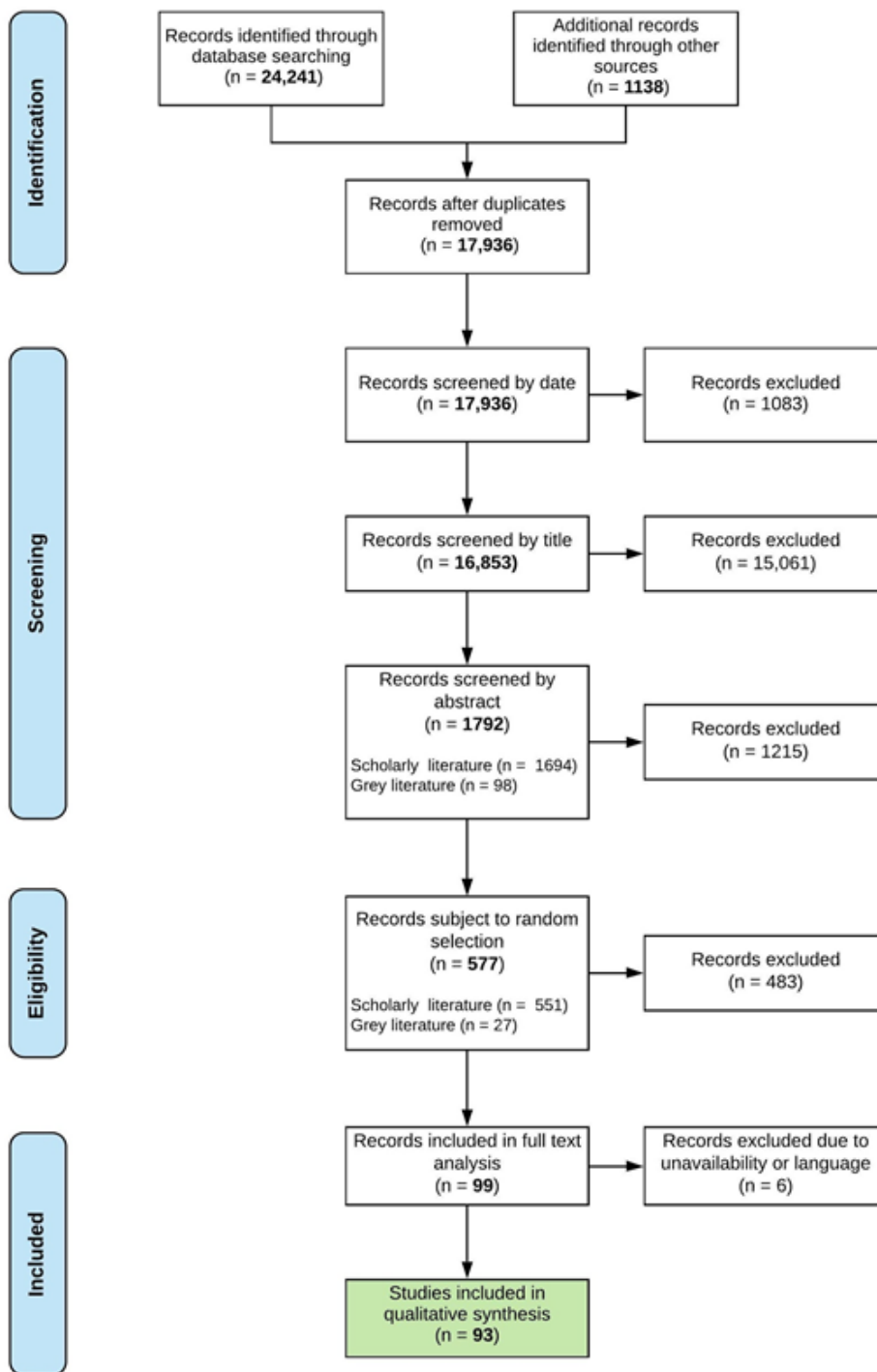

Supplementary information

A scoping review on incentives for adoption of sustainable agricultural practices and their outcomes

In the format provided by the
authors and unedited



Supplementary information, figure 1: Prisma flow diagram

Annex 1: Selected 44 papers with full incentive-adoption-outcome logic

Citation	Incentive			Conn ection	Ado ption	Conn ection	Outcome			Fa cto rs
	Ma rke t or no n- ma rke t bas ed	Regu lator y	Cros s- comp lianc e				Profit ability	Produ ctivity	Enviro nmenta l Sustain ability	
1. Adhikari, R. K., Kindu, M., Pokharel, R., Castro, L. M. & Knoke, T. Financial compensation for biodiversity conservation in Ba Be National Park of Northern Vietnam. <i>Journal for Nature Conservation</i> 35, 92–100 (2017).	no	no	yes	yes	yes	yes	yes	no	yes	yes
2. Alix-Garcia, J. M., Sims, K. R. E. & Yañez-Pagans, P. Only One Tree from Each Seed? Environmental Effectiveness and Poverty Alleviation in Mexico's Payments for Ecosystem Services Program. <i>American Economic Journal: Economic Policy</i> 7, 1–40 (2015).	no	no	yes	yes	yes	yes	yes	no	yes	no
3. Alves-Pinto, H. N., Hawes, J. E., Newton, P., Feltran-Barbieri, R. & Peres, C. A. Economic Impacts of Payments for Environmental Services on Livelihoods of Agro-extractivist Communities in the Brazilian Amazon. <i>Ecological Economics</i> 152, 378–388 (2018).	yes	no	no	yes	yes	yes	no	yes	no	no
4. Ananda, J. & Herath, G. Price and Subsidy Policy on Soil Conservation: Application to Smallholder Tea Growers. <i>Economic Analysis and Policy</i> 31, 99–110 (2001).	yes	no	no	yes	yes	yes	yes	yes	yes	no
5. Ariti, A. T., van Vliet, J. & Verburg, P. H. Farmers' participation in the development of land use policies for the Central	no	yes	no	yes	yes	yes	no	yes	yes	yes

Rift Valley of Ethiopia. Land Use Policy 71, 129–137 (2018).										
6. Banks-Leite, C. et al. Using ecological thresholds to evaluate the costs and benefits of set-asides in a biodiversity hotspot. Science 345, 1041–1045 (2014).	yes	no	no	yes	yes	yes	yes	no	no	no
7. Baumber, A. Enhancing ecosystem services through targeted bioenergy support policies. Ecosystem Services 26, 98–110 (2017).	no	yes	yes	yes	yes	yes	no	yes	yes	no
8. Bremer, L. L., Farley, K. A. & Lopez-Carr, D. What factors influence participation in payment for ecosystem services programs? An evaluation of Ecuador's SocioPáramo program. Land Use Policy 36, 122–133 (2014).	yes	yes	yes	yes	yes	yes	no	no	yes	yes
9. Caviglia-Harris, J. L. Sustainable agricultural practices in Rondônia, Brazil: do local farmer organizations affect adoption rates? Economic Development and Cultural Change 52, 23–49 (2003).	yes	no	no	yes	yes	yes	no	no	yes	yes
10. Cole, R. J. Social and environmental impacts of payments for environmental services for agroforestry on small-scale farms in southern Costa Rica. International Journal of Sustainable Development & World Ecology 17, 208–216 (2010).	yes	no	yes	yes	yes	yes	yes	no	yes	yes
11. Garbach, K., Lubell, M. & DeClerck, F. A. J. Payment for Ecosystem Services: The roles of positive incentives and information sharing in stimulating adoption of silvopastoral conservation practices. Agriculture, Ecosystems & Environment 156, 27–36 (2012).	yes	yes	yes	yes	yes	yes	yes	no	yes	yes

12. Gibbon, P. & Bolwig, S. The economics of certified organic farming in tropical Africa: A preliminary assessment. https://www.econstor.eu/handle/10419/84534 (2007).	yes	no	yes	yes	yes	yes	yes	yes	yes	no
13. Green, K. M., DeWan, A., Arias, A. B. & Hayden, D. Driving adoption of payments for ecosystem services through social marketing, Veracruz, Mexico. <i>Conservation Evidence</i> 10, 48–52 (2013).	yes	no	no	yes	yes	yes	no	no	yes	no
14. Himberg, N., Omoro, L., Pellikka, P. & Luukkanen, O. The benefits and constraints of participation in forest management. The case of Taita Hills, Kenya. <i>Fennia</i> 187, 61–76 (2009).	no	yes	no	yes	yes	yes	yes	no	yes	yes
15. Ipe, V. C. A group incentive program for farmer adoption of best practices: An application to the nitrate pollution problem in central Illinois. in <i>American Agricultural Economics Association (AAEA) 1999 Annual meeting</i> 25 (1999).	yes	no	no	yes	yes	yes	yes	no	yes	yes
16. Khanna, M., Isik, M. & Zilberman, D. Cost-effectiveness of alternative green payment policies for conservation technology adoption with heterogeneous land quality. <i>Agricultural Economics</i> 27, 157–174 (2002).	yes	no	no	yes	yes	yes	no	no	no	no
17. Kiem, A. S. Drought and water policy in Australia: Challenges for the future illustrated by the issues associated with water trading and climate change adaptation in the Murray–Darling Basin. <i>Global Environmental Change</i> 23, 1615–1626 (2013).	yes	yes	no	yes	yes	yes	yes	yes	yes	yes
18. Kumar, A. et al. Adoption and diffusion of improved technologies and production practices in agriculture: Insights from a donor-led intervention in Nepal. http://ebrary.ifpri.org/cdm/singleitem/collection/p15738coll2/id/133024 (2018).	yes	no	no	yes	yes	yes	yes	no	no	yes

19. Lagan, P., Mannan, S. & Matsubayashi, H. Sustainable use of tropical forests by reduced-impact logging in Deramakot Forest Reserve, Sabah, Malaysia. <i>Ecological Research</i> 22, 414–421 (2007).	yes	yes	yes	yes	yes	yes	yes	no	yes	no
20. Lankoski, J., Ollikainen, M., Marshall, E. & Aillery, M. Environmental Co-benefits and Stacking in Environmental Markets. https://www.oecd-ilibrary.org/agriculture-and-food/environmental-co-benefits-and-stacking-in-environmental-markets_5js6g5khdvhj-en (2015) doi:10.1787/5js6g5khdvhj-en.	yes	yes	yes	yes	yes	yes	no	no	yes	yes
21. Lungarska, A. & Chakir, R. Climate-induced Land Use Change in France: Impacts of Agricultural Adaptation and Climate Change Mitigation. <i>Ecological Economics</i> 147, 134–154 (2018).	yes	no	no	yes	yes	yes	no	no	yes	no
22. Maffioli, A., Ubfal, D., Vazquez-Bare, G. & Cerdan-Infantes, P. Improving technology adoption in agriculture through extension services: evidence from Uruguay. <i>Journal of Development Effectiveness</i> 5, 64–81 (2013).	yes	yes	no	yes	yes	yes	yes	yes	no	yes
23. Mahasuweerachai, P. Farmers' Adaptation to Flood Disasters: Evidence from the Mekong River Basin in Thailand. https://ideas.repec.org/p/eep/repot/rr2015112.html (2015).	yes	yes	no	yes	yes	yes	yes	yes	no	yes
24. Marennya, P., Nkonya, E., Xiong, W., Deustua, J. & Kato, E. Which policy would work better for improved soil fertility management in sub-Saharan Africa, fertilizer subsidies or carbon credits? <i>Agricultural Systems</i> 110, 162–172 (2012).	yes	no	no	yes	yes	yes	yes	no	yes	yes
25. Meyer, C., Reutter, M., Matzdorf, B., Sattler, C. & Schomers, S. Design rules for successful governmental payments for ecosystem services: Taking agri-environmental measures in	no	no	yes	yes	yes	yes	no	no	yes	no

Germany as an example. Journal of Environmental Management 157, 146–159 (2015).										
26. Nakano, Y., Tanaka, Y. & Otsuka, K. Impact of training on the intensification of rice farming: evidence from rainfed areas in Tanzania. Agricultural Economics 49, 193–202 (2018).	yes	no	no	yes	yes	yes	yes	yes	yes	yes
27. Quillérou, E., Fraser, R. & Fraser, I. Farmer Compensation and its Consequences for Environmental Benefit Provision in the Higher Level Stewardship Scheme: Farmer Compensation and its Consequences for Environmental Provision. Journal of Agricultural Economics 62, 330–339 (2011).	yes	no	yes	yes	no	yes	no	yes	yes	no
28. Ragasa, C., Lambrecht, I. & Kufoalor, D. S. Limitations of Contract Farming as a Pro-poor Strategy: The Case of Maize Outgrower Schemes in Upper West Ghana. World Development 102, 30–56 (2018).	yes	no	no	yes	yes	yes	yes	yes	no	yes
29. Reid, G. H. Building resilience to climate change in rain-fed agricultural enterprises: An integrated property planning tool. Agriculture and Human Values 26, 391–397 (2009).	yes	no	no	yes	yes	yes	no	yes	yes	yes
30. Saha, D. K. Farmers' need and adoption of technologies in some arid areas of Western Rajasthan. Journal of Arid Legumes 4, 117–120 (2007).	yes	no	no	yes	yes	yes	yes	yes	no	yes
31. Santiago, T. M. O., Caviglia-Harris, J. & Pereira de Rezende, J. L. Carrots, Sticks and the Brazilian Forest Code: the promising response of small landowners in the Amazon. Journal of Forest Economics 30, 38–51 (2018).	no	yes	no	yes	yes	yes	no	no	yes	yes

32. Santos, R., Antunes, P., Baptista, G., Mateus, P. & Madruga, L. Stakeholder participation in the design of environmental policy mixes. <i>Ecological Economics</i> 60, 100–110 (2006).	yes	yes	yes	yes	yes	yes	no	no	yes	yes
33. Schirmer, J., Dovers, S. & Clayton, H. Informing conservation policy design through an examination of landholder preferences: A case study of scattered tree conservation in Australia. <i>Biological Conservation</i> 153, 51–63 (2012).	yes	yes	yes	yes	yes	yes	no	no	yes	yes
34. Sheng, J., Qiu, H. & Zhang, S. Opportunity cost, income structure, and energy structure for landholders participating in payments for ecosystem services: Evidence from Wolong National Nature Reserve, China. <i>World Development</i> 117, 230–238 (2019).	yes	no	yes	yes	yes	yes	yes	no	yes	no
35. Soto, I. et al. Which factors and incentives influence the intention to adopt precision agricultural technologies? in <i>International Association of Agricultural Economists (IAAE) No 277470</i> (International Association of Agricultural Economists, 2018). doi:10.22004/ag.econ.277470.	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
36. Ward, P. S., Bell, A. R., Parkhurst, G. M., Droppelmann, K. & Mapemba, L. Heterogeneous preferences and the effects of incentives in promoting conservation agriculture in Malawi. <i>Agriculture, Ecosystems & Environment</i> 222, 67–79 (2016).	yes	no	no	yes	yes	yes	yes	yes	yes	yes
37. Weber, M. & Cutlac, M. Agricultural and Water in Canada – Challenges and Reform for the 21 C. in <i>Water Policy and Governance in Canada</i> (eds. Renzetti, S. & Dupont, D. P.) vol. 17 395–416 (Springer International Publishing, 2017).	yes	yes	no	yes	yes	yes	no	no	yes	yes

38. Wei, Y., Chen, D., Hu, K., Willett, I. R. & Langford, J. Policy incentives for reducing nitrate leaching from intensive agriculture in desert oases of Alxa, Inner Mongolia, China. <i>Agricultural Water Management</i> 96, 1114–1119 (2009).	yes	no	yes	yes	yes	yes	yes	no	yes	no
39. Weltin, M. & Zasada, I. Farmers' choices of adopting and coupling strategies of sustainable intensification - evidence from European farm level data. in 13th European International Farming Systems Association (IFSA) Symposium, Farming systems: facing uncertainties and enhancing opportunities 1–11 (2018).	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
40. Winters, P., Crissman, C. C. & Espinosa, P. Inducing the adoption of conservation technologies: lessons from the Ecuadorian Andes. <i>Environment and Development Economics</i> 9, 695–719 (2004).	yes	no	no	yes	yes	yes	yes	yes	yes	no
41. Wunder, S., Engel, S. & Pagiola, S. Taking stock: A comparative analysis of payments for environmental services programs in developed and developing countries. <i>Ecological Economics</i> 65, 834–852 (2008).	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
42. Wünscher, T., Engel, S. & Wunder, S. Spatial targeting of payments for environmental services: A tool for boosting conservation benefits. <i>Ecological Economics</i> 65, 822–833 (2008).	yes	no	yes	yes	yes	yes	no	no	yes	yes
43. Yang, A. L., Rounsevell, M. D. A., Wilson, R. M. & Haggett, C. Spatial analysis of agri-environmental policy uptake and expenditure in Scotland. <i>Journal of Environmental Management</i> 133, 104–115 (2014).	yes	yes	no	yes	yes	yes	no	no	yes	yes
44. Zapata, Á., Murgueitio, E., Mejía, C., Zuluaga, A. F. & Ibrahim, M. Effects of payments for environmental services in the adoption of silvopastoral systems in cattle landscape in the middle	no	no	yes	yes	yes	yes	no	no	yes	yes

[illegible]

Annex 2: Registered protocol

Amendments to registered protocol

September 19, 2019

The following is an amended version of the protocol (<https://osf.io/cmhuq>) for the project addressing the question: *What are the market, non-market, regulatory and compliance incentives or compulsory/voluntary programs for farmers to adopt environmentally sustainable practices?*

Due to the size of the corpus of literature screened, efficiencies were identified and applied to the title/abstract screening and the full text screening phases of the project. These changes are noted as amendments to Section 7.

The initial protocol draft was completed and registered on June 6, 2019 (<https://osf.io/cmhuq>).

Amendments were submitted to the editable project page on September 19, 2019 (<https://osf.io/hqnp3/>).

Protocol

Title: Market, regulatory and compliance incentives for farmers to adopt environmentally sustainable practices: a protocol for a scoping review

Administrative Information

1. **Identification:** Scoping review/systematic map.

2. **Registration:** <https://osf.io/cmhuq>

3. **Authors:**

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4. Roles and responsibilities:

- a. Content expertise:
 - i. Valeria Piñeiro
 - ii. Joaquin Arias
 - iii. Jochen Dürr
 - iv. Pablo Elverdin
 - v. Jikun Huang
 - vi. Ana Maria Ibañez
 - vii. Cristian Morales
 - viii. Nkechi S. Owoo
 - ix. Steve Prager
 - x. Maximo Torero
- b. Systematic review methods:
 - i. Jessica Page
 - ii. Wayne Thompson
 - iii. Alison Kinengyere
- c. Statistical analysis: TBD.
- d. Information retrieval:
 - i. Jaron Porciello
 - ii. Kate Ghezzi-Kopel

Introduction

1. Background:

Competing uses for land and water resources contribute to the degradation of our natural capital. This has negative consequences for farmers and other users, with related negative implications for future generations. A combination of best practices can facilitate the protection of our ecosystem (SDG13), enable sustainable production (SDG 14 and SDG 15), reduce hunger and advance food security (SDG 2).

The adoption of sustainable practices in agriculture will contribute to achieve sustainable and more resilient food production systems that increase productivity and production, and help maintain ecosystems, that strengthen capacity for adaptation to climate change and climate variability, and that progressively make more efficient use of natural resources (SGG 2.4). The implementation of these sustainable practices, however, requires significant effort from farmers.

The goal of this article is to make recommendations about how to promote environmental practices for more sustainable, and at the same time competitive, agricultural production systems. This scoping review will look at the overall landscape of evidence of these instruments and their effectiveness in achieving higher levels of productivity, profitability and equity.

This review is about incentives to farmers with the objective of having favorable impacts on environmental outcomes by changing the way it is produced, the amount that it is produced, the production activity, and the ecosystem in which it is produced. These incentives take the form of market-based, non-market based regulations and standards, some involving conditionalities and context or geographic specificity. Some measures or practices can be compulsory and others voluntary. Some other practices respond to public or private standards to meet food safety requirements or consumer preferences. Countries and sectors that have identified this as a potential solution and offer solutions based on the assessed early-impact, and the markers for successful implementation and adoption.

This mapping spans both developed and developing world contexts and characterizes how the incentives associated with different instruments may affect adoption given local institutional, environmental and socioeconomic factors.

Methods

1. Objectives:

a. Setting

The setting will not be restricted by geography or country status.

b. Population

Farmers in developed and developing countries, establishing differentiations of incentives in terms of ownership (landowners, rentals), farm size, production type or system (organic, low tillage, multi-crop, integrated crop-livestock-forestry, ect.), type of ecosystem, linkage to market, demographic characteristics and organizational level (linkage to enterprises, associations, cooperatives or value chain organizations).

c. Single intervention

The review will include multiple interventions: Market based; non-market based i.e. regulations; voluntary or compulsory measures; public and private standards; and cross compliance incentives for farmers to adopt sustainable environmental practices and integrated risk management systems (crop insurance, catastrophic insurance, price options, mitigation and adaptation programs, etc.)

d. Comparators

No comparators.

e. Outcomes of interest

Identification of practices adopted by farmers, and their impact on the multiple objectives of environmental sustainability, increased productivity and profitability.

f. Study design/publication type

Original research (qualitative and quantitative reports) and/or reviews of existing research, including gray literature.

2. Definitions:

Farmer: This is a person or entity who owns or manages a farm either commercially or to sustain himself or his family

Farm: A farm may be defined as an area of land, together with the buildings on it, that is used for agricultural production. The focus is primarily on agricultural processes with the primary objective of producing food, animal feed and other crops including livestock, farm fishing, forestry and products for household consumption or for the market.

Agriculture: Agriculture may be described as the science, art, and occupation of producing crops, raising and breeding of animals, harvesting timber and other plants, and cultivating the soil. Also includes aquaculture activity. It includes activities such as processing, financing, marketing, and distribution of agricultural and aquaculture products; farm production supply and service industries; the use and conservation of land and water resources; health, nutrition, and food consumption; development and maintenance of recreational resources; and related economic, sociological, political, environmental, and cultural characteristics of the food and fiber system.¹

¹ <https://articles.extension.org/pages/64505/what-is-agriculture>

Incentive: “Instruments used by the public and private sector to encourage farmers to protect or enhance ecosystem services beneficial to them and others, improving at the same time the competitiveness of the agricultural sector.”²

Market-based incentive: These are simply enabling measures to encourage farmers to adopt sustainable agricultural practices. Market-based incentives encourage behavioural change through market signals by providing economic incentives rather than through traditional regulations (prices of input and output, subsidy (or compensation), income transfer, tax and other incentives in cash or in kind to agricultural producers can be included in market-based incentives) (green trading bonds, carbon trade exchange, contract farming, etc.)

Regulatory measures: General rules or specific actions imposed by government agencies or private entities to enhance environmental and economic outcomes through improved practice. In the agricultural sector, certifications, and environmental laws and standards are examples.

Cross-compliance incentive: “A mechanism that links direct payments to compliance by farmers with basic standards concerning the environment, food safety, animal and plant health and animal welfare, as well as the requirement of maintaining land in good agricultural and environmental condition.”³

Environmentally sustainable: This is the maintenance of natural capital. Environmental sustainability is concerned with whether environmental resources are being protected and maintained for future generations. Could be defined more lengthily as a condition of balance, resilience, and interconnectedness that allows human society to satisfy its needs while neither exceeding the capacity of its supporting ecosystems to continue to regenerate the services necessary to meet those needs nor by our actions diminishing biological diversity.

Environmentally sustainable farming practices: This refers to meeting society's food needs in the present without compromising the ability of future generations to meet their own needs. There is a focus on reducing environmental damage from farming activities.

Sustainable environmental practices: These are practices which reduce harm on the environment and reduce wastage of resources. Farming practices that are contributing to climate change mitigation and adaptation are also part of this category.

Adoption: Uptake and use of specific technologies resulting from research, extension or other development initiatives in farmers' practices.

Rate of adoption: This may be conceived as the pace at which a new environmental practice is acquired and used by farmers. The period of time that it takes for farmers to begin using a particular sustainable practice; or the length of time required for a certain percentage of farmers to adopt environmental practices.

² <http://www.fao.org/ecosystem-services-biodiversity/incentives/en/>; see also <http://www.fao.org/3/ad524e05.htm>

³ <https://stats.oecd.org/glossary/detail.asp?ID=7350>

3. Research question:

What are the market, non-market, regulatory and compliance incentives or compulsory/voluntary programs for farmers to adopt environmentally sustainable practices?

4. Eligibility criteria:

For an article to be included in this study, it must meet all of the following inclusion criteria:

1. Studies published in 1994 or later. (Argument: United Nations Framework Convention on Climate Change (UNFCCC), which entered into force in 1994; Marrakesh Agreement (WTO) signed on 1994; 1992 reform in CAP and Kyoto Protocol to the UNFCCC, adopted in Kyoto, Japan, on 11 December 1997, that entered into force on 16 February 2005.)
2. Studies with an explicit focus on incentives for sustainable environmental agricultural practices as defined above.
3. Studies with an explicit focus on adoption of sustainable environmental agricultural practices as defined above.
4. Studies that explicitly connect the adoption of agricultural practices to sustainability outcomes as defined above.
5. Studies with an explicit analysis of the impact of incentives on income, production, productivity, profits, and/or environmental sustainability.
6. Original research (qualitative and quantitative reports) and/or review of existing research including gray literature.

For an article to be excluded from this scoping review, it must meet one of the following exclusion criteria:

1. Studies published earlier than 1994.
2. Studies with no explicit focus on incentives for sustainable environmental practices
3. Studies with no explicit focus on adoption of environmentally sustainable agricultural practices
4. Studies that do not explicitly connect the adoption of practices to sustainability outcomes
5. Studies with no explicit analysis of the impact of the incentives on income, production, productivity, profits and/or environmental sustainability
6. Not original research or a review of original research

5. Information sources:

Three research synthesis experts will conduct searches of the following electronic databases:

- CAB Abstracts (access via CAB Direct)
- Web of Science Core Collection (access via Web of Science)
- Scopus (access via Elsevier)
- EconLit (access via EBSCOhost)

A search of the following grey literature sources will also be conducted:

- Africa Theses and Dissertations (DATAD-R)
- AGRIS (FAO)
- Campbell Collaboration
- Cochrane Collaboration
- Collaboration for Environmental Evidence (CEE)
- Commonwealth Scientific and Industrial Research Organisation (CSIRO)
- Council for Agricultural Science and Technology (CAST)
- French Agricultural Research Centre for International Development (CIRAD)
- Gardian (searches 15 CGIAR websites)
- Inter-American Institute for Cooperation on Agriculture (IICA)
- International Fund for Agricultural Development (IFAD)
- International Institute for Environment and Development (IIED)
- JPAL/ATAI impact evaluations (IPA)
- Organisation for Economic Cooperation and Development (OECD)
- Overseas Development Institute (ODI)
- UK Department for International Development (DFID)
- United States Department of Agriculture (USDA)
- USAID's Development Experience Clearinghouse
- The World Bank
- AgEcon Search
- EMBRAPA
- UNEP
- WFP
- WHO

We shall also screen through the list of references of included studies for additional relevant studies that we may have missed during the search process.

6. Search strategy:

A comprehensive search strategy will be developed to identify all available research pertaining to the market, non-market, regulatory and compliance incentives for farmers to adopt environmental sustainable practices. Search terms will include variations of the key concepts in the research question: farmers, incentives, implementation of agricultural practices, and environmental impact. See Appendix A for a presentation of the search strategy in its entirety such that it may be reproduced in CAB Abstracts (accessed via the CAB Direct platform).

7. Study records

a. Data management:

Searches will be performed across all sources listed in section 5 of this protocol¹, and search results will be de-duplicated to remove redundant citations identified from multiple sources. Titles, abstracts, and keywords of all citations will be exported as .RIS files. We will use machine learning processes to accelerate the screening process. This includes adding machine-derived

metadata to individual citations, such as identifying populations, geographies, interventions, and outcomes of interest. This will allow for accelerated identification of potential articles for exclusion at the title/abstract screening stage.

b. Selection process:

Systematic review software, Covidence, will be used for title and abstract and full text screening decision-making for this scoping review. Article screening will take place in three phases:

- Title screening of all de-duplicated citations. Citations will be screened for relevance against the inclusion and exclusion criteria listed in section 4 of this protocol.
- Abstract screening of all de-duplicated citations. Citations will be screened for relevance against the inclusion and exclusion criteria listed in section 4 of this protocol.
- Full text screening of a semi-structured, stratified, randomized sample of all articles deemed relevant in the title and abstract screening phase. Citations will be screened for relevance against the inclusion and exclusion criteria listed in section 4 of this protocol. Reasons for exclusion will be documented within Covidence.

In the beginning of the title screening phase, citations will be reviewed for relevance by two independent reviewers from among the team's content experts. Given a sufficiently high level of interrater agreement over approximately 2000 titles, a rapid review single screener review process will be used for the remainder of all three screening phases. Each citation that meets all of the inclusion criteria at the title and abstract and full text screening phases will be included. Each citation that meets one of the exclusion criteria at the title and abstract and full text screening phases will be excluded. All conflicts during the initial two-screener portion of the title screening will be resolved in Covidence by a third, independent reviewer.

c. Data collection process:

We will develop a data extraction template to document all themes of interest listed in section 9 of this protocol (Data Synthesis/Charting) for each included study. The data extraction template will be tested by the review team before use, and data will be extracted by the reviewers.

8. Critical appraisal of individual sources of evidence:

The proposed evidence synthesis will be informed by methodological guidelines for scoping reviews^{43,44}, versus standards for preparation of systematic review or meta-analyses. A key difference between scoping reviews and systematic reviews is that the former are generally conducted to provide an overview of the existing evidence regardless of methodological quality or risk of bias.⁴¹ Due to the expected heterogeneity in study design of the included studies, we may assess individual sources of evidence for methodological quality or risk of bias. We will not perform a formal critical appraisal of all included studies but rather perform selective critical appraisal of groups of similar study types identified within included studies. Quality of data assessment may include appraisal of study replicability, multi-year, multi-location, size of sample population. The final manuscript will include an explanation of how the appraisal aligns with the review methods.

9. Data synthesis/charting:

To summarize findings and linking them to the question of interest, we plan to identify, tag and chart the outcomes by a number of criteria including:

- Impact of incentives on the adoption on environmental practices
- Impact of environmental practices on production, productivity and profitability
- Study type (quantitative or qualitative impact analysis, case studies, participatory/consultative/surveys)
- Journal peer review status (yes/no)
- Differentiation criteria:
 - land ownership
 - farm size
 - production type or system
 - type of ecosystem
 - linkage to market
 - organizational level
 - country status (e.g., lower/middle income countries)
 - Farmer demographics
 - age
 - gender
 - educational level
 - socioeconomic status
- Type of incentive (market, voluntary, compulsory, regulatory, public/private standards, etc.)
- Type of sustainable practice implemented

Appendix 2A

CAB Abstracts (CAB Direct) Date of Search: 5/23/2019 Number of results: 11,281

Row #	Search string	# of results
1	("farm*" OR "mixed-farm*" OR "agriculture" OR "producer*" OR "grower*" OR "agronomy" OR "husbandry" OR "aquaculture" OR "floriculture" OR "horticulture" OR "forestry" OR "forester*" OR "landowner*" OR "agroforestry" OR "agrofood" OR "agrarian") AND (sc:("CA" OR "X0" OR "HE" OR "X9"))	2,217,947

2	("environmental impact" OR "mitigation" OR "sustainab*" OR "climate resilient technolog*" OR "climatic change" OR "climatic resilience" OR "greenhouse gas*" OR "emissions" OR "carbon" OR "precipitation trapping" OR "runoff collection" OR "water reuse" OR "water conservation" OR "water harvesting" OR "organic amendment*" OR "soil conservation" OR "crop diversification" OR "permanent grassland" OR "land diversion" OR "ecological focus area*" OR "conservation" OR "ecosystem production" OR "biodiversity" OR "Sustainable intensification" OR "use of inputs" OR "input use" OR "no tillage" OR "no-till" OR "climate smart" OR "climate-smart" OR "climate smart agricultur*" OR "climate change adaptation*" OR "sustainable farming system*" OR "environmentally friendly" OR "sustainable agricultur*" OR "sustainable practice*" OR "environmentally beneficial technolog*" OR "best management practice*" OR "stewardship" OR "sustainable land management" OR "ecosystem service*" OR "ecotourism" OR "biodiversity prospecting" OR "non-timber forest product*" OR "selective logging" OR "wildlife habitat*" OR "agri-environment*" OR "agrobiodiversity" OR "environmental service*" OR "ecological service*" OR "foot-print" OR "footprint" OR "sylvopasto*" OR "conservation agriculture" OR "good agricultural practice*" OR "ecological" OR "good practice*" OR "best practice*" OR "agricultural practice*") AND (sc:("CA" OR "X0" OR "HE" OR "X9"))	1,328,539
3	("adoption of innovations" OR "innovation adoption" OR "adoption" OR "uptake of innovations" OR "innovation uptake" OR "adaptation*" OR "diffusion of innovation" OR "adopt*" OR "participate" OR "participation") AND (sc:("CA" OR "X0" OR "HE" OR "X9"))	435,847
4	("market-based environmental polic*" OR "market-based mechanism*" OR "market mechanism*" OR "market incentive*" OR "market-based incentive*" OR "market*" OR "agricultural marketing" OR "produce marketing" OR "land policy" OR "land use policy" OR "land use policies" OR "land policies" OR "tax*" OR "tax incentive*" OR	1,120,806

	"cross-compliance" OR "payments for environmental services" OR "payment for environmental services" OR "Common Agricultural Policy" OR "CAP greening" OR "CAP" OR "greening" OR "subsidy" OR "subsidies" OR "input subsidies" OR "input subsidy program*" OR "conservation program*" OR "paid land diversion" OR "conservation polic*" OR "agri-environmental policy" OR "benefit-cost targeting" OR "competitive bidding" OR "Conservation Reserve Program*" OR "Environmental Quality Incentives Program*" OR "policy design" OR "landowner compensation" OR "compensation of landowners" OR "direct- payment initiative*" OR "voluntary standard*" OR "certification" OR "tax credit*" OR "grant*" OR "loan*" OR "price support*" OR "financial incentive*" OR "economic incentive*" OR "market oriented" OR "land set-aside" OR "decoupling" OR "decoupled payments") AND (sc:("CA" OR "X0" OR "HE" OR "X9"))	
5	#4 AND #3 AND #2 AND #1	11,281