▪ Has the proposed solution anticipated potential capture in its design? 2. Intervention model: ■ Is there a logical model integrating theory, assumptions, and how inputs lead to outcomes and impacts? 3. Monitoring and evaluation methods: ▪ Are there monitoring and evaluation (M&E) approaches and systems set up at the design stage? ▪ Are there clear procedures for M&E feedback to inform the evolution of policy? *Source:* Based on Rogers 2017; Wu and Ramesh 2014. *See also Box 7.5 page 165 Agriculture Extension: The case of EMBRAPA*
UNDP	Innovation Facility 2016 Year in review (strong emphasis on technology)
UNFPA	Formative evaluation of the UNFPA Innovation Initiative July 2017 (includes a comparative analysis)
WFP	Innovation Accelerator Annual report 2017. May 2018

Evaluation framework

Questions for innovation synthesis	
0. GENERAL INFO	
# Evaluation	
Country	
Project name	
Approval date	
0.5 Closing date	
0.6 List of technologies/Strategy for innovation	
Project area	
0.8 Total number of beneficiaries	
Overall Goal Specific objective(s) (if technology related)	
1. Relevance	
Poverty relevance To what extent was the innovation pro-poor?	
1.2 Strategic relevance Was the innovation in line with national strategy?	
1.3 Relevance of partners How relevant and appropriate was the choice of partners?	
1.4 Relevance of enabler support How relevant was support to enablers that was provided?	
2. Effectiveness	
2.1 Results What technical innovations were implemented? (e.g. Agricultural tools, Crops, Energy, Fertilisers and chemicals, Fisheries, Forestry, Land management practices, Livestock, Planting techniques and practices, Post-harvest and processing, Seeds, Water)	
2.2 Pro-poor or equitable benefits To what extent were benefits pro-poor or equitable?	
2.3 Innov Enabling Fact. Were associated financial, institutional and social interventions also innovative?	
2.4 Success of enabler support Was support to enablers a necessary factor for success?	
2.5 Scaling up In what ways has the innovation been scaled up: Organisational scaling-up? Appropriation by partners? Scaling from practice to policy?	
2.6 IFAD processes for innovation design or implementation	

Were IFAD processes effective in support of design and implementation of innovation?	
3. Efficiency	
Cost-effectiveness Is there evidence about cost-effectiveness?	
3.2 Efficiency Is there evidence that technical innovations have increased efficiency and reduced risk?	
4. Impact What is the impact of technical innovations on rural poverty? Are there specific details about quantified productivity; processing; social (assets/consumption/GEEW); knowledge & behaviour; ENRM and resilience? Use the IOE Impact domains below.	
4.1 Household incomes and assets	
4.2 Human and social capital	
4.3 Food security and agricultural productivity	
4.4 Institutions and policies	
4.5 Gender &Youth	
4.6 ENRM &Climate Change	
4.7 Project types or intervention models Are any particular project types or intervention models more successful in promoting technical innovation?	
4.8 Impact on partners To what extent did IFAD supported innovations contribute to changes at institutional / sector/ policy levels?	
5. Sustainability	
5.1 Sustainability How sustainable were the technical innovations supported by IFAD? What were the factors behind?	
5.2 Sustainability en- or disabling factors What is the sustainability of enabling or disabling factors?	
6. Good practices	
6.1 Enabling factors	
Empowerment and social capital	
Access and empowerment	
Demonstration plots and training	
Information and communication technologies	
Social networking and peer learning	
Finance	
Financial literacy and advice on risk management	
Insurance	
Transfers, credit and incentives	
Institutional rules and regulations	

Community infrastructure	
Contract farming	
Cooperatives and farmer federations	
Farming certification	
Land titling and property rights	
Marketing	
6.2 Disabling factors	
6.3 (UN)SUCCESS [What worked well and what didn't?]	
6.4 Lacking good practices Where are good practices not applied or lacking?	
7. Lessons learnt	
7.1 Lessons learnt What are the lessons learnt from this review?	
7.2 Lessons from other IOs What are the lessons that could be learned from other international organisations?	
8. Recommendations	
8.1 Recommendations Recommendations for technical innovation for rural transformation and poverty eradication (opportunities)	
9. Limitations Limitations of technical innovation for rural transformation and poverty eradication.	
X. Other/Notes Comments, thoughts not fitting in the above categories.	

Descriptions and examples of interventions

	Intervention	*Sub-intervention*	*Examples*
1	Crop types	Improved/ new varieties	New or improved varieties of the following crops were introduced: roots, bulbs and tubers (incl. cassava, onion, yam, cocoyam, potato, sweet potato, turmeric, ginger); tree crops (incl. mango, papaya and palm tree); field crops (incl. maize, soybean, groundnut, peanut, cowpea, millet, fava beans); fodder crops (incl. alfafa and barley); biofuel crops and high-value crops (incl. tea, coffee, sorghum and jatropha); vegetables[49].
			The new or improved crop characteristics included: culinary or physical characteristics, such as seedlessness; field performance/production characteristics, such as high-yielding or short-duration varieties; abiotic stress tolerance/climate-smart varieties, such as drought or salinity tolerance; biotic stress tolerance, such as pest and disease resistance.
		Diversification	The range of introduced crop types included: vegetable species, including spiny bitter cucumber, melon, chilli, summer tomatoes; cash crops/high-value crops, including flowers, asparagus, coffee, patchouli, castor, pyrethrum, saffron, oil palm; tree crops, including pistachio, Indian butter tree, acacia, olive, almond, apple, cherry, carob; field crops, including soybean and mung beans; fodder crops, including elephant grass and Napier grass; roots and tubers, including cassava, potato, sweet potato, ginger, arrowroot; various perennials, including bananas, hibiscus, grape, pineapple.
		Improved rice varieties	Improved rice varieties include saline-tolerant rice varieties for climate resilience, high-yielding varieties, short season rice, drought and stress-tolerant varieties, Nerica and special-flavoured rice varieties.
2	Crop management	Improved crop management techniques	Improved crop cultivation techniques were introduced in 21 countries, across 5 regions. In 16 cases, there is only a general mention of improved crop production methods in the evaluation reports, without further detail as to the precise nature of the innovations. The range of crops included vegetables (in 7 projects), roots and tubers (in 3 projects), maize (in 2 projects) and fodder crops (in 2 projects). Specific management practices listed in the evaluation reports included mulching, seedling nurseries, crop establishment and spacing, timing of planting, and harvesting. In India, improved jhum (shifting cultivation) was introduced, which comprised integration of diversified cash crops, multipurpose trees and homestead vegetable production.
		Rice production techniques (incl. SRI)	On a total of 15 innovations related to rice production techniques, 10 were specifically referring to SRI. Other innovations included the introduction of a second season to irrigated rice and proper weeding.
		Intensification	New practices for more intensive farming included off-season vegetable production and organic agriculture, crop intensification through improved water use, integrated soil fertility and pesticide management.
		Integrated crop management techniques	Four crop management techniques referred specifically to an integrated approach. These included organic coffee production, application of Moringa Oleifera phytohormones, pollinisation of palm trees, and integrated crop management techniques for legumes (pest, soil and nutrient management).
		Protected horticulture/floriculture	Protected horticulture and floriculture included greenhouse crop production, shade-cloth greenhouses, polyhouse cultivation of flowers and strawberries, and vegetable production in net houses.

[49] Specific species/types of vegetables were not indicated in the evaluation reports.

		Orchard	Interventions focused on orchard management included organic apple production, establishment of fruit tree nurseries, and rehabilitation of old olive groves by deep pruning.
		Grazing/forage	Improved cultivation of forage (Pennicetum grass cuttings) and fodder production techniques, as well as backyard forage development.
3		Water	Water-related crop management innovations were mentioned in two instances: establishment of hydro-agricultural facilities for market gardening and raised bed planting package for water conservation.
		Diversification	Off-season vegetable cultivation (e.g. chilli)
		Harvest	Innovative harvesting techniques to reduce tree damage combined with simple, labour-saving technology for Brazil plum, Ouricury palm , and cassava production.
3	Livestock	Improved breeds/AI	Interventions focused on the introduction of improved breeds and activities included introduction of rams, cockerels, German Alpine and Toggenburg dairy goats, ducks, genetically improved rams and bucks, Sardi stud rams. There were 4 instances of artificial insemination and 2 instances of technologies to manage livestock reproduction. All but one of the introductions of new or improved breeds and AI constituted incremental enhancements to the productivity.
		Animal health and nutrition	Thirteen instances of animal health and nutrition techniques were introduced in 10 countries in 4 regions. The innovations focused on vaccinations and de-worming (6 projects) – in particular large ruminants but also pigs, sheep and poultry. Other techniques included multi-nutrient and mineral blocks and other animal health practices (5 projects), and other cow rearing practices (2 projects).
		Small animal husbandry	Seven innovations were identified for small animal husbandry across 5 countries in 3 regions. Innovations included improved management of small ruminants in fundo de pasto (Fundo de Pasto communities in the Brazilian semiarid state of Bahia) and improved production methods (piggery, goat rearing, duck).
		General livestock husbandry	Improved animal husbandry techniques were reported in six instances, without providing further details.
		Beekeeping/Sericulture	Improved beekeeping practices included annual bee treatment campaigns to combat the varroa mite, disease control, and modern beehive management. Sericulture was identified in one instance.
		Poultry husbandry	Livestock innovations related to poultry encompassed sand-based mini hatcheries, housing and better feed for chicken, integrated poultry-aquaculture scheme and general improved production practices.
		Housing	Improved housing for ruminants and poultry for efficient collection of manure, penning of livestock and area enclosure.
		Feeding	Innovations in livestock feeding included stall-feeding, trial of animal feed alternatives (molasses blocks and compound feed) and improved livestock forage technologies.
		Intensification	Intensification of animal production, specifically piggeries.
		Dairy	Improved, productive dairy farming referred specifically to milk collection and chilling, basic husbandry, health, breeding/breed selection, and feeds.
4	Post-harvest and processing	Methods	Technologies included sundried camelid, fodder preservation and pig feed processed from cassava, roots and tubers incl. cassava, rice, sweet potato yoghurt/potato chips, fish , tea, beef, honey, butter/cheese, crispy corn (tengma), castor oil, fibre weaving nettles, and bamboo chopsticks.

		Tools and equipment	Innovative equipment for post-harvest and processing included chorkor ovens for smoking fish, improved bakery ovens, néré steamers, processing plants for Brazil plum, ouricoury palm, cassava and honey, weaving machines for camelid wool, sisal manufacturing tools, crushing units and fixed threshers for olives, apples and meat, maize mills, bundling machines for bourgou conservation, rice drying technologies and rice huskers, processing equipment for cassava, onions and forest products (e.g. mushrooms, chikada).
		Management	Post-harvest management
		Storage	On-farm grain/bean storage
5	Land management	Soil conservation/improvement	Soil conservation practices included contour tillage, gully control, construction of crest/infiltration ditches, live fencing/hedge rows, mixed cropping of cactus legumes and millet, use of legumes as a cover plant, conservation agriculture and zero tillage, cut-and-curry livestock production, introduction of Moringa plantations, introduction of nitrogen-fixing trees in maize-based agroforestry, biological and structural measures to prevent land degradation, forage-based conservation measures.
		Land use	Innovations in land use mentioned home gardening (3), planting of seedling to foster local vegetation and regeneration of bourgou flood plains.
		Land and pasture management	Improved pasture and land management were mentioned in four instances. Details were provided only for pasture reseeding to improve grazing areas.
		Land preparation	New approaches for land preparation included stubble incorporation.
		NRM (Water/Watershed/Soil)	Methods and technologies for watershed protection, soil and water conservation techniques.
		Agroecology	Implementation of agro-ecological techniques
6	Fertilisers and chemicals	Fertiliser use efficiency	Fertiliser use efficiency encompassed 1) Improved fertiliser use such as fertiliser use management tools, improved fertilizer use, split use fertilizer, compacted fertilizer, palm tree management practices (fertilizer use) and leaf colour chart and Urea super granule); and 2) Introduction of fertilizers, including fodder improvement for cows-phosphate fertilisation of fodder- and introduction of fertilisers.
		PM/WM	Innovations related to pest/weed management included IPM/WPM practices, biological plant protection, biological repellent to animals, palm tree management practices (specifically mite control, DBM biological control, organic pesticides, and pheromone traps.
		Organic fertilisers	For organic fertilisers all of the innovations involved composting and included: a) Introduction of new composting techniques e.g. vermicomposting and use of composting and animal manure, and b) promoting improved compost use.
7	Energy	Biogas	Biogas technologies were mentioned in 10 instances, encompassing both the introduction of bio digesters and biogas units.
		Efficient stoves/wood sources	Improved and eco-efficient stoves were introduced in eight instances.
		Renewable (solar/wind)	Renewable energy sources included mainly solar and wind energy. Solar panels were used to power solar pumps (2), solar lanterns (1), for general irrigation purposes (1) and lighting (1). Wind energy was used for irrigation purposes in Nigeria [19], where windmills were used to provide a reliable water supply (1).
		Biogas and renewable (solar/wind)	Biogas was combined with alternative energy sources, including solar and wind-powered technologies.

8	Water	Drip irrigation	Drip irrigation was mentioned seven times. Specific examples referred to an integrated fertilization and irrigation approach, new agricultural technologies for efficient water use and modern pressurized irrigation schemes.
		Harvesting	Innovative water harvesting techniques included the Vallerani mechanized system in micro-catchments for higher fodder shrubs and fruit tree production, multifunctional boreholes, a submerged solar pumping system, and water-saving home gardens.
		AWD	Alternate wetting and drying (AWD) was mentioned three times, as a water conservation measure, for arsenic load reduction, and as a technology for rice production.
		Small-scale irrigation	Small-scale irrigation technologies included rainwater harvesting for hillside irrigation, manual pump and spate irrigation.
		Drainage	Water drainage was reported in two instances, referring specifically to drainage trenches and water drainage for reuse in irrigation.
		Delivery	Innovations related to water delivery included new irrigation technologies and grey-water reuse in agriculture for olive production.
		Drinking	Improved light-weight pitchers were introduced to improve drinking water collection.
		Sea water exclusion	Climate-smart and sustainable strategy to prevent contamination of soils and aquifers by sea water
9	Fisheries	Fish cultivation and aquaculture	Twelve examples of new fish cultivation and aquaculture activities were identified. Technologies included cage fish culture, trout farming, and prawn catfish culture (5), small nutrient–rich fish species (Amblypharyngodon mola) to improve human nutrition (1); prawn hatchery establishment (hatchery establishment to ease the supply constrain of post-larva to prawn farmers in flood plains areas (1); crab fattening/hardening (1), paddy filed/fish raising model (1); modern management in pisciculture (1); fish rearing in large fish ponds (1).
		Fishing equipment	Innovations related to fishing equipment included new fishery tools (1), navigation equipment (including new gear for fishing off-shore) (1) and alternative fishing gears, such as hand lines, long lines and gill nets (1).
		Boat construction	Improved boat building techniques included solar-powered ice-makers and freezer systems promoting use of ice as a post-capture conservation measure.
10	Seeds	Production of certified/quality seeds	Certified/quality seeds were introduced for the following crops: rice, groundnut, cowpea, maize, peanut, mung bean and cassava resistant cultivars.
		Multiplication of tuber/seeds	Seed production and multiplication was reported for imported Acacia, spiny bitter gourd, onion and potato. Other innovations related to seed multiplication included use of hydroponics and the Maria model for rice seed production and preservation.
11	Forestry	Agroforestry	Sustainable forest protection programmes and intensive mixed agroforestry systems (including hedgerows).
		Forest nurseries	Forest nurseries were mentioned twice, referring specifically to Acacia seedlings in one instance.
		Forest resource harvesting	Innovations related to harvesting forest resources included bamboo and rattan production as well as harvesting of mushrooms.
		Tree planting	Tree planting was reported in one instance, in Bolivia.
12	Agricultural tools	Tools	Innovative agricultural tools included camelid shearing machines and ergonomically agricultural tools for drudgery

			reduction.
		Mechanisation	Technologies for farm mechanization included power tillers and motorized wheat threshers.
13	Other	Environmental services/carbon credit	Payment for environmental services was mentioned twice. Another innovation referred to extracting carbon credit under a Clean Development Mechanism.
		Farming systems	Innovations related to farming systems included integrated farming system models (including intercropping, new improved varieties of cash and non-cash crops, new approaches for land preparation; integrated drainage and irrigation interventions combined with soil monitoring).
		Dryland agriculture	New technologies for dryland agriculture were introduced, including crops-rangeland-livestock integration in low rainfall areas.
		Non-land based activities	Non-land based activities, including handicrafts.
		Cropping systems	Newly introduced cropping systems, including the use of legumes for soil improvement and introduction of new crop varieties.
		Climate-resilient technologies	Climate-resilient technologies were introduced in one instance in Zambia.

Key people met

(in alphabetical order)

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Sample for review

Evaluation Number	Country	Evaluation product	Year of publication	Evaluation title	Region	IFAD cofinancing (USD millions)
1	Bangladesh	CSPE	2016	Overall	APR	142
2	Bolivia	CSPE	2015	Overall	LAC	112.7
3	Brazil	CSPE	2015	Overall	LAC	260
4	Cambodia	CSPE	2018	Overall	APR	166.2
5	Cameroon	CSPE	2018	Overall	WCA	84.3
6	China	CSPE	2014	Overall	APR	775
7	DR Congo	CSPE	2017	Overall	WCA	156.07
8	Egypt	CSPE	2017	Overall	NEN	321.4
9	Ethiopia	CSPE	2016	Overall	ESA	473
10	Gambia	CSPE	2016	Overall	WCA	73.1
11	Ghana	CSPE	2012	Overall	WCA	225
12	Jordan	CSPE	2014	Overall	NEN	70.5
13	Kenya	CSPE	2011	Overall	ESA	175
14	Madagascar	CSPE	2013	Overall	ESA	175
15	Mali	CSPE	2013	Overall	WCA	183
16	Mozambique	CSPE	2017	Overall	ESA	147.41
17	Nepal	CSPE	2013	Overall	APR	146
18	Nicaragua	CSPE	2017	Overall	LAC	80.64
19	Nigeria	CSPE	2016	Overall	WCA	317.9
20	Rwanda	CSPE	2012	Overall	ESA	150
21	Senegal	CSPE	2014	Overall	WCA	208
22	Tanzania	CSPE	2015	Overall	ESA	360
23	Uganda	CSPE	2013	Overall	ESA	294
24	Vietnam	CSPE	2012	Overall	APR	257
25	Zambia	CSPE	2014	Overall	ESA	188.5
26	n/a	ES	2016	Environment and Natural Resource Management	n/a	n/a
27	n/a	ES	2018	Building partnerships for enhanced development effectiveness	n/a	n/a
28	n/a	ES	2016	FAO's and IFAD's Engagement in Pastoral Development	n/a	n/a
29	n/a	ES	2017	IFAD's Support to Scaling up of Results	n/a	n/a
30	n/a	ES	2016	Non-lending activities in the Context of South-South Cooperation	n/a	n/a
31	n/a	ES	2014	Water Conservation and Management	n/a	n/a
32	n/a	ES	2014	Rural Youth	n/a	n/a
33	India	IE	2015	Jharkhand-Chhattisgarh Tribal Development Programme	APR	20.8
34	Mozambique	IE	2016	Sofala Bank Artisanal Fisheries Project	ESA	20.2
35	Sri Lanka	IE	2013	Dry Zone Livelihood Support and Partnership Programme	APR	21.9
36	Azerbaijan	PPA_PPE	2013	North-East Development Project	APR	12.5

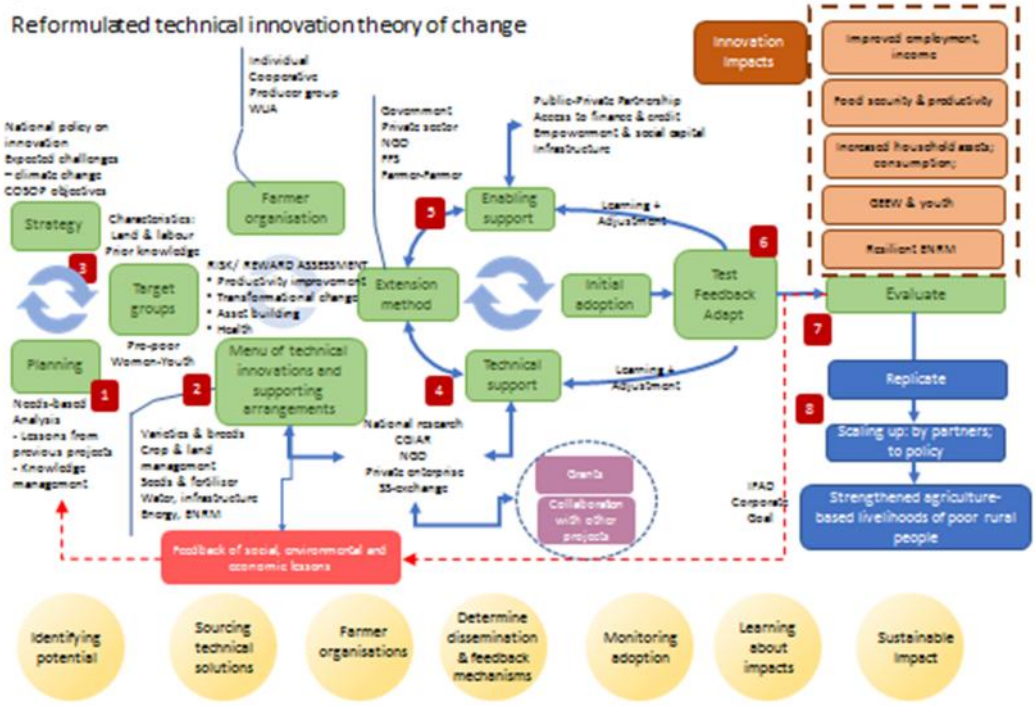
37	Bangladesh	PPA_PPE	2012	Microfinance and Technical Support Project	APR	16.3
38	Bangladesh	PPA_PPE	2014	Microfinance for Marginal and Small Farmers Project	APR	20
39	Bangladesh	PPA_PPE	2016	Finance for Enterprise Development and Employment Creation Project	APR	35.6
40	Bhutan	PPA_PPE	2014	Agriculture, Marketing and Enterprise Promotion Programme	APR	13.9
41	Brazil	PPA_PPE	2015	Gente de Valor - Rural Communities Development - Project in the Poorest Areas of the State of Bahia	LAC	30
42	Cambodia	PPA_PPE	2012	Community-Based Rural Development Project in Kampong Thom and Kampot	APR	9.9
43	Cambodia	PPA_PPE	2013	Rural Poverty Reduction Project in Prey Veng and Svay Rieng	APR	15.6
44*	**China**	**PPA_PPE**	**2016**	**Environment Conservation and Poverty-reduction Programme in Ningxia and Shanxi**	**APR**	**33.8**
45	DR Congo	PPA_PPE	2016	Agricultural Rehabilitation Programme in Orientale Province of Tshopo	WCA	14.1
46	Egypt	PPA_PPE	2017	West Noubaria Rural Development Project	NEN	18.4
47	India	PPA_PPE	2015	Livelihoods Improvement Project in the Himalayas	APR	44.6
48	Laos	PPA_PPE	2015	Rural Livelihoods Improvement Programme in Attapeu and Sayabouri	APR	16.1
49	Laos	PPA_PPE	NP	Northern Region Sustainable Livelihoods through Livestock Development Project (NRSLLDP)	APR	3
50	Lesotho	PPA_PPE	2014	Sustainable Agriculture and Natural Resource Management Programme (SANRMP)	ESA	9.8
51	Malawi	PPA_PPE	2017	Rural Livelihoods Support Programme	ESA	14.8
52	Mauritania	PPA_PPE	2016	Oasis Sustainable Development Programme	WCA	11.4
53*	**Moldova**	**PPA_PPE**	**2013**	**Rural Business Development Programme**	**NEN**	**14**
54	Morocco	PPA_PPE	2014	Rural Development Project in the Mountain Zones of Al-Haouz Province	NEN	20.4
55	Nicaragua	PPA_PPE	2017	National Agricultural Technology and Training Programme: Technical Assistance Fund	LAC	15
56	Pakistan	PPA_PPE	2015	Community Development Programme (CDP)	APR	22
57	Rwanda	PPA_PPE	2015	Support Project for the Strategic Plan for the Transformation of Agriculture	ESA	13.9
58	Vietnam	PPA_PPE	2011	Rural Income Diversification Project in Tuyen Quang Province	APR	23.6
59	VietNam	PPA_PPE	2018	Pro-Poor Partnerships for Agroforestry Development Project (3PAD)	APR	21.4

* These evaluation documents were initially included in the sample for analysis, but did not report any significant technical innovations.

Theory of Change

1. Theory of Change The analytical framework for this synthesis is developed around a theory of change and a typology of technical innovations. An initial theory of change (ToC) was developed in the Approach Paper, derived from IFAD's 2007 Innovation Strategy and informed by IOE's 2002 and 2010 CLEs on capacity to promote innovation and scaling up. The findings in this synthesis have allowed a reassessment of that model and preparation of a ToC that reflects actual practice in Figure 1.

Figure 1



2. Evidence from evaluations indicates the theory of change has three distinct cycles:

- to identify the scope;
- plan the innovations and their dissemination; and
- provide a supportive framework.

The change process for technical innovation involves a complex interaction of feedback loops, associated with the adjustment of the technical innovation during piloting, adaptation and learning. Whilst the dotted red line and red box highlights the main feedback loop, the blue arrows indicate interaction, learning and adjustment.

Identifying the scope

3. Interventions must meet farmers' needs but within the framework of national policies and expected challenges such as climate change. The COSOP is a source to guide direction; lessons from previous projects and experience from IFAD's Knowledge Management help inform choice. Targeting is an iterative process, taking into account the people IFAD is trying to support, their assets and their existing knowledge. Targeting of innovations can be a subset of wider targeting for the project as a whole.

Planning the innovations

4. Responding to needs, policy framework and lessons, one or more technical options can be considered. Many IFAD promoted innovations will be hybrids of technical innovation supported by complementary process and institutional innovations

which enable or add impact to the technical innovation. At this stage the nature of the desired change can be identified: to improve productivity; introduce a more transformational change; help build individual or community assets; or contribute to improving health. The type of change has a bearing on the assessment of risks faced by the target group.

Dissemination

5. Decisions about dissemination bring together the nature of the technical innovation, the preference or otherwise of working through farmer organisations and the method of extension and dissemination. Many innovations are promoted as part of a combination of practices. The choice of farmer organisation can have a direct relationship with the need to empower targeted participants for the innovation.

Enabling support

6. The technical innovation (TI) concept embraces three classes (1) sole TI or (2) TI + essential process and institutional innovation for effectiveness of the TI or (3) TI + optional complementary process and institutional innovation which magnifies impact of the TI. Some innovations are enabled by access to finance and credit; others are dependent on infrastructure; some benefit from social support to empower participants which might be directly linked to farmer organisations, noted above. During implementation there is likely to be a need for continued technical support, which may require a partnership with a research organisation or the private sector. South-South exchange has fulfilled that role in some instances. Grants and direct collaboration with other projects are a way of sourcing that support. The timing of all support is important.

Monitoring and evaluation

7. Far too many innovations are never properly evaluated. Few projects report robust evidence for productivity and farm incomes. There are two desirable cycles here. One for rapid feedback during implementation so that technology can be modified and dissemination improved. Secondly, to generate convincing evidence for partners to pick up and scale up. Outcomes can be evaluated using standard IOE criteria.

Scaling up, feedback and learning

8. There are examples where the innovation process takes the form of replicating from one setting to another, often before being scaled up by partners or incorporated in policy. But there is little evidence that this process is planned and predetermined. Serendipity appears to play a significant role.

9. Learning plays in important role in an effective process. Information from the economic, social and environmental outcomes is a consideration in the selection of technical packages and is updated by early results from adoption and periodic evaluation. Evaluations need to assess the three decision cycles in this model: matching potential solutions to target groups; the selected implementation package and modalities; and the adoption/adaptation practice.

10. All theories of change rest on assumptions. These are indicated as numbered red boxes in the diagram and are listed here.

Assumptions

1. IFAD is able to source cross-discipline lessons and examples relevant to the preferred target group from own or partner knowledge resources.
2. Planners bring mix of technical skills and field experience to create adaptable, innovative intervention packages.
3. Innovation process embedded in IFAD's procedures and decision-making
4. IFAD staff have autonomy of decision-making to create and finance technical support.

5. Adequately resourced partnerships are created with shared objectives, agreed priorities and supportive policies.
6. Routine monitoring is comprehensive, documenting initial and wider adoption, farmer perceptions, physical and financial returns.
7. Evaluation is planned during project design, with adequate resources where necessary for counterfactual models.
8. Replication is actively promoted to demonstrate effectiveness in other settings and test the innovation.

Innovation Theory

1. Innovation has been defined by Schumpeter (1939) as the introduction of a new production method, new inputs into a production system, a new good or a new attribute of an existing good, or a new organizational structure (Phillips et al., 2013). He clearly distinguished innovation from research and invention, stating that: “innovation is possible without anything we should identify as invention, and invention does not necessarily induce innovation” (Schumpeter, 1939). IFAD (2007) further explains this distinction defining innovation as “the dissemination of something new in a given context, not as something new in absolute terms “The World Bank (2010) defines innovation as "means, technologies and practices that are new to a given society. They are not necessarily new, but they are being diffused in that economy or society". More recent definitions have extended this to include “what is used and has resulted in substantial social and or economic benefit to the user” (FAO, 2014).

2. Many reviews of innovation in agriculture refer back to Rogers’ “Diffusion of Innovations”[50]. where Rogers characterized stages of innovation as phases within which individuals participate: from innovators, early adopters, the late majority adopters, and those laggards averse to change (Rogers, 2003). However, this characterization assumes that innovation – taken as the adoption of externally introduced technologies – is always progress, that innovations are technology-based, and that they disrupt past ways of conducting business (Joly 2018).

3. More recent conceptualizations of innovation refer to innovations as a process embedded in local circumstances, based on local knowledge and adaptation, in continuity with the past (Joly, 2018; van der Veen, 2010). The concept of innovation itself derives its meaning from specific context and needs. Current discussions of innovations therefore emphasise the benefit to the livelihoods and well-being as perceived by stakeholders (Kilelu et al., 2013).

4. With regards to agriculture, innovation has been a major driver of progress (Sunding and Zilberman, 2000). Both process and product innovations have been developed at the farm or individual level, including change in production processes (e.g. inter-cropping), introduction of new crops or varieties, as well as change in farm management. The uptake of these innovations generates a wide array of results, including productivity growth, output diversification, drudgery-reduction, among others (FAO, 2014). However, in recent times, innovations in the field of agriculture had to take into account major social and environmental challenges in order to transition to sustainable food systems.

5. It has therefore been recognized that adaptation of an agricultural innovation to local environmental and social conditions is fundamental (van der Veen, 2010).

6. Following this perspective the adoption of agricultural innovations is therefore linked to the social circumstances of farmers, including household structure, land tenure, size of farms, personal wealth and agency (van der Veen, 2010). While agricultural innovations often address a need to increase food production, frameworks for food security and nutrition recognize that many farmers in resource-constrained conditions, tend to prioritize security stability and flexibility to ensure their ability to feed their families and minimize risk (FAO, 2006). On a similar note, innovations requiring investments that save labour may not be seen as desirable where labour is more readily available than capital (Dorin, 2017).

[50] First 23 published in 1962, with a fifth edition from 2003.

Enabling Factors for sustainability

Enabling factors

1. The sustainability of technical innovations is linked to the sustainability of the relative enabling factors. Among these, common trends were identified in relation to partnerships, extension services and technical support, marketing and cooperatives and farmer federations. These are discussed in turn.

Partnerships

2. Partnerships can provide continuity for innovations. Continuity of partnerships or partners' functions is often the critical requirement for sustainability of technical innovations [01, 05, 14, 19, 20, 45, 52]. The partners involved included national and international research institutes, private actors and NGOs.

3. In Bangladesh [01], post-project technology support was expected to continue through governmental departments in partnership with local and international research institutes, such as IRRI, Bangladesh Agricultural Research Institutes and Bangladesh Rice Research Institute. In contrast, the sustainability of rice seed multiplication in Cameroon [05] might be constrained once the project stops financing the seed programme of the Institute of Agricultural Research for Development.

4. Sometimes the private sector can fill a gap in the public sector. In Madagascar [14] the 2009 political crisis resulted in a decrease in international aid, which in turn limited the replication of innovations. However, partnerships with local and international private enterprises were identified as a source of support for innovations. In Nigeria [19], the sustainability of new or improved crops as well as of flour production from cassava, was partially driven by private actors. In Laos [49], the sustainability of livestock vaccination was constrained by lack of inputs, usually distributed by extensions officers, who rarely visited the villagers. However, this innovation could not be supported by private actors, because of the limited number of veterinarians available and lack of cold chambers.

5. The veterinary system introduced by the project to support herd genetic improvement in Rwanda [20] risked to be discontinued after project closure, due to withdrawal of service providers (Heifer International and Send a Cow Rwanda – two international NGOs). In order to ensure the sustainability of the innovation, training of para-vets and provision of veterinary kits was required.

Extension services and technical assistance

6. Many innovations need continuing extension and technical assistance services. The provision of extension services and technical assistance was identified as enabling factor for the sustainability of several technical innovations [02, 04, 08, 18, 35, 46, 52]. Continuation of technical support after project closure needs to be assured, perhaps by institutional commitments or by the willingness of farmers to pay for such services once the project subsidies were no longer available [58].

7. Strong demand is a positive driver for sustainability of multistage seed potato production in Sri Lanka [35], but the high-technology approach using hydroponics creates a dependence on scientific and technical support, which could become critical after project closure.

8. The technical assistance provided by the artificial insemination centre in Egypt [46], supporting livestock genetic improvement, was sustainable. The centre was covering the majority of its operational costs with service fees, reaching farmers outside the project areas. In Mauritania [52], support for oasis producers was sustainable, as facilitators reportedly provided services to producers no longer supported by the project through the establishment of "producers support associations". On the contrary, a market for technical assistance did not develop in

Bolivia [02], despite the provision of resources to pay for such services. However, such incentives terminated upon project completion and some of the most skilled technicians engaged in different activities, further reducing the sustainability of technical support.

Marketing (Value-Chain Approach)

9. Support to move up the value chain needs to develop relationships as well as introduce technology and processes. As part of a value chain approach, promoting value addition and a shift from subsistence to market agriculture, the sustainability of several technical innovations was linked to the strength of their connection with buyers and markets [2, 3, 11, 23, 35, 42, 58].

10. The sustainability of oil palm, introduced as a cash crop in Uganda [23] as part of a value chain intervention, showed good prospects. Commercial viability of the product, combined with private investment attractiveness and spill-over effects to the transport sector and other businesses were among the factors affecting the sustainability of the initiative.

11. Increased market access and growing local demand supported the sustainability of new crop varieties (maize, soybean, aromatic and hybrid rice) and improved breeds promoted in Vietnam [58]. This was an indicator of an agricultural sector transitioning towards enhanced market linkages and value addition.

12. In Ghana [11] there was a need to identify additional markets should the production of planting materials continue to increase, otherwise the project benefits in terms of increased income may not be sustainable. Market connections were also identified as a driver for the sustainability of camelid enterprises in Bolivia [02]. The VALE project promoted several innovative interventions, including weaving machines for camelid wool, processing techniques for sun-dried meat and shearing machines. However, investments in processing of camelid products were not sustainable, due to the lack of a long-term vision and health registrations required to access more competitive markets.

Cooperatives and farmer federations

13. Local organisations help farmers share experience and manage risks. Functioning cooperatives and farmer associations, including those created to implement project activities and foster the adoption of technical innovations, helped members manage innovations and cope with new challenges [05, 08, 20, 46, 55, 58].

14. Cooperatives providing technical assistance for production and marketing enhanced the sustainability of new production techniques in Nicaragua [55]. Similarly, reseeding of degraded areas in Lesotho [50] proved to be more sustainable on land managed by Grazing Associations, rather than in open communal grazing areas.

15. In several cases [05, 20, 46], cooperatives and farmer associations were institutionally or financially too weak to foster long-term adoption of innovations. In Cameroon [05], the sustainability of technical innovations was hindered by the limited capacity of producers' organizations. According to the PCR, less than one third of the producers' organizations supported by the project were able to supply improved inputs, seeds and technical assistance to their members without project support. Cooperatives formed to support the introduction of improved breeds in Rwanda [20] were institutionally and financially weak, and dependent on the project for further support.

16. The few examples illustrate potential in several ways:

- To enhance social capital and self-reliance by a combination of technical training, exposure to markets and an appreciation of production and processing quality and standards;
- Stimulating institutional change sometimes in recognition of people's rights, or to establish a legal framework such as for supply of quality seeds.

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