Income Intervention Quick Scan: Productivity Enhancement

Farmer Income Lab Intervention Quick Scan

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Abstract UK This quick scan, commissioned by the Farmer Income Lab, is part of a wider research effort looking at, “What are the most effective actions that lead buyers can take to enable smallholder farmers in global supply chains to meaningfully increase their incomes?”. The quick scan provides an overview of the publicly available evidence on the impact of productivity enhancement measures have had on raising farmer income. Such subsidies have had little positive effect on farmer income, are not notably beneficial for women nor is this effect long-term. They have been applied at large scale. This quick scan is part of a series of 16, contributing to a synthesis report “What Works to Raise Farmer’s Income: a Landscape Review”.

Keywords: farmers’ income, intervention, agriculture, input subsidies, smallholders, productivity enhancement, good agricultural practices, producer organizations, multi-stakeholder coordination, technological innovations

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List of abbreviations and acronyms

NGO	Non-Governmental Organization
WCDI	Wageningen Centre for Development Innovation, Wageningen University & Research
WUR	Wageningen University & Research

1 Introduction

1.1 Definition

For this review, productivity enhancement interventions are defined as: interventions aimed at improving smallholder family farmers production through the adoption and use of improved agricultural technologies and practices.

Productivity enhancement interventions have the potential to improve smallholder farmers net farm income and livelihoods through i) raising crop yield and productivity, ii) reducing crop loss caused by pests, diseases or drought and iii) reducing costs of production.

This review specifically focusses on the income impact of the adoption and use of:

- **Improved agricultural technologies**: including improved crop varieties, improved seed technology and use of fertilizers, herbicides and pesticides.

Improved agricultural practices / Good agricultural practices including amongst others: intercropping, crop diversification, compost and manure application, reduced tillage, application of crop residue, crop rotation and soil and water conservation practices (including Integrated Pest Management and Conservation Agriculture).

1.2 Theory of change

Adopting productivity enhancing technologies and practices allows smallholder farmers to improve crop yields, reduce production losses and/ or reduce production costs, thereby improving their net income. (Kassie, Shiferaw, and Muricho 2011) (FAO 215; IFAD 2016). The impact of productivity enhancing interventions on smallholders' livelihoods is strongly dependent on the assumption that smallholders are integrated in markets and that there is an unlimited market demand for specific agricultural commodities.

Smallholder family farms produce up to 80% of the food supply in Asia, Latin America and Sub-Saharan Africa but remain plagued by widespread poverty (FAO, 2015; IFAD 2016). Smallholder farmers face a number of constraints that limit their opportunity to improve their yields and farm productivity including, amongst others: limited access to productive resources (land and financial capital), limited access to agricultural technologies and markets, limited access to rural roads and other productive infrastructure and limited access to information and knowledge related to climate, technological innovations and markets (IFAD 2016).

Positive and sustained impact requires investments to be coordinated at multiple levels by actively and financially involving public sector, research and development institutions, private sector and producer organizations.

1.3 Geography

Productivity enhancement programs and projects have been implemented throughout the world in lower, middle and higher income countries, in different agro-ecological and socio-economic contexts.
The literature reviewed draws from research conducted in Africa, Asia, Europe and Eurasia, South America, Central America, North America and Australia.

1.4 Role of actors

Agricultural programs focusing on productivity enhancing technologies and practices are mostly developed and disseminated by governmental actors with the financial support of an international donor community and implementing support offered by NGO's. Many of the documents reviewed highlight the need for sustained public investment and involvement and embrace the implementation efficiency that has been generated through partnership with implementation agencies and NGO's.

Strong producer organizations are often highlighted in literature as fundamental pillars guaranteeing sustained success of productivity enhancing interventions. Inclusive and active farmer organizations can improve producers access to agricultural services and supplies at reduced costs, improving net income. Additionally producer organizations can improve market integration and negotiating capacities as they can play a role in aggregating, storage and adding value to agricultural produce with the objective of collectively selling produce in the quantities and quality desired my buyers.

Cross-sectoral, multi-stakeholder coordination drives sustained impact. Strengthening of farmer-to-farmer relations and producer organizations together with effective concertation and articulation between value chain actors (producers, producer organizations, buyers, agricultural service providers, processors, retailers, wholesalers and consumers) in combination with sustained involvement of public sector has proven to provide greatest impact.

The private sector has proven to play a positive role in intervention approaches by effectively approaching constraints that otherwise negatively affect adoption of agricultural technologies, namely by:

- improving timely access and distribution of guaranteed quality agricultural input supplies.
- providing demand driven, smallholder oriented agricultural extension and support services.
- providing market access and value chain integration (for example through outgrower schemes and contract farming).

Table 1 summarizes the complementary and supporting roles that different actors can potentially take on in productivity enhancing interventions.

Table 1 *Roles of different actors in productivity enhancing interventions.*

PUBLIC SECTOR	PRIVATE SECTOR	DONOR COMMUNITY	FARMERS ASSOCIATIONS	NGO'S
Supportive policy and sustained investments in rural agricultural research and development and production enhancing technology development, agricultural innovation systems and agricultural extension and advisory services	Investment in Agricultural R&D	Financing productivity enhancing R&D programs and supporting agricultural innovation systems	Setting the agenda for agricultural R&D and agricultural innovation systems	Coordinating support and capacity building
Coordination and articulation of multi stakeholder partnerships in support for rural agricultural development and strengthening of smallholder farming systems	Support and development of smallholder sourcing strategies and providing agricultural advisory and extension services	Coordination and financing in support for effective multi stakeholder partnerships and programs with a focus on smallholder producers	Providing and supporting farmer-to-farmer agricultural extension and service provision	Effective support in project implementation and stakeholder management
Investments in rural roads and productive infrastructure	Engaging in public-private partnerships in support for smallholder agricultural development	Impact assessment and evaluation of effectivity of productivity enhancing interventions targeted at female headed smallholder households and youth.	Improving smallholders collective bargaining power and access to quality and inexpensive agricultural inputs.	Providing improved access to market information and serving as knowledge broker
Promoting agricultural financing mechanisms and insurance schemes	Supporting smallholder market integration through outgrower schemes, contract farming	Developing financing mechanisms in support for public private partnerships and smallholder integration in value chains and inclusive business	Improving smallholders' access to market information and improving value chain and market integration	Providing and supporting agricultural extension and advisory services

2 Summary and justification of assessment

Strength of outcome		
Assessment criterion	**WUR score**	**Rationale for score**
Scale: Size of the population intervention could impact and potential to scale to other contexts (i.e., geographies, value chains)	MEDIUM	• The documents taken into account for this review assess the impact of productivity enhancing interventions on groups of smallholders ranging from 1000 to 4000 households[1]. • Productivity enhancing technologies and practices have been studied, developed, applied and implemented throughout the world in different contexts and for a large variety of commodities. • In order to scale to other smallholder communities in different geographies with different agro-ecologies, types of farmers, farming systems, commodities and value chains; productivity enhancing interventions must be tailored to each specific biophysical and socio-economic context and each proposed technological innovation. o Source: Villano et al.,2015; Kassie et al., 2011; Kangemennaang et al., 2017; FAO, 2015; IEG, 2011; López, Salazar, and De Salvo, 2017
Impact: degree of increase in incomes	MEDIUM	• Adoption of productivity enhancing technologies, can improve smallholders' net income by 10 – 40 %. • Impact on smallholders' net farm income is highly variable and dependent on a variety of biophysical factors and a variety of enabling (socio-economic) conditions, most importantly market access and market prices. o Source: Villano et al.,2015; Kassie et al., 2011; Kangemennaang et al., 2017; FAO, 2015; IEG, 2011; López, Salazar, and De Salvo, 2017
Sustainability: financial ability of farmer income increase to endure independent of ongoing external support	MEDIUM	• This review assessed a number of documents providing evidence on the ex-post impact of productivity enhancing interventions on farmers net income, 2 to 7 years after finalization of a project or program. In all cases there is a significant positive and sustained impact on net income from the adoption of productivity enhancement technologies. o Source: Kangmennaang et al., 2017; Kassie et al., 2011; IEG, 2011; Lopez, Salazar, and De Salvo, 2017 • Single technology based interventions have the lowest sustainability score, whilst bundled interventions employing an inclusive and demand driven approach have the potential to generate positive and sustained impacts for smallholder farmers and drive agricultural development. o Source: Kangmennaang et al., 2017; Kassie et al., 2011; IEG, 2011; Lopez, Salazar, and De Salvo, 2017; FAO, 2015

[1] It must be noted that we found a large amount of case studies that look at the effects of productivity enhancing technologies on groups smaller than 1000 households.

Gender: Potential of intervention to positively impact women	LOW	• There is a lack of documented evidence highlighting the impact of productivity enhancements on the income of women and female headed households was found in the reviewed literature. • All programs and projects reviewed mention an intentional focus to integrate women and female headed households. In most cases, interventions report low rates of participation by women (< 25%), but do not explain why this occurs. • In those cases where projects report active participation by women and female headed households success rates are equal to those obtained by male headed households. o Source: FAO, 2015
Strength of evidence		
Assessment criterion	**WUR score**	**Rationale for score**
Breadth: amount of rigorous literature that exists on the impact of the intervention, as defined by the minimum quality of evidence for this paper	LOW	• After initially scanning 44 documents provided through our searches, we ended up selecting only 8 documents for this review as they specifically focus on the impacts on smallholders net income and meet the set standards for methodological rigor.
Consistency: Degree to which the studies reviewed are in agreement on the direction of impact (i.e., positive or negative)	HIGH	• Assuming that the enabling conditions that support adoption and enhance profitability of productivity enhancing technologies are largely satisfied, all of the studies reviewed provide evidence that productivity enhancing interventions generate increase in smallholders net income ranging from 10% to 40%. • Impact is consistently high when embedding productivity enhancing innovations and technologies within sector wide and multi-actor 'support packages'. o Source: Villano et al.,2015; Kassie et al., 2011; Kangemennaang et al., 2017; FAO, 2015; IEG, 2011; López, Salazar, and De Salvo, 2017

3 Methodology

After initially scanning 44 documents (including: project evaluations, impact evaluations, meta-reviews and academic documents) a total of 8 documents were selected for this review in compliance with the set standard for methodological rigor. The evidence reviewed covers over 38 countries including: Niger, Ethiopia, Kenya, Madagascar, Uganda, Zambia, Ghana, Malawi, Ivory Coast, Mali, Burkina-Faso, Zimbabwe, India, Philippines, China, Thailand, Vietnam, Indonesia, Nepal, Bangladesh, Pakistan, Myanmar, Georgia, Russia, Bulgaria, Albania, Argentina, El Salvador, Peru, Nicaragua, Uruguay, Guatemala, Colombia, Honduras, Costa Rica, Bolivia, USA and Australia.

Due to the nature of this literature review and its attempt to provide a quick scan of existing evidence, strict rule bases were set up to select appropriate documents. In the initial documents scanned , **generally speaking, the impact of production enhancing technologies and practices is measured in terms of yield increase or increment in production. Focusing exclusively on yield potentially overlooks important variables that influence net income**, such as for example: changes in production costs (changes in labor demand and costs), costs in addressing new quality concerns, variability in market prices and quality of inputs, and variable market prices affecting crop value. For this review we **exclusively selected documents that provided direct evidence on net income** and discarded documents referring to other proxies.

A large majority of evidence provided is based on case-studies focusing on a specific project or program and a particular agro-ecology, a concrete commodity or a specific agricultural innovation and technology. For this review we have methodologically chosen to **only taken into account evidence that assess country-wide impacts of interventions and meta-reviews**. On occasions we refer to case studies to highlight a specific point. Furthermore, for the quick and efficient review of evidence, we only shortlisted documents that make use of panel data, randomized control trails, propensity score matching or endogenous switching regression to assess evidence on smallholders' net income. Finally, this review limited its shortlist to literature referring to **evidence from samples with more than 900 smallholder households, published between 2011 and 2018**.

The following documents provided the main sources of evidence taken into account in this review:

1. Modern Rice Technologies and Productivity in the Philippines: Disentangling Technology from Managerial Gaps (Villano et al. 2015).
2. Agricultural Technology, Crop Income and Poverty Alleviation in Uganda (Kassie, Shiferaw, and Muricho 2011).
3. Impact of a participatory agro ecological development project on household wealth and food security in Malawi (Kangmennaang et al. 2017).
4. The economic lives of smallholder farmers, An analysis based on household data from nine countries (FAO 2015).
5. Productivity limits and potentials of the principles of conservation agriculture (Pittelkow et al. 2015).
6. Public Expenditures, Impact Evaluations, and Agricultural Productivity. Summary of the Evidence from Latin America and the Caribbean (Lopez, Salazar, and De Salvo 2017).
7. Impact Evaluations in Agriculture, An assessment of the evidence (IEG 2011).
8. Impact of improved maize adoption on welfare of farm households in Malawi: A panel data analysis (Bezu et al. 2014).

The identified evidence gaps across the longlist of literature are:

- Lack of evidence related to net farm income.
- There is a lack of disaggregated data on the impact of productivity enhancements on women and female headed smallholder farmer households.

- There is not much disaggregated evidence on the impact and effects of productivity enhancements on different ‘categories’ and ‘types’ of smallholders’ and landless farm workers.
- There is a lack of long term, ex-post assessments on the sustained impact of productivity enhancement interventions on smallholders income, income stability after interventions.
- There is a strong research bias towards productivity enhancement interventions related to the adoption of improved agricultural technologies, thus largely overlooking, farm management practices and soil and water management practices (Ogundari and Bolarinwa 2018).

There is a lack of evidence regarding the costs effectiveness of productivity enhancing interventions.

4 Impact

4.1 Effect on income

On average, this review found evidence of a 10% to 40% increase in net farm income related to productivity enhancing programs and projects. The large majority of documents reviewed provide evidence that smallholders' net income improves thanks to the adoption of production enhancing technologies (seeds and fertilizer technologies). Impacts on net income from the adoption of production enhancing practices are more variable. Some studies indicate that production enhancing practices primarily generate positive impact on income stability over the long term. It is important to note that the impact of productivity enhancing interventions heavily relies on the condition that smallholders are integrated in markets and that there is an unlimited demand for the agricultural commodities they produce.

Production enhancing technologies that have the ability to produce high yields under conditions of stress (drought resistance and disease resistant crops) have generated the largest success and impact. The impact of production enhancing practices is largest with practices aimed to improve soil fertility and soil water retention capacity, allowing farmers to produce stable yields throughout conditions of stress (IEG 2011) (Pittelkow et al. 2015).

4.2 Applicability of impact

Gender

Women play an important role in smallholder farmer households. For females in smallholder households and for female headed households, productivity enhancing technologies and practices can improve net farm income. **Interventions must be accompanied with gender sensitive implementation approaches in order to generate positive impact for men and women**, rather than increasing the demand on labor from women and increasing risks for vulnerable female headed households.

Sustainability

Interventions that have proven to have a sustained impact on smallholder livelihoods and net income combine a variety of approaches and bundled elements and are promoted within a sector wide implementation package. The promotion of **policies that are conductive for agricultural development** (such as for example: improving roads, providing and attracting stable markets, improving access to agricultural inputs, credits and insurance schemes, investment in agricultural research and development and agricultural innovation systems), combined with **improved access to information and knowledge exchange through investment in demand-driven agricultural advisory and extension services** and the **strengthening of smallholder producer organizations and market integration** have proven to significantly improve the adoption of productivity enhancing innovations and *generate greater sustained usage of the innovations by smallholders*.

Farmer segments

Positive impacts from production enhancing interventions were documented for both subsistence and pre-commercial farmers. Although a number of the reviewed studies theoretically assumed that wage workers and landless workers should also benefit from production enhancement innovations due to higher demand for labor and improved farm wages, no evidence is provided to substantiate this.

Pre-commercial farmers and commercial farmers tend to be more market oriented and therefore, in theory, they benefit from production enhancing innovations. Nevertheless, none of the reviewed documents provided that level of evidence. In theory, agribusinesses also benefit from production enhancing interventions, thanks to an increase of available agricultural produce, lower bulk prices of agricultural produce, but importantly also due to the potential to improve products quality specifications in compliance with specific end markets. Involvement of Agribusinesses within the process of developing and introducing production enhancing technologies and practices can significantly improve and strengthen the supply chains of Agribusinesses whilst also generating increased impacts for all stakeholder groups involved along the chain. Improving coordination between all stakeholder groups and in particular coordination between the public and private sector and knowledge institutions has proven to generate sustained and lasting positive impacts throughout the entire supply chain.

Most of the evidence reviewed draws similar conclusions with regards to identifying elements that increase the probability of smallholders adopting production enhancing technologies and practices. In general terms there are clear indications that **households with larger landholdings, larger amounts of available labour, more productive resources, higher levels of education and lower exposure to production risks (such as high rainfall variability, lack of access to markets and roads) are more likely to adopt technological innovations** (FAO, 2015; IEG, 2011). A number of documents report evidence of stronger adoption rates of agricultural technologies amongst households with smaller landholdings, claiming that **smallholder farmers are more prone to invest in agricultural inputs when they are restricted in their possibilities to acquire more land in order to raise their production levels**. **Smallholders that have better access to rural roads and markets are also more likely to adopt agricultural innovations**. Generally speaking, **productivity enhancing interventions have greatest impact and effectiveness when they are driven by producers demands and when they relieve or alleviate production constraints that generate potential production risks.**

Appendix 1 provides summaries of the 8 key studies reviewed and the evidence regarding the impact of production enhancing technologies and practices on smallholder net income.

5 Key success factors

Enabling environment

Risk aversive production strategies tend to prevail in smallholder production systems. Smallholders will assess new agricultural technologies and practices from different perspectives before adopting them.

Adoption of agricultural technologies remains limited in low and middle income countries as a result of market failures and an inadequate understanding of the demand, needs and preferences of the potential users and producers, in particular smallholder farming families. **Productivity enhancing interventions lead to success when they are demand driven and embedded within a conductive inter-sectoral policy environment that supports effective knowledge and information transfer.**

Adoption rates and the impact of productivity enhancement on smallholder net income increased significantly and were sustained over time with the support of specific enabling policies and regulations. **The largest and most lasting impacts on net farm income were provided by production enhancing programs and projects in which the technologies and practices that were being promoted within a sector-wide bundled intervention packages implemented in coordination with multiple stakeholders.** These bundled approaches include amongst others: investment in improved agricultural research and development, strengthening of agricultural innovation systems, improving access to market information and linkages, improve farmer driven agricultural advisory and extension services, promotion of timely access to quality inputs, providing access to agricultural credit mechanisms and insurance schemes, improving market integration, investment in rural and productive infrastructure and strengthening of smallholder producer organizations.

Incentives for the generation of public-private partnerships positively catalyze agricultural and rural development. Providing stronger linkages to the private sector, integrating smallholders into value chains and improving market access has proven to positively impact the effect of productivity enhancing interventions on net income.

Implementation factors

Coordination and articulation between government institutions, research and development institutions, private sector actors, producers organizations and NGO's are considered key success factors safeguarding long term sustained impact of productivity enhancing interventions.

Productivity enhancing interventions need to be tailored and designed for each specific place, commodity and value chain. Development of innovations should focus on smallholder demands and be based on an understanding the specific biophysical and socio-economical contexts in which the particular technologies and practices are to be applied. Technologies that are context specific and demand driven enjoy higher adoption rates and can significantly improve smallholders livelihoods.

Smallholders and producer organizations

Independent, financially autonomous, demand-driven and service-oriented farmers organizations are fundamental in facilitating long term and sustained success. **Producer organizations play a strong role in providing market information and access whilst simultaneously reducing production costs by creating improved access to farm inputs and advisory services.** Strengthening of farmer organizations that have the potential to involve themselves in setting the agendas of agricultural research and development whilst providing farmer-to-farmer agricultural, technical and advisory services have proven to be of vital importance for sustained impact.

6 Barriers addressed

Smallholder farming households are particularly vulnerable to shocks and stress. When contemplating adopting production enhancing technologies and practices, smallholder households will assess the risks involved, the investments required and calculate what the opportunity for success is based on short, medium and long term considerations. Smallholders make decisions to adopt productivity enhancing technologies and practices based their assessment of land and labor availability and requirements, climatological conditions, cultural and culinary preferences, reliance and access to market, availability of roads, availability of agricultural inputs, access to irrigation, access to productive infrastructure and many other determinants.

The literature reviewed refers to specific intervention approaches to address these barriers for adoption structurally which can be summarized under three main headings**: i) approaches that offer context specific solutions that alleviate smallholders' risks and reduce volatility. ii) approaches that enhance market integration and improve negotiation power and iii) approaches to strengthen stakeholder coordination and articulation.** Some of the specific approaches found in the literature reviewed are summarized below.

Addressing risks and volatility

- Innovations that have strong market linkages and enjoy stable market prices exhibit higher rates of adoption as they offer a guaranteed profit and return on investment hence reducing smallholders' risk upon adoption.
- Innovations that reduce the potential for crop loss by for example offering drought or pest resistance enjoy high rates of adoption as they have the potential to alleviate risk.
- Policies that target price stability or policies that provide financial support programs (agricultural credit, insurance, etc.) positively enhance conditions for success and reduce the risks of adopting agricultural technologies and therefore can significantly affect smallholders net income.

Market integration and negotiating power in price setting

- Being part of a local and or regional farmers organization significantly improves the opportunity a smallholder has to access the market and negotiate prices, access agricultural extension and advisory services, and improve access to agricultural inputs at reduced costs.

Multi Stakeholder coordination and inclusive sector wide articulation

- Stakeholder coordination and alignment of sector wide, bottom-up support programs aimed at improving smallholder productivity have proven to improve smallholder adoption rates and the impact of interventions. Multi-tier intervention approaches that address rural agricultural development from multiple angles and integrate multiple stakeholders whilst implementing policy agendas in support for smallholder farming households have proven to generate sustained impact for all actors involved driving development throughout the agricultural sector.

7 Questions for further research

Future research should aim at improving understanding with regard to **what drives smallholders to adopt agricultural technologies and practices** generating approaches whereby the design of innovations and interventions is shaped and targeted at improving the net income of smallholder farming families in general and specifically thinking of strategies and approaches targeting female headed households and young farmers.

Future research should focus on understanding **how to embed productivity enhancing interventions within sector wide approaches** towards local and regional economic development that move beyond commodity based approaches towards value chain approaches and sector-wide approaches.

Sustained agricultural development and effective agricultural innovation systems require continuous contributions from all stakeholders involved (producers, public and private sector actors, consumers, food based businesses, etc.) A **unified measurement to assess the cost effectiveness of productivity enhancing** interventions needs to be developed in order to indicate and compare the relationship between investment and impact of project interventions. All involved, would greatly benefit from collectively agreed upon indicators and measurements that permit comparing and reviewing implementation strategies and distilling best practices.

A lot of efforts have been put in developing productivity enhancing technologies for staple crops and cash crops. Renewed investments and research is required on **nutrition dense crops and nutrition secure food** systems. Productivity enhancing interventions have the potential to target food and nutrition security issues by improving yields and reducing the risk of pest infestation and crop deterioration during production and after harvest.

Similarly, there is yet much ground to break with regard to our understanding of sustainable, resilient nutrition and food secure food systems. Research on productivity enhancement should integrate current approaches in **designing resilient and climate smart food systems that integrate productivity enhancing approaches.**

Specific productivity enhancing technologies and practices have the potential to offer increased resilience in adverse and unpredictable climatological conditions. Research has a strong potential to contribute to food and nutrition security taking into account the climatological variabilities smallholder producers will be facing in the future.

References

Shortlist of reviewed literature

Bezu, Sosina, Girma T. Kassie, Bekele Shiferaw, and Jacob Ricker-Gilbert. 2014. "Impact of Improved Maize Adoption on Welfare of Farm Households in Malawi: A Panel Data Analysis." World Development 59: 120–31. http://dx.doi.org/10.1016/j.worlddev.2014.01.023.

FAO. 2015. "The Economic Lives of Smallholder Farmers." FAO 4(4): 1–4. http://www.macrothink.org/journal/index.php/rae/article/view/6320%0Ahttp://www.upov.int/edocs/mdocs/upov/en/upov_sym_ge_11/upov_sym_ge_11_10.pdf%0Ahttp://ajae.oxfordjournals.org/cgi/doi/10.2307/1241587%0Awww.iosrjournals.org%0Ahttp://link.springer.com/10.

IEG. 2011. Impact Evaluations in Agriculture, An Assessment of the Evidence.

IFAD. 2016. Rural Development Report 2016. https://www.ifad.org/ruraldevelopmentreport.

Kangmennaang, Joseph et al. 2017. "Impact of a Participatory Agroecological Development Project on Household Wealth and Food Security in Malawi." Food Security 9(3): 561–76.

Kassie, Menale, Bekele Shiferaw, and Geoffrey Muricho. 2011. "Agricultural Technology, Crop Income, and Poverty Alleviation in Uganda." World Development 39(10): 1784–95.

Lopez, Cesar Augusto, Lina Salazar, and Carmine Paolo De Salvo. 2017. "Public Expenditures, Impact Evaluations, and Agricultural Productivity. Summary of the Evidence from Latin America and the Caribbean." (January 2017). https://publications.iadb.org/bitstream/handle/11319/8156/Public-Expenditures-Impact-Evaluations-and-Agricultural-Productivity-in-LAC.PDF?sequence=1.

López, César Augusto, Lina Salazar, and Carmine Paolo De Salvo. 2017. "Public Expenditures, Impact Evaluations and Agricultural Productivity: Summary of the Evidence from Latin America and the Caribbean." (January 2017). https://publications.iadb.org/handle/11319/8156.

Ogundari, Kolawole, and Olufemi D. Bolarinwa. 2018. "Impact of Agricultural Innovation Adoption: A Meta-Analysis." Australian Journal of Agricultural and Resource Economics 62(2): 217–36.

Pittelkow, Cameron M. et al. 2015. "Productivity Limits and Potentials of the Principles of Conservation Agriculture." Nature 517(7534): 365–68.

Villano, Renato, Boris Bravo-Ureta, Daniel Solís, and Euan Fleming. 2015. "Modern Rice Technologies and Productivity in the Philippines: Disentangling Technology from Managerial Gaps." Journal of Agricultural Economics 66(1): 129–54.

Longlist of literature scanned

Abdoulaye, T., Wossen, T., & Awotide, B. (2018). Impacts of improved maize varieties in Nigeria: ex-post assessment of productivity and welfare outcomes. *Food Security*, *10*(2), 369–379. https://doi.org/10.1007/s12571-018-0772-9

Alem, Y., Eggert, H., & Ruhinduka, R. (2015). Improving Welfare Through Climate-Friendly Agriculture: The Case of the System of Rice Intensification. *Environmental and Resource Economics*, *62*(2), 243–263. https://doi.org/10.1007/s10640-015-9962-5

Awotide, B. A., Karimov, A. A., & Diagne, A. (2016). Agricultural technology adoption, commercialization and smallholder rice farmers' welfare in rural Nigeria. *Agricultural and Food Economics*, *4*(1). https://doi.org/10.1186/s40100-016-0047-8

Brouder, S. M., & Gomez-Macpherson, H. (2014). The impact of conservation agriculture on smallholder agricultural yields: A scoping review of the evidence. *Agriculture, Ecosystems and Environment*, *187*, 11–12. https://doi.org/10.1016/j.agee.2013.08.010

Corbeels, M., Sakyi, R., Kühne, R., & Whitbread, A. (2014). Meta-analysis of crop responses to conservation agriculture in sub-Saharan Africa. *Rapport CIRAD*, (12). https://doi.org/CCAFS Report No.12

Daniels, S. (2017). Enabling smallholder farmers to improve their incomes. *Sustainable Food Lab and Business Fights Poverty*.

Das, A., Layek, J., Ramkrushna, G. I., Patel, D. P., Choudhury, B. U., Krishnappa, R., … Yadav, G. S. (2018). Modified system of rice intensification for higher crop and water productivity in Meghalaya, India: opportunities for improving livelihoods for resource-poor farmers. *Paddy and Water Environment*, *16*(1), 23–34. https://doi.org/10.1007/s10333-017-0609-8

Duflo, R. E., & Kremer, M. (2005). Nudging Farmers to Use Fertilizer : Experimental Evidence from Kenya Policy Issue : https://doi.org/10.1257/aer.101.6.2350

Emerick, K., Raitzer, D., Janvry, A. De, & Sadoulet, E. (2013). Adoption of Improved Fertilizer Management Practices under Risk Reduction due to Flood-Tolerant Rice in India Partners :

Fountain, A. C., & Hütz-Adams, F. (2015). Cocoa Barometer - Looking for a Living Income. *Cocoa Barometer*, 42–43.

Francis, Judith, A., Mytelka, L., Huis, A. Van, & Röling, N. (2016). *Innovation Systems: Towards Effective Strategies in support of Smallholder Farmers*. Retrieved from https://publications.cta.int/media/publications/downloads/1829_PDF.pdf?

Gine, X., Patel, S., Cuellar-Martinez, C., Mccoy, S., & Ralph, L. (2015). Impact Evaluation Report 23 Enhancing food production and food security through improved inputs An evaluation of Tanzania's National Agricultural Input Voucher Scheme with a focus on gender impacts International Initiative for Impact Evaluation. Retrieved from http://www.3ieimpact.org/en/about/3ie-affiliates/3ie-members/.

GIZ. (2019). Sustainable Smallholder Agri-Business Cocoa-Food Link Programme.

Gockowski, J., Afari-Sefa, V., Sarpong, D. B., Osei-Asare, Y. B., & Dziwornu, A. K. (2011). Increasing income of ghanaian cocoa farmers: Is introduction of fine flavour cocoa a viable alternative. *Quarterly Journal of International Agriculture*, *50*(2), 175–200.

Gockowski, J., & Sonwa, D. (2011). Cocoa intensification scenarios and their predicted impact on CO 2 emissions, biodiversity conservation, and rural livelihoods in the Guinea rain forest of West Africa. *Environmental Management*, *48*(2), 307–321. https://doi.org/10.1007/s00267-010-9602-3

Huber, C., Knoke, I., Morazán, P., & Bonn, M. M. (2016). Strengthening the competitiveness of cocoa production and improving the income of cocoa producers in West and Central Africa, *49*(0). Retrieved from https://suedwind-institut.de/files/Suedwind/Publikationen/2017/2017-06 Strengthening the competitiveness of cocoa production and improving the income of cocoa producers in West and Central Africa.pdf

IFAD. (2016). *Rural Development Report 2016*. https://doi.org/ISBN 978-92-9072-682-1

Ioan, A. (2017). the Evaluation of Innovation in Agriculture . a Meta -, *17*(1), 111–120.

Jack, K., & Tobias, J. (2017). Seeding success: Increasing agricultural technology adoption through information. *IGC Brief*, (December), 1–8. Retrieved from https://www.theigc.org/wp-content/uploads/2017/12/IGCJ5833-Agriculture-growth-brief-171214-Web.pdf

Jamnadass, R. H., Dawson, I. K., Franzel, S., Leakey, R. R. B., Mithöfer, D., Akinnifesi, F. K., & Tchoundjeu, Z. (2011). Improving livelihoods and nutrition in sub-Saharan Africa through the promotion of indigenous and exotic fruit production in smallholders' agroforestry systems: a review. *International Forestry Review*, *13*(3), 338–354. https://doi.org/10.1505/146554811798293836

Keniston, D., Duflo, E., & Suri, T. (2012). Promoting Agricultural Technology Adoption in Rwanda Partners :

Muzari, W., Gatsi, W., & Muvhunzi, S. (2012). The Impacts of Technology Adoption on Smallholder Agricultural Productivity in Sub-Saharan Africa: A Review. *Journal of Sustainable Development*, *5*(8). https://doi.org/10.5539/jsd.v5n8p69

Nakano, Y., Tanaka, Y., & Otsuka, K. (2018). Impact of training on the intensification of rice farming: evidence from rainfed areas in Tanzania. *Agricultural Economics (United Kingdom)*, *49*(2), 193–202. https://doi.org/10.1111/agec.12408

Noltze, M., Schwarze, S., & Qaim, M. (2013). Impacts of natural resource management technologies on agricultural yield and household income: The system of rice intensification in Timor Leste. *Ecological Economics*, *85*, 59–68. https://doi.org/10.1016/j.ecolecon.2012.10.009

OECD. (2015). Analysing Policies To Improve Agricultural Productivity Growth , Sustainably, (December), 1–18. https://doi.org/10.1787/9789264200593-en

Ogundari, K., & Bolarinwa, O. D. (2018). Impact of agricultural innovation adoption: a meta-analysis. *Australian Journal of Agricultural and Resource Economics*, *62*(2), 217–236. https://doi.org/10.1111/1467-8489.12247

Owusu, V., Frimpong, F. K., & Owusu, V. (2014). Impact of cocoa agroforests on yield and household income: Evidence from Ghana, 1–11.

Oxfam. (2016). END LINE EVALUATION REPORT OF INCREASING SMALLHOLDER AGRICULTURAL PRODUCTIVITY THROUGH IMPROVED FARMER TRAINING CENTERS (ISAP) PROJECT.

Quarmine, W., Haagsma, R., Sakyi-Dawson, O., Asante, F., Van Huis, A., & Obeng-Ofori, D. (2012). Incentives for cocoa bean production in Ghana: Does quality matter? *NJAS - Wageningen Journal of Life Sciences*, *60–63*, 7–14. https://doi.org/10.1016/j.njas.2012.06.009

Stewart, R., Rebelo, N., & Silva, D. (2016). Effects of training , innovation and new technology on African smallholder farmers ' economic outcomes and food security July 2016 Systematic Review Summary 6, (July).

Tibbo, K., Velden, I., Randall, I., & Peppelenbos, L. (n.d.). Private sector insights on service delivery models that boost profitability and improve farmer livelihoods. Retrieved from http://www.idhsustainabletrade.com

Wessel, M., & Quist-Wessel, P. M. F. (2015). Cocoa production in West Africa, a review and analysis of recent developments. *NJAS - Wageningen Journal of Life Sciences*, *74–75*, 1–7. https://doi.org/10.1016/j.njas.2015.09.001

World Bank. (2012). *Agricultural Innovation Systems: An Investment Sourcebook*. *The World Bank*. https://doi.org/10.1596/978-0-8213-8684-2

Appendix 1 Findings per key source

A global meta-analysis of impact evaluations on agricultural development commissioned by the World Bank in 2011 reviewed 86 impact evaluation studies from agricultural development programs from 32 countries, ranging from 2000 to 2009. The assessment focusses on evidence regarding the impact of different development interventions on productivity and farm income for individuals, households and communities. Ex-post impact of interventions was assessed from 6 months to 2 decades after project finalization (IEG, 2011).

The meta-analysis provides evidence of positive impacts on agricultural welfare from input technology interventions emphasizing that there are less clear effects from specific crop and farm management practices. The authors remain cautious claiming they found insufficient evidence to conclude that agricultural development always positively impacts smallholders livelihoods. The review stresses that **there is a lack of evidence to analyze the cost effectiveness of the intervention approaches** and that the **impact evaluations have not analyzed the distributional impacts of the interventions on females and males and youth**. This assessment highlights the synergy between input technologies and effective agricultural extension systems, illustrating that **adoption rates and the productive impact of improved technologies significantly increase with extension systems and farmer training components being in place.** Additionally the assessment considers **varietal technology that incorporates improved features such as disease resistance without increasing the need for additional inputs as the optimal option for resource poor farmers**.
Interventions implemented by the private sector were considered highly successful linking the use of improved input technology directly to improved market integration. Evidence presented in this assessment demonstrates that **interventions that involve new technologies generate the largest impacts when complemented by knowledge transfer and credit-related support activities** (IEG 2011).

In their research, Villano et al. (2015) assess the impact of modern rice technologies on farm productivity of using farm level data from 3164 rice-farming households from 30 provinces in the Philippines. They conclude that **adoption of certified seeds has a positive impact on net farm income increasing rice based income up to 10%.** Their assessment highlights that **the impact of modern rice technologies is greater in smallholder households that enjoy higher levels of education, higher levels of resource ownership and household welfare, access to irrigation and credit and have secure access to land**. They conclude that **agricultural technologies have highest impacts (and adoption rates) when they reduce and mitigate associated risks that are linked to the investment in these technologies**. Hence households that are in risk prone situations are not likely to invest in input technologies and certified seeds. Similarly this assessment highlights that interventions offering technological packages to overcome biophysical constraints such as drought, water logging and disease have highest impact on smallholder net income and enjoy highest adoption rates. This study provides evidence demonstrating **that interventions whereby new technologies are accompanied by training, on farm demonstration and agricultural extension components enjoy the highest adoption rates and generate highest impacts** (Villano et al. 2015).

Kassie et al. (2011) in their research, evaluate the ex-post impact of improved groundnut varieties on crop income and poverty in Uganda, using data from 927 households from seven districts and 74 villages. The survey, conducted on average 5 years after the release of the improved agricultural technologies, concludes that **adoption of improved high yielding and disease resistant varieties increased smallholders' yields by 35%, reduced production costs by 41% and improved net farm income by 40%.** Adoption of improved technologies potentially increases net crop income by $160 to $180 per hectare, even though the labor requirements for improved technologies are higher than with traditional varieties. Producers make use of the groundnuts for household consumption but

also rely on both domestic and export markets to sell produce and buffer fluctuations in market price. **Interventions that generated a conductive policy environment to improve access to seeds and markets and combined this with extension services generated the highest benefit and impact on farmers net income.** Producers were constrained in adopting the improved technology by a variety of factors including: lack of access to quality seeds and inputs, lack of access to credit, lack of access to market information and opportunities and lacking rural infrastructure. The study found that **adoption rates were highest amongst producers linked up to producer organizations, producers with higher levels of education and farmers with relatively smaller farms.**

In their publication, Kangmennaang et al. (2017) assess the ex-post impact of the Malawi Farmer to Farmer Agroecological research and development project on household wealth and net income, two years after project intervention. Applying propensity score matching on panel data from a sample of 1000 households in 12 villages from 2 provinces, Kangmennaang and colleagues provide **evidence of household wealth increases of 42%.** This study highlights that the **design and development of context specific productivity enhancing technologies and practices needs to be driven by smallholders' demand and needs to be guided and supported by farmer to farmer teaching and active participation of producers in research and development, in order to generate lasting impacts** (Kangmennaang et al. 2017).

Pittlekow et al,. (2014), in a meta-analysis, comparing yields from conservation agriculture and its tilling practices to conventional tilling practices, review 610 studies, across 48 crops and 63 countries (covering North America, South and Central America, Europe, Asia, Africa and Australia). They conclude that **in dry climates with high rainfall variability, no-tillage practices in combination with crop rotation and usage of crop residue significantly increase yields, indicating to the potential of conservation agriculture as a strategy for climate change adaptation**. This meta-analysis highlights the need to take caution when scaling conservation agriculture as resource poor and vulnerable smallholder farming systems are often found to be constrained in leaving crop residues on the field rather than utilization as livestock fodder. Exclusive adoption of no tillage practices without improving soil qualities and water retention capacities increase the likelihood of reducing yields (Nature 2014).

By reducing the investment costs of agricultural inputs or subsidizing the initial purchase of technological innovations, farmers are more likely to take the risk of adopting agricultural innovations. Benzu et al,. (2014) in their assessments of the impact of the adoption of improved maize on smallholder farmers' welfare in Malawi, make use of panel data from three rounds of data collection taken from a sample of 1375 households throughout the entire country. Even though the evidence provided does not explicitly look at smallholders' net farm income, this study produces valuable evidence regarding how public programs that stimulate and subsidize the use of agricultural input have great potential to significantly increase the adoption of productivity enhancing technologies and improve smallholders welfare.

In a meta-analysis conducted by FAO (2015) on the economic lives of smallholder family farmers, evidence on the impacts of adoption of production enhancing technologies was assessed based on rural household surveys and Smallholder farmers' DataPortrait (taken between 2005-2009) from 9 countries (Albania, Bangladesh, Bolivia, Kenya, Nepal, Nicaragua, Tanzania, Vietnam, Ethiopia). Using evidence from a cumulative sample of 44894 smallholder households, the assessment highlights that **positive impacts are achieved when the proposed technologies and practices have the potential to increase yields, reduce crop failure risks and when there is a access to market to sell produce**. This meta-analysis claims that **investment in development of human capital through education, literacy and numeracy programs and improvement of rural infrastructure are also vital to drive adoption, benefits from improved production and reduce transactions and transportation costs** (FAO 2015) .

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The Centre for Development Innovation works on processes of innovation and change in the areas of food and nutrition security, adaptive agriculture, sustainable markets, ecosystem governance, and conflict, disaster and reconstruction. It is an interdisciplinary and internationally focused unit of Wageningen UR within the Social Sciences Group. Our work fosters collaboration between citizens, governments, businesses, NGOs, and the scientific community. Our worldwide network of partners and clients links with us to help facilitate innovation, create capacities for change and broker knowledge.

The mission of Wageningen UR (University & Research centre) is 'To explore the potential of nature to improve the quality of life'. Within Wageningen UR, nine specialised research institutes of the DLO Foundation have joined forces with Wageningen University to help answer the most important questions in the domain of healthy food and living environment. With approximately 30 locations, 6,000 members of staff and 9,000 students, Wageningen UR is one of the leading organisations in its domain worldwide. The integral approach to problems and the cooperation between the various disciplines are at the heart of the unique Wageningen Approach.