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Farmer Field Schools for Improving Farming Practices and Farmer Outcomes: A Systematic Review

Hugh Waddington, Birte Snilstveit, Jorge Hombrados, Martina Vojtkova, Daniel Phillips, Philip Davies, Howard White

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Authors	Waddington, Hugh Snilstveit, Birte Hombrados, Jorge Vojtkova, Martina Phillips, Daniel Davies, Philip White, Howard
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Corresponding authors

Hugh Waddington
International Initiative for Impact Evaluation (3ie)
London International Development Centre
London WC1H 0PD
E-mail: hwaddington@3ieimpact.org

Birte Snilstveit
International Initiative for Impact Evaluation (3ie)
London International Development Centre
London WC1H 0PD
E-mail: bsnilstveit@3ieimpact.org

Campbell Systematic Reviews

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The Campbell Collaboration
P.O. Box 7004 St. Olavs plass
0130 Oslo, Norway
www.campbellcollaboration.org

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List of Abbreviations

3ie	International Initiative for Impact Evaluation
AEC	Agricultural Extension Component, Bangladesh
AESA	agro-ecosystem analysis
ASPS	Agricultural Sector Program Support, Bangladesh
ATE	average treatment effect
ATET	average treatment effect on the treated
C2	Campbell Collaboration
CASP	Critical Appraisal Skills Programme
CI	confidence interval
CIMMYT	International Maize and Wheat Improvement Center
CIP	International Potato Center
DID	difference-in-differences
EAP	East Asia & Pacific
EIQ	environmental impact quotient
EPOC	Effective Practice and Organisation of Care Group
FAO	Food and Agriculture Organization of the United Nations
FGD	focus group discussion
FFS	farmer field school(s)
ICM	integrated crop management
ICPM	integrated crop and pest management
IDM	integrated disease management
IE	impact evaluation
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IRRI	International Rice Research Institute
IPBM	integrated pest biosystem management

IPCM	integrated crop and pest management
IPM	integrated pest management
IPNM	integrated plant nutrient management
IPPHM	integrated production and post-harvest handling management
IPPM	integrated production and pest management
IPVM	integrated pest and vector management
ISM	integrated soil management
ISNM	integrated soil nutrient management
ISPI	integrated soil productivity improvement
ITS	interrupted time series
IV	instrumental variables
IVM	integrated vector management
ITT	intention-to-treat
IWMI	International Water Management Institute
IWSM	integrated water and soil management
JFFLS	Junior Farmer Field and Life Schools
LAC	Latin America & Caribbean
LATE	local average treatment effect
LMICs	low- and middle-income countries
MCC	Millennium Challenge Corporation
MENA	Middle_East & North Africa
NGO	non-governmental organisation
NONIE	Network of Networks on Impact Evaluation
ODA	official development assistance
OLS	ordinary least squares
PSM	propensity score matching
RCT	randomised controlled trial
RDD	regression discontinuity design
RR	response ratio
SA	South Asia
SMD	standardized mean difference
SPUH	safe pesticide use and handling
SSA	sub-Saharan Africa

WLS	weighted least squares

Authors' conclusions

Farmer field schools (FFS) are a common approach used to transfer specialist knowledge, promote skills and empower farmers around the world. At least 10 million farmers in 90 countries have attended such schools.

FFS are implemented by facilitators using participatory "discovery-based" learning based on adult education principles. Many different implementing bodies have been involved. Field schools have a range of objectives, including tackling overuse of pesticides and other harmful practices, improving agricultural and environmental outcomes, and empowering disadvantaged farmers such as women.

We conducted a systematic review of evidence on FFS implementation to investigate whether FFS make a difference, to which farmers, and why or why not. We synthesised quantitative evidence on intervention effects using statistical meta-analysis, and qualitative evidence on the barriers and enablers of effectiveness using a theory of change framework.

The results of statistical meta-analysis provide evidence that FFS are beneficial in improving intermediate outcomes relating to knowledge learned and adoption of beneficial practices, as well as final outcomes relating to agricultural production and farmers' incomes. The findings suggest this to be the case for FFS promoting integrated pest management (IPM) technology, as well as other techniques. However, the rigorous impact evaluation evidence base is small and there are no studies that we were able to identify as having a low risk of bias.

There is no evidence that neighbouring non-participant farmers benefit from diffusion of IPM knowledge from FFS participants. Therefore, they do not experience improvements in IPM adoption and agriculture outcomes.

The evidence of positive effects on agricultural outcomes is largely limited to short-term evaluations of pilot programmes. In the few examples where FFS have been scaled up, the evidence does not suggest they have been effective in improving agricultural outcomes among participating farmers or neighbouring non-participants.

Although empowerment is a major objective of many FFS, very few studies have collected information on this outcome in a rigorous manner. A few studies suggest farmers feel greater self-confidence.

What explains the lack of scalable effects among FFS participants, or diffusion of IPM practices among the community? FFS differ from standard agricultural extension interventions, which tend to focus on disseminating knowledge of more simple practices such as application of fertiliser and pesticides, or adoption of improved seeds. The experiential nature of the training, and the need for the benefits of the FFS technology to be observed, are barriers to spontaneous diffusion. Furthermore, the effectiveness of scaled-up interventions has been hampered by problems in recruiting and training appropriate facilitators at scale.

The review provides implications for policy, practice and research.

Executive Summary

BACKGROUND

After almost three decades of decline in public support, agriculture is now back on the development agenda. Since the late 1980s, support to agriculture has shifted from top-down approaches to those identifying technologies and methods of communicating technologies which are suitable to support farmers' livelihoods in a sustainable manner, including participatory approaches based on the notion of creating spaces for farmer self-learning. One such approach is the farmer field school (FFS), an adult education intervention which uses intensive "discovery-based" learning methods with the objectives of providing skills in such areas as integrated pest management (IPM) and empowering farmers and communities. FFS have been implemented in 90 countries worldwide, reaching an estimated 10–15 million farmers. Farmer field schools may appear to be the latest tool, but what does the evidence say regarding their effectiveness?

OBJECTIVES

This systematic review synthesises evidence on interventions identified as "farmer field schools" conducted in low- and middle-income countries. The review aims to provide answers to the following research questions:

Review question (1):

a) What are the effects of farmer field schools on final outcomes such as yields, net revenues and farmer empowerment?
b) What are the effects of farmer field schools on intermediate outcomes such as knowledge and adoption of improved practices (e.g. reduced use of pesticides)?
c) What are the effects on outcomes for non-participating neighbouring farmers living in the same communities as FFS farmers?

Review question (2): What are the enablers of and barriers to FFS effectiveness, diffusion and sustainability?

STUDY SELECTION CRITERIA

Studies included in the review satisfied the following criteria.

Eligible participants included farmers growing arable crops, living in low- or middle-income countries at the time of the intervention. The review included those participating directly in the field school and also non-participant neighbour farmers who may benefit through spillover effects or more formal dissemination methods.

Eligible interventions were those identified as "farmer field schools," regardless of the design or implementation, including FFS programmes providing training in IPM and other techniques. Studies combining FFS with other intervention components, such as input or marketing support, were also included.

Comparisons eligible for the effectiveness review were farmers who received no intervention, or access to agricultural extension services from another source, including IPM (or equivalent) training.

All outcomes reported were eligible for the review.primary *Primary outcomes* were agricultural outcomes , including yields and profits (net revenues). *Secondary outcomes* included other final outcomes such as environmental outcomes, health status and empowerment; and intermediate outcomes, including farmer knowledge and adoption of practices. Qualitative evidence on barriers to and enablers of effectiveness and sustainability were also included, including process and implementation information and measures of beneficiaries' attitudes and experiences with FFS.

Eligible study designs for the effectiveness synthesis (review question 1) were measurable using counterfactual impact evaluations, including experimental or quasi-experimental study designs and methods of analysis. Studies eligible for the synthesis of barriers and enablers (review question 2) were based on primary data collected from FFS participants, extension agents or experts, analysed using qualitative methods or descriptive statistics. The qualitative studies needed to report at least some information on the research question, procedures for collecting data, sampling and recruitment, and at least two sample characteristics.

SEARCH STRATEGY

The search included electronic academic databases, internet search engines, websites and theses, as well as handsearches of key journals and literature snowballing. Searches included general social science sources as well as agriculture subject-specific sources of published and unpublished literature. All searches were updated in October 2012.

The farmer field schools evaluation community has generated a large number of evaluations. We screened the titles and abstracts of over 28,000 papers, the majority of which were irrelevant to the topic. Four-hundred-sixty (460) relevant papers on FFS were assessed for inclusion based on full text. After the final screen by two authors, 134 quasi-experimental studies comprising 92 distinct evaluations meeting the inclusion criteria were eligible for the review. The impact evaluations provide quantitative estimates of effects on outcomes for 71 FFS projects. However, only 15 of the impact evaluations meeting the inclusion criteria were judged to be of sufficient internal validity to make predictions for policy. The review also includes 20 qualitative evaluations meeting the inclusion criteria, which discuss the barriers to and enablers of change in 20 FFS projects. A portfolio review of 337 project documents was also conducted.

DATA COLLECTION AND ANALYSIS

Two independent reviewers assessed the full text papers against the inclusion criteria; discrepancies were resolved by consensus or by a third author if needed. Two reviewers extracted data from included studies. Quantitative impact evaluation studies were critically appraised according to the likely risk of bias according to threats to internal validity (causal identification), external validity (generalisability) and file-drawer effects (publication bias). Qualitative evaluations were assessed according to adequacy of reporting, data collection, presentation, analysis and conclusions drawn.

We used a hypothesised programme theory of change (White, 2009) as the framework for integrating the evidence. We collected data on programme design, implementation, targeting and contextual factors, and linked individual studies by programme in order to assess whether heterogeneous programme effects were correlated with study design, implementation and context.

For the quantitative synthesis (review question 1), we extracted effect size estimates from included studies, calculating standard errors and 95 per cent confidence intervals using data provided in the studies, where possible. We used random effects meta-analysis, estimating average effects of farmer field schools on the different outcomes, and examining heterogeneity. The results of the publication bias analysis suggested under-reporting of small sample studies with negative or insignificant findings for studies reporting evidence on agricultural yields, which is evidence for possible publication bias.

For the synthesis of qualitative evidence (review question 2), we used a thematic approach (Thomas & Harden, 2008), combining predetermined themes based on the links and assumptions in the theory of change model, as well as any other themes emerging from the detailed coding of the included studies.

In the final stage of analysis, we used an iterated approach in which some effect moderators identified during the qualitative synthesis were tested in meta-analysis and meta-regression.

RESULTS

Review question (1)

No studies with a low risk of bias were identified for the review of effects and only 15 (out of 92) quasi-experimental studies were assessed as being of medium risk of bias and therefore policy-actionable. The results of these medium-risk-of-bias studies (reported in Summary of Findings Table 1) suggest farmer field schools impact positively on intermediate and final outcomes for participating farmers in the short to medium term.

Findings for intermediate outcomes were as follows:

- There was a significant increase of 0.21 standard deviations on *knowledge* about beneficial practices among farmer field school participants over comparison farmers (SMD=0.21, 95% confidence interval (CI)=0.07, 0.35; Q=5, Tau-sq=0.008, I-sq=55%; evidence from 3 studies).

- There was a significant reduction in *pesticide use* by 23 per cent for IPM and IPPM FFS participants over comparison farmers (RR=0.77, 95% CI=0.61, 0.97; Q=40, Tau-sq=0.07, I-sq=83%; 8 studies). Effects on pesticide use were particularly large and consistent for cotton IPM projects in Asia.

- There was a significant increase in indices of *adoption of other beneficial practices* by 0.22 standard deviations over comparison farmers (SMD=0.22, 95% CI=0.06, 0.38; Q=10, Tau-sq=0.02, I-sq=80%; 3 studies).

For final outcomes, the findings were as follows:

- A significant increase in *agricultural yields* was estimated among FFS participants, by 13 per cent over comparison farmers (RR=1.13, 95% CI=1.04, 1.22; Q=53, Tau-sq=0.008, I-sq=81%; 11 studies).

- A significant increase in *profits (net revenues)* was estimated, by 19 per cent among FFS participants over comparison farmers (RR=1.19, 95% CI=1.11, 1.27; Q=1, Tau-sq=0, I-sq=0%; 2 studies). The increase in profits was higher for FFS projects which also included complementary interventions involving input or marketing support (RR=2.51, 95% CI=1.51, 4.16, Q=1, Tau-sq=0, I-sq=0%; 2 studies).

- There was a 39 per cent reduction in estimated *environmental impact quotient (EIQ)* score as a result of reduced pesticide use among FFS farmers over comparison farmers (RR=0.61, 95% CI=0.48, 0.78; Q=3, Tau-sq=0.01, I-sq=33%; 3 studies).

- We could not identify any studies which provided valid estimates of impacts on farmer *health outcomes*.

- Very few studies assessed *empowerment* using quantitative counterfactual methods, and only one provided estimates of statistical precision.

However, there is no evidence of effects on outcomes over the longer term (follow-up surveys greater than two years after implementation) in programmes which have been scaled up nationwide.

For IPM farmer field schools, there is no evidence that diffusion from FFS participants to non-participating neighbour farmers usually happens:

- Overall, studies found no significant change in knowledge among FFS neighbours over comparison farmers. There was also no evidence for improvements among neighbours on pesticide use, yields or environmental impact quotient.

- When relatively better-educated farmers are targeted to participate in the IPM field schools, diffusion may occur for simple practices (such as reduced pesticide use) and yields. However, even in a few cases where diffusion appeared to occur, the evidence does not suggest diffusion to non-participants is sustained over time.

Review question (2)

Qualitative evaluations (reported in Summary of Findings Table 2) in the review helped us to understand the different types of farmer field schools implemented around the world, the reasons for heterogeneous impacts among FFS participants, and the limited diffusion to non-participating neighbour farmers. FFS use discovery-based learning methods which differ from agricultural extension interventions that tend to focus on disseminating knowledge of more simple practices, for instance application of fertiliser and pesticides, or adoption of improved seeds. However, there are several barriers to spontaneous diffusion of knowledge and practices. The FFS curriculum is complex and the training should be experience-based, so that farmers are able to observe that FFS practices have a relative advantage over conventional farmer practices. Existing levels of social capital, the reach of social networks, and approaches to targeting FFS participants were found to be potentially important factors in influencing diffusion. More generally, the studies identify some of the more common problems in implementation, notably where a top-down “transfer of technology” approach has been implemented for an intervention which is intended to be based on a “bottom-up” participatory approach. All qualitative evaluations presented some evidence of use of triangulation to verify their findings, although most studies had weaknesses in reporting on sampling, analysis, and presentation of data, making quality appraisal of this evidence base challenging.

IMPLICATIONS FOR POLICY AND PROGRAMMES

Farmer field schools can have beneficial effects for participating farmers, in pilot programmes in the short term. The impacts on agricultural outcomes may be of substantial importance to farmers, in the region of a 10 per cent increase in yields and 20 per cent increase in profits (net revenues). The effects are particularly large when FFS are implemented alongside complementary upstream or downstream interventions (access to seeds and other inputs, assistance in marketing produce) for cash crops.

However, the few studies of scaled-up programmes measuring outcomes over the longer term (more than two years post-training) do not find any evidence of effects of FFS. Farmers may also feel more confident, but again very few studies have assessed empowerment outcomes rigorously.

There is little evidence of diffusion of improved practices or outcomes from FFS participants to non-participating neighbour farmers. Field schools targeting more educated farmers may be better able to diffuse simple practices, such as on reduced pesticide use, than field schools that target less educated farmers. However, there is no evidence that any diffusion of practices is sustained over time, nor any evidence for adoption of more complex IPM practices via diffusion.

As a method of rural adult education, FFS appear suited for gradual scale-up provided there is a clear focus on ensuring local institutionalisation (i.e. favouring intensiveness of coverage in each community over geographical breadth of coverage). On the other hand, FFS seem unsuited to solve the problems of large-scale extension. The approach may not be cost-effective compared with agricultural extension in many contexts, except where existing farming practices are particularly damaging, for example due to overuse of pesticides. This is because of the highly intensive (and therefore relatively costly) nature of the training programme, the relative successes in targeting more educated farmers as compared with disadvantaged groups, and failures in promoting diffusion of IPM practices.

Targeting FFS participants: Proponents of FFS have recommended targeting more highly educated farmers, those with greater land endowments, younger farmers and women, favouring those with relatively low opportunity costs of labour or farmers with relatively high pesticide costs. Problems were highlighted in targeting women who lived in household where they were not in a decision-making position, and youth who were unable to dedicate sufficient time to the FFS plot or their fields.

Where the aim is to include women and disadvantaged members of the community, implementers may need to tailor the intervention to enable their participation in the programme. The curriculum needs to be relevant and consistent with the needs and opportunities of women and the poor. Most obviously, in contexts where women are primarily responsible for growing subsistence crops, a curriculum that covers only commercial crops is unlikely to attract women participants. More generally, the curriculum and crops covered in FFS should also be adapted according to the local agricultural system and the needs of the farmers targeted by the programme. Curricula need to deal with the major challenges facing farmers. In most cases, these challenges will be multifaceted, highlighting the need to balance comprehensiveness with being able to cover all issues in sufficient depth to ensure appropriate learning. A cumulative approach over several seasons, including exchanges between field schools, may be preferable.

FFS facilitators: The evidence also suggests that appropriate targeting and training of FFS facilitators is important. The theory of change suggests FFS should be delivered according to a participatory and discovery-based approach to learning, including opportunities for farmers to experiment and observe new practices, particularly if farmers are to be empowered with lifelong skills capacity development. Attempts to target facilitators based on education or literacy levels may be less effective than targeting based on ability to communicate, and appropriate training which enables facilitators to use a bottom-up approach. This is most obviously a barrier in scaled-up programmes where FFS facilitators are recruited from extension staff who previously used more top-down agricultural extension methods. Recruitment of facilitators should take into account personal attitude, maturity, literacy, leadership skills, knowledge in local language and experience with farming. In many contexts the gender of the facilitator should be carefully considered. Facilitators should have access to ongoing support and backstopping from supervisors and technical experts connected to local research centres. Regular monitoring of facilitators may help to identify schools where additional support is required.

Complementary policies: Institutional actors involved in FFS should consider farmers' needs and interests in the design and implementation of the FFS programme. In some contexts stronger policies and regulatory measures may be necessary to counteract the activities of the pesticide industry, including the promotion and sale of pesticides by extension workers who are promoting FFS. New policies facilitating participatory agricultural extension approaches, replacing earlier extension policies aimed at promoting off-the-shelf technologies and input packages, may also be necessary.

Local institutionalisation: Formal support and encouragement of FFS alumni, including technical assistance and backstopping, may be important for the sustainability of FFS practices and related activities. Given the skills-based nature of the practices promoted in FFS, formal community-building activities, support and successful attempts to institutionalise the approach, to encourage FFS graduates to train other farmers, are likely to be needed for any broader diffusion to non-participating neighbour farmers, although the evidence base does not indicate that such attempts have been successful in the past.

IMPLICATIONS FOR RESEARCH

The majority of FFS impact evaluations (68 out of 92) use designs of questionable internal validity, and are therefore of limited value in determining whether farmer field schools have made a difference to outcomes. We were not able to locate any completed evaluations which used randomised assignment, an approach which is feasible for FFS. In three-quarters of evaluations, no serious attempts were made to control for confounding through statistical matching or other statistical analysis, and in one-third of cases statistical significance tests were not reported. The likely consequence, as indicated in the meta-analysis, was the systematic overestimation of effects for all outcomes. The extent of resources that has been devoted to farmer field schools evaluations might therefore be usefully re-allocated to conducting fewer but more rigorous impact evaluations, particularly those based on a solid counterfactual, with prospective cluster-level assignment (randomised or otherwise) to allow measurement of community-wide diffusion and to assess effects on agriculture and empowerment outcomes in the medium to longer term (three years or more).

Evaluations should report information on both intervention design and implementation processes so that it is possible to assess whether programme causal chains break down because the intervention design is simply not appropriate for the context or because of poor implementation.

Many qualitative evaluations need to report aspects of the research process in greater detail to allow users to assess their credibility and applicability. In particular, clear reporting on objectives, on methods of sampling, data collection and analysis should be provided. Greater use of structured abstracts will facilitate easier access to quantitative and especially qualitative research. Future studies should include data on views and experiences of FFS facilitators and agricultural extension workers.

Summary of Findings Tables

Summary of Findings Table 1: Effectiveness studies (review question 1)

Outcomes	Summary of findings			Quality assessment[3]	Statement
	No. of studies (participants)	Relative effect size (95% CI)	Percentage change compared with control group		
Final outcomes – all farmer field school participants (review question 1a)					
Yields (primary outcome)	11 (3,198)	1.13 RR[1] (1.04, 1.22)	13% increase in yields of FFS participants on average relative to comparison group (4%, 22%)	++oo Low Moderate risk of bias and publication bias strongly suspected	FFS may increase yields of FFS participants by an average of 13% relative to comparison group, though there is notable variation across populations and contexts
Net revenues (primary outcome)	2 (488)	1.19 RR (1.11, 1.27)	19% increase in net revenue of FFS participants on average relative to comparison group (11%, 27%)	++oo Low Moderate risk of bias and small number of studies	FFS may increase net revenues (profits) of FFS participants by an average of 19% relative to comparison group
Empowerment	1 (200)	2.13 RR (1.46, 3.12)	FFS participants 1.13 more likely to report positive empowerment outcomes relative to comparison group (0.46, 2.12)	+ooo Very low Moderate risk of bias, serious indirectness and very serious imprecision	The evidence on the impact of FFS on empowerment for FFS participants is inconclusive
Environmental outcomes (environmental impact quotient)	3 (1,149)	0.61 RR (0.48, 0.77)	39% reduction in environmental impact quotient of FFS participants on average relative to comparison group (52%, 23%)	++oo Low Moderate risk of bias and small number of studies	FFS may reduce the environmental impact quotient by 39% on average relative to comparison group

Outcomes	Summary of findings			Quality assessment[3]	Statement
	No. of studies (participants)	Relative effect size	Percentage change compared with		
Intermediate outcomes – farmer field school participants (review question 1b)					
Knowledge test scores	3 (426)	0.21 SMD[2] (0.07, 0.35)	The knowledge test scores achieved by FFS participants are on average 0.21 standard deviations greater than in the comparison group (0.07, 0.35)	++oo Low Moderate risk of bias and small number of studies	FFS may increase knowledge of FFS participants by 0.21 standard deviations on average relative to comparison group
Pesticide use (IPM/IPPM FFS only)	9 (2,335)	0.83 RR (0.66, 1.04)	17% decrease in pesticide use by FFS participants on average relative to comparison group (-34%, 4%)	++oo Low Moderate risk of bias and serious imprecision	FFS may decrease pesticide use of IPM/IPPM FFS participants by 17% on average relative to comparison group though there is notable variation across populations and contexts
Adoption of beneficial practices	3 (794)	0.22 SMD (0.06, 0.38)	The number of practices adopted by FFS participants is on average 0.22 standard deviations greater than in the comparison group	+ooo Very low Moderate risk of bias, serious inconsistency and small number of studies	Evidence on the effect of FFS on the adoption of beneficial practices is inconclusive
Diffusion to neighbour farmers (review question 1c)					
Pesticide demand neighbours (pesticide use, pesticide costs)	5 (1,115)	0.95 RR (0.64, 1.39)	No statistically significant effect on pesticide use of FFS neighbours relative to comparison group	++oo Low Moderate risk of bias and serious imprecision	FFS may not have any diffusion effect on pesticide use

Outcomes	Summary of findings			Quality assessment[3]	Statement
	No. of studies (participants)	Relative effect size	Percentage change compared with		
Yields	4 (986)	1.02 RR (0.97, 1.08)	No statistically significant effect on the yields of FFS neighbours relative to comparison group	++oo Low Moderate risk of bias, serious inconsistency	FFS may not have any diffusion effect on yields

Notes: 1/ RR = response ratio. 2/ SMD = standardised mean difference.
3/ The rating guide used for the assessment of the quality of the evidence was adapted from GRADE and is available from the authors.
Source: authors based on GRADE.

Summary of Findings Table 2: Barriers to and enablers of effects (review question 2)

Outcomes	No. of studies	Statement
Barriers to and enablers of knowledge acquisition	17 studies	**Barriers:** FFS facilitators do not receive sufficient training and ongoing support (6 studies). Facilitators do not have enough farming experience and/or appropriate characteristics (2 studies). Lack of adequate and timely resources for FFS schools (3 studies). Farmers excluded due to restrictive targeting criteria or procedures (4 studies). Farmers unable to participate due to gender, cultural norms or poverty (7 studies). High levels of drop-out due to incorrect expectations or lack of interest, access or time (7 studies).Training delivered in a top-down manner, using transfer of technology approach (4 studies). Curriculum not appropriate or relevant to the local context (7 studies). Imbalance in relationship between farmers and facilitators (3 studies). Facilitators use national language, in which farmers are not fluent, or too many foreign and scientific terms (2 studies). **Enablers:** FFS facilitators have experience with farming, are literate and mature, and have a positive personal attitude and leadership skills (3 studies). Gender of facilitator acceptable to participants and their families (2 studies). Farmers motivated to learn and improve livelihoods (5 studies). Training delivered in a participatory, bottom-up manner (9). Curriculum appropriate and relevant to the local context (7 studies). Facilitators use local language and concepts and metaphors common to farmers (2 studies).
Barriers to and enablers of adoption of FFS practices	18 studies	**Barriers:** Training delivered in a top-down manner, using transfer of technology approach (4 studies). Curriculum is not appropriate and relevant to the local context (7 studies). Farmers do not observe benefits from FFS practices (2 studies). Practices too complex for farmers to implement (3 studies). Farmers lack access to inputs, capital and/or markets (5 studies). Low levels of social capital among participants (1 study). **Enablers:** Training delivered in a participatory, bottom-up manner (9 studies). Curriculum is appropriate and relevant to the local context (7 studies). Farmers observe benefits of FFS practices (5 studies). High levels of social capital among participants and tradition of collective action (3 studies).
Barriers to and enablers of effectiveness and sustainability	14 studies	**Barriers:** Diverging institutional incentives and objectives (3 studies). Conflicting agricultural policies (2 studies). Institutional legacy from top-down extension approaches (4 studies). Power of pesticide industry and continued links with the extension service (2 studies). Lack of technical assistance and backstopping from researchers and extensionists (4 studies). **Enablers:** Active follow-up and continued support from implementing agency (11 studies). FFS groups with consistent membership, good leadership, collective goals and a supportive group environment (4 studies).
Barriers to and enablers of diffusion of knowledge and practices	11 studies	**Barriers:** Complexity and experiential nature of FFS learning (5 studies). Farmers unable to observe FFS practices (2 studies). Farmers are not convinced of the relative advantage of FFS practices (2 studies). Socioeconomic differences between FFS participants and non-participants (1 study). Low levels of social capital and cohesion limiting communication (2 studies). **Enablers:** Concrete and relatively easy practices (2 studies). Farmers observe FFS practices (5 studies). Farmers perceive FFS practices to have relative advantage over existing practices (2 studies). High levels of social capital and social networks extending beyond FFS group (3 studies). Active promotion of FFS practices post-graduation (1 study).

Source: authors.

1 Background

1.1 DESCRIPTION OF THE PROBLEM

Agriculture is the main source of income for around 2.5 billion people in the developing world (FAO, 2003, p. 1). Around 70 per cent of the extreme poor – or over 1 billion people – live in rural areas in low- and middle-income countries (IFAD, 2010, p. 233), most of whom rely directly or indirectly on agriculture for their livelihoods. Investment in agriculture has been shown to have beneficial impacts on agricultural growth (Fan & Rao, 2003) and, since the poorest population groups benefit significantly more from agricultural growth than from growth in other sectors of the economy, poverty reduction (United Nations, 2008; World Bank, 2007).

The modernisation of farming practices in the 1960s and 70s during the "Green Revolution" improved agricultural yields substantially in those areas it reached and raised national production and food security (IFAD, 2001). However, a number of challenges emerged. The first problem was that poor farmers were being left behind, particularly in Sub-Saharan Africa where many were not reached by modernisation approaches. Those technologies that were promoted were not appropriate to the challenges facing smallholders in the African context, particularly women farmers (Inter-Academy Council, 2004). Second, where modernisation was successful, it was also associated with adverse environmental and health consequences, relating to water pollution, declining soil quality, soil erosion, pest resistance and loss of biodiversity (Van den Berg & Jiggins, 2007).

A particular problem emerged around the environmental and health consequences of chemical pesticide use. Chemical pesticides were so heavily promoted and publicly subsidised under the modernisation agenda that their overuse led to pesticide resistance and major outbreaks of insect pests in rice crops in Asia in the 1970s and 80s. In addition, prolonged exposure to pesticides was associated with chronic and acute health problems among rural residents (Pingali & Roger, 1995). Use of broad-spectrum insecticides in agriculture has also been linked to mosquito resistance to insecticides used in malaria control programs (Diabate et al., 2002; cited in Van den Berg & Jiggins, 2007).

It was increasingly recognised that different approaches were required to reach smallholders. These approaches needed to fulfil a broad range of objectives, including tackling the use of harmful pesticides (and other inputs), and reaching disadvantaged farmers, in particular women, for whom appropriate technologies and methods of dissemination were needed.

1.2 DESCRIPTION OF THE INTERVENTION

From agricultural extension to adult education

Agricultural extension and advisory services (hereafter extension services) comprise "the entire set of organisations that support and facilitate people engaged in agricultural production to solve problems and to obtain information, skills and technologies to improve their livelihoods" (Anderson, 2007, p. 6). Extension was traditionally viewed as a means of transferring technologies developed in research stations as well as farm management practices to farmers, and used top-down institutions of delivery, as characterised, for example, by the World Bank's Training and Visit System (Gautam & Anderson, 2000).

These traditional extension approaches were criticised for providing a "one size fits all" approach (Birner et al., 2006), which failed to factor in the diverse socioeconomic and institutional environments faced by farmers, or involve farmers in the development of technology and practices appropriate to their contexts. Ultimately, extension is considered to have failed in achieving its main objective of farm productivity improvements and in reaching the poor, particularly in Africa (Anderson, 2007; Birkhaeuser, Evenson, & Feder, 1991).

Since the 1980s, the approach to reaching rural smallholder farmers has drawn increasingly on more participatory methods, which enable farmer self-learning and sharing, and also allow those facilitating farmer training, as well as agricultural researchers further upstream, to learn from the farmers (Birner et al., 2006).[1] More intensive training is considered necessary to disseminate complex messages, such as on integrated pest management. It may also empower farmers more generally to become problem-solving decision-makers, more adaptive and resilient to change.

The IPM farmer field school

Farmer field schools (FFS) have become a prominent participatory and learner-centred approach for agricultural development (see Appendix A for more information on the implementation of FFS around the world). FFS originated in Asia as a means of improving farmers' analytic and decision-making skills, of which a key objective was to promote use of integrated pest management as an alternative to intensive pesticide spraying, which was severely damaging farm production, the environment and farmers' health. Integrated pest management (IPM) was developed in the 1960s and 70s (Kogan, 1998; cited in Kelly, 2005) and aimed to minimise pesticide use through use of more natural pest management

1 There has been a similar evolution in the use of more bottom-up approaches to technology development through agricultural research, such as the local agricultural research committees (CIALs) approach (Braun et al., 2000).

techniques. Integrated pest management methods promoted in FFS typically range from more simple practices, such as not applying pesticides in the first 30 days after planting ("no early spray") and placing branches in rice fields for birds to perch on, to more complex methods that require in-depth agro-ecological and crop management knowledge, such as being able to differentiate beneficial from harmful insects, and creating a conducive environment for pest predators (Ricker-Gilbert et al., 2008).

Figure 1 Components of a farmer field school intervention

The core of FFS is experiential learning resulting from participation in the FFS process (Pontius et al., 2002). The FFS intervention contains a handful of components which can be broadly categorised into three groups: the inception phase (field school development); the training phase (technology and curriculum); and the dissemination phase (components to promote diffusion of messages to non-participants (field days) or other farmer field schools (exchange visits), and institutionalisation of the schools through platform building and training of farmer trainers) (Figure 1). A bottom-up participatory approach should underlie each component of the farmer field school intervention. Thus, the approach to group learning should be "discovery based" (Khisa, 2004). The choice of curriculum should be based on priorities identified by farmers. And the aim of schools should not be just to disseminate IPM technology but also to focus on building problem-solving capabilities to "empower farmers to solve problems" for themselves (Kenmore, 1996).

The standard FFS training involves a field-based season-long programme overseen by an FFS-facilitator, with weekly meetings near the plots of participating farmers (Pontius et al., 2002). Each FFS typically has 20 to 25 participants, with farmers working together in smaller groups. FFS-facilitators can be extension agents or selected graduates from previous FFS who undergo a training-of-trainers course tailored to equip them to facilitate field schools (Braun & Duveskog, 2008). The facilitators should use experiential, participatory and learner-centred educational methods, including experimentation through use of demonstration plots using the new practices based on the FFS technology (e.g. integrated pest management) with existing (business-as-usual) "farmer practice" plots, to enable farmers to observe benefits (Pontius et al., 2002). Standard field school curriculum includes agro-ecosystem analysis, involving presenting pictorially the factors which affect crops, special topics comprising locally specific problems, and activities to improve group dynamics. In addition, exchange visits to other field schools are organised to promote lessons learning, as are field days, in which participants present course material and the results of their studies to the broader community. Diffusion to the wider community may also involve encouraging participating farmers to engage in informal farmer-to-farmer communication, training of farmer trainers or approaches to institutionalise field schools locally.

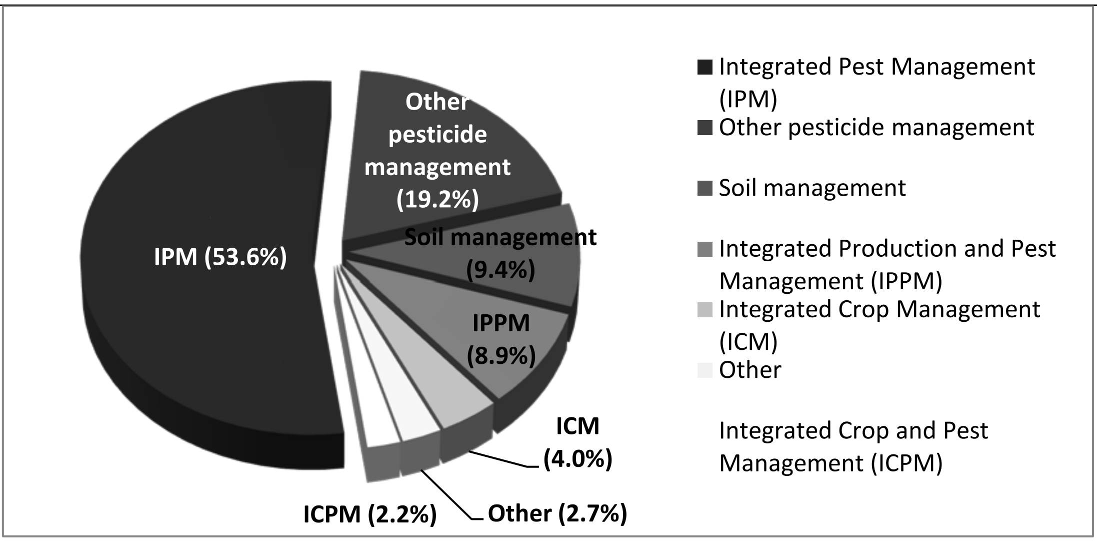
Broadening the farmer field school curriculum

While all FFS are supposed to be based on the same process, the approach can be adopted to suit particular needs, crops or contexts (Pontius et al., 2002). Thus, as FFS have been promoted around the world, the technology has been modified to address the needs of farmers in different contexts, and applied to other food staples, vegetables and cotton (Appendix A). In Africa, integrated production and pest management (IPPM) has been promoted. IPPM reflects a more “holistic” approach to improving production, in which pests and pesticide use are not necessarily the main production problems (Stathers et al., 2005).[2] Other variants include integrated disease management (IDM), integrated crop management (ICM), integrated plant nutrient management (IPNM)[3] and integrated water and soil management (IWSM). The main types of technology incorporated in FFS projects are shown in Figure 2, which indicates that IPM and pesticide management are the most common technologies that have been promoted.

As the approach has gained prominence, FFS have been implemented using different intervention components. FFS have also been implemented alongside complementary interventions to improve access to inputs, markets or collectivisation. Figure 3 shows the curricula and complementary interventions incorporated in farmer field schools design. Most project designs include FFS inception, but relatively few project documents indicated that the FFS training or dissemination involved key curriculum activities such as agro-ecosystems analysis. A minority of projects incorporated input supply and/or produce marketing interventions.

2 Drawing on the lessons of IPM, integrated vector management (IVM) is being applied in the health sector to combat malaria and other vector-borne diseases (van den Berg et al., 2007). This variant is beyond the scope of this review.
3 See http://www.fao.org/agriculture/crops/core-themes/theme/spi/scpi-home/managing-ecosystems/integrated-plant-nutrient-management/en.

Figure 2 Technologies incorporated in farmer field school curricula (percentage of projects)

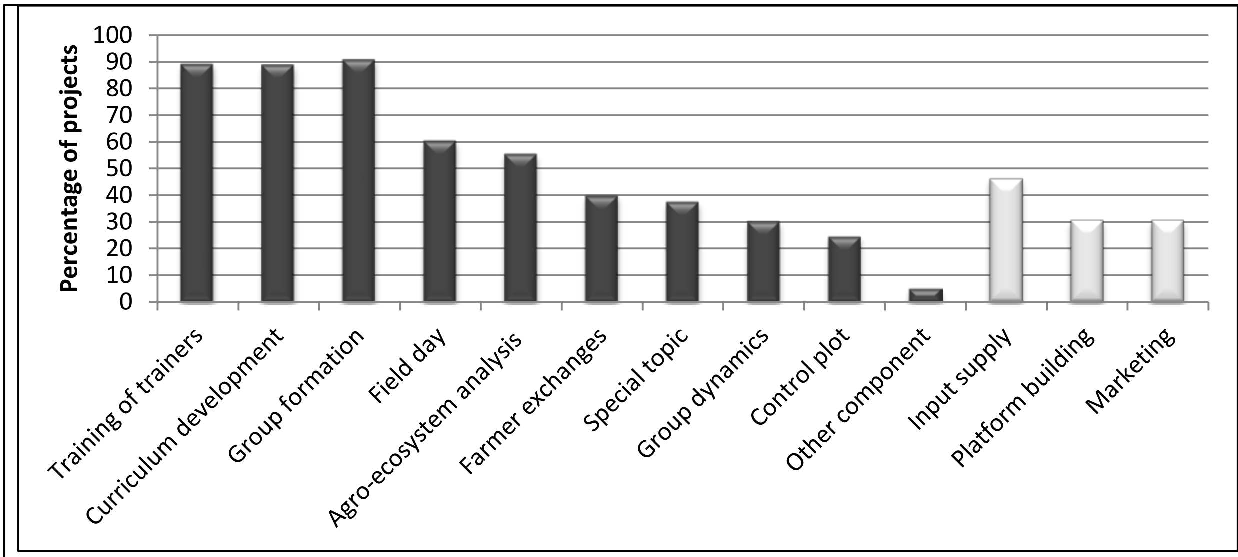


Definitions:

- *Integrated pest management (IPM):* IPM draws on an understanding of the life cycles of pests and their interaction with the environment to manage populations of pests economically while minimising risks to the environment or human health.
- *Integrated production and pest management (IPPM):* IPPM is a variant of IPM which has eveolved in Africa and which emphasises both the management of natural pests and the production of a healthy crop.
- *Integrated crop management (ICM)*: ICM draws on an understanding of interactions between soil, the natural environment and biological pests or weeds to promote sustainable crop production. Example components include site selection, crop-specific production strategies, nutrient management and cover cropping.
- *Integrated crop and pest management (ICPM):* ICPM combines chemical, biological and cultural pest control methods with crop management strategies.
- *Other pesticide management:* This category includes non-specific references to chemical or pesticide management techniques.
- *Soil management:* This category includes non-specific references to soil or crop management techniques.
- *Other:* This category includes other variants (examples include integrated pest and vector management [IPVM] or integrated pest biosystem management [IPBM]), or other general references to management techniques.

Source: Review of FFS project reports, conducted by the authors and documented in Appendix A.

Figure 3 FFS curricula and complementary components



Inception:

- *Training of trainers:* This entails providing theoretical and practical training to all FFS trainers. Training is usually season-long and typically includes facilitation and teaching skills, farming techniques and management skills.
- *Curriculum development:* This involves planning a farmer field school's workplan, setting out the different modules to be studied, usually with some inbuilt flexibility.
- *Group formation:* This involves setting up an organised group with specified goals such as a shared workplan, and which has an organisational structure such as a representative committee.

Field school training and dissemination:

- *Agro-ecosystem analysis (AESA)*: This involves undertaking regular observations of crops to understand the interrelationship between soil, the natural elements and biological pests or weeds.
- *Special topic:* This curriculum component involves the selection of a topic which is usually either suggested by the farmers themselves or is chosen as a response to field observations (e.g. the discovery of a pest in a field).
- *Group dynamics:*This activity is designed to develop leadership, problem-solving, discussion and communication skills. The emphasis is also on collaboration and the promotion of collective action.
- *Control plot*: This involves the setting aside of control plots, which either receive no treatment at all or continue to be farmed as before. These plots serve as a baseline comparison for those where new techniques or technologies are implemented.
- *Other component:* This category includes components specifically built for a particular group, such as hill farmers or ethnic minorities. Other additional components include community education and animal husbandry.
- *Field day:* Field days are designed to promote the work going on in an FFS by inviting local farmers and people of influence to see what has been learned and the benefits that can be produced.
- *Farmer exchanges:* This involves visits by FFS members to other schools with a view to observing their activities and exchanging ideas.
- *Platform building:* This includes efforts to ensure that the benefits of FFS are sustained in the long term. Examples of such activities include organising farmers' clubs or building local networks which can ensure continued collective action.

Complementary components:

- *Input supply:* This entails the provision of farmers with seeds, tools or other equipment.
- *Marketing*: This component involves providing farmers with training and help in setting up networks, transport and information-sharing geared towards marketing their products.

Source: Review of FFS project reports conducted by the authors and documented in Appendix A.

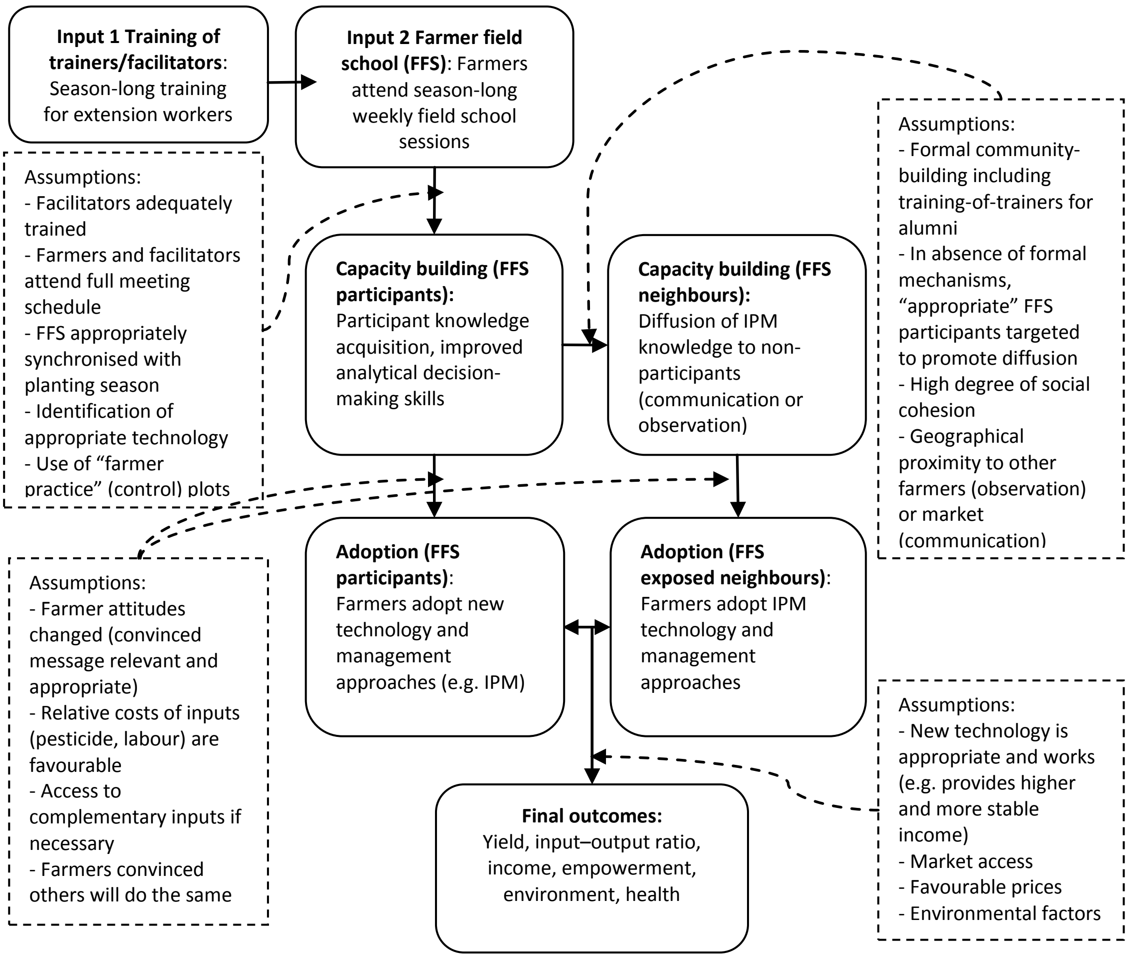
FFS are seen as a way to overcome the traditional problems of extension in reaching and empowering disadvantaged farmers, particularly women in Africa (see, for example, Saito & Weidemann, 1990; World Bank & IBRD, 2009). In addition, the curriculum has also been broadened to tackle populations in particular contexts, such as Junior Farmer Field and Life Schools (JFFLS) which have been implemented with youth across Africa and include HIV-risk reduction in addition to the agriculture components more standard to FFS (Braun & Duveskog, 2008). Other variants, such as business or marketing FFS, are intended to develop additional skills which can improve farmer livelihoods, or to adapt the original approach for an alternative type of farming.

1.3 HOW FARMER FIELD SCHOOLS ARE SUPPOSED TO WORK

Farmer field school programmes aim to build farmers' capacity and promote adoption of better practices, and consequently improve farmers' lives in terms of agricultural outcomes, health, environment and empowerment. The FFS approach has roots in Paulo Freire's (1970) approach to "dialogical education" using discovery-based learning. The FFS process aims to enable farmers to internalise the advantages of the improved agricultural practices through learning by doing and observation. FFS aim to empower farmers by encouraging them to develop skills in problem-solving using "scientific" methods of analysis, while the group activities aim to empower farmers both within and outside their own communities and promote social cohesion through increased cooperation.

A hypothesised causal chain for farmer field schools is depicted in Figure 4, which links farmer field school delivery inputs with final outcomes for FFS participants and for neighbouring non-participants who benefit through knowledge spillovers, via the intermediate outcomes of capacity building and technology adoption. The causal chain is rooted in transfer-of-technology models of extension (Bennett, 1975; cited in Funnell & Rogers, 2011) due to the objectives of many field schools to disseminate technology such as IPM. However, a key objective of FFS may also be to empower farmers cognitively through skills development, organisationally through group activities, and politically through collective action (Friis-Hansen, 2008). As recognised by Mancini and Jiggins (2008, p. 540) FFS "have social goals beyond mere changes in pest-management techniques: goals that seek to position farmers as field experts, who collaborate with the extension staff to find solutions relevant to the local realities. FFS programmes emphasise farmers' ownership of development processes, partnership with other development agents, and group collaboration."

Figure 4 Farmer field school hypothesised causal chain



Source: authors.

Underlying each link in the causal chain are the assumptions theorised to be important for changes to take place at each stage, and which therefore determine the extent to which impacts are likely to materialise in practice. These can be broadly grouped into intervention design and implementation characteristics, and local characteristics including those of farmers themselves.

For instance, with respect to implementation, facilitators are a key input. Facilitators may be "traditional" extension agents who have received training in the FFS approach, meaning they are required to move away from the top-down approaches to which they are familiar, and adopt a more participatory, learner-centred approach (Feder et al., 2004a). Facilitators should be adequately trained, involving season-long theoretical and practical training. Similarly, the relevance of the FFS curriculum to farmers – the extent to which the new practices are appropriate given inputs availability, and are observed to work compared with existing farmer practices (control plots which use standard approaches to pest management) – will likely influence farmers' attitudes and behaviour change. Indeed, Pontius et al. (2002) state that existing "farmer practice" plots should be a part of every FFS for comparison purposes.

Farmers also need to be trained adequately, so that they have attended sufficient meetings over the planting season, which means identifying the "right" farmers who are willing and able to participate in FFS training throughout the full season, and be able to implement FFS practices in their fields. Characteristics of local communities, such as heterogeneity in terms of land- and asset-holdings, ethnicity, education, gender roles and the degree of social cohesion, will determine the ability of the schools to reach appropriate beneficiaries, including disadvantaged farmers such as women.

In the case of IPM field schools, diffusion to neighbouring farmers who have not attended formal training may be necessary for sustained adoption due to externalities associated with pesticide overuse – that is, where the social costs of pesticide use for the community exceed the private costs to the individual farmers.[4] Approaches to diffusion may be through informal farmer-to-farmer communication, one-off activities such as field day visits, or formal attempts to institutionalise community-based field schools and conduct training-of-trainers programmes for FFS alumni (Figure 1) (Pontius et al., 2002). In the absence of such approaches, characteristics of local communities may be important determinants of the degree of diffusion of knowledge and practices from participants to non-participants.

The assumption that there will be some diffusion of IPM practices between farmers may not be an unreasonable one in principle for simple practices. However, FFS graduates may be limited in their ability to transmit all but the simplest of messages effectively to other farmers through informal means.[5] Guidelines from the Food and Agriculture Organization of the United Nations (FAO) on "community IPM" indicate formal approaches involving FFS alumni are considered necessary: "without post-FFS educational opportunities, there will be no community movement" (Pontius et al., 2002). Whether the diffusion mechanism is informal or formalised will, therefore, have implications for beneficiary targeting (Feder & Savastano, 2006). Without formal mechanisms, participants would ideally be selected if they have characteristics which will enhance diffusion, such as those respected in their communities and those with strong social networks. This may conflict with other objectives of FFS, such as targeting women farmers.

Contextual factors, notably weather conditions, soil fertility, plant disease and climate trends, are obvious factors determining production and yields. The policy environment is also important, including whether FFS are implemented in the context of complementary agricultural policies, including those relating to input supply and marketing. Market prices and market access, both to purchase inputs and sell produce, determine the value of production and therefore farmer income. The price of inputs such as pesticide relative to (opportunity costs of) labour is also likely to determine adoption of IPM and other

[4] Lack of adoption of IPM practices by neighbouring farmers is theorised to curtail the effectiveness of the intervention, as pests from fields of non-adopters may re-infest the fields of adopters, eventually leading to disadoption of IPM by FFS participants (Feder et al., 2004b).

[5] Evidence suggests that, in the case of technically complex issues or costly technologies, farmers prefer first-hand knowledge or advice from specialised information sources such as experts (Feder & Slade, 1984; cited in Feder et al. 2004b).

technologies, where adoption involves substantial increases in demands on farmers' time. Indeed, FFS projects commonly incorporate complementary components, such as seeds or tools, setting up of farmer organisations and networks, and providing marketing training (Appendix A).

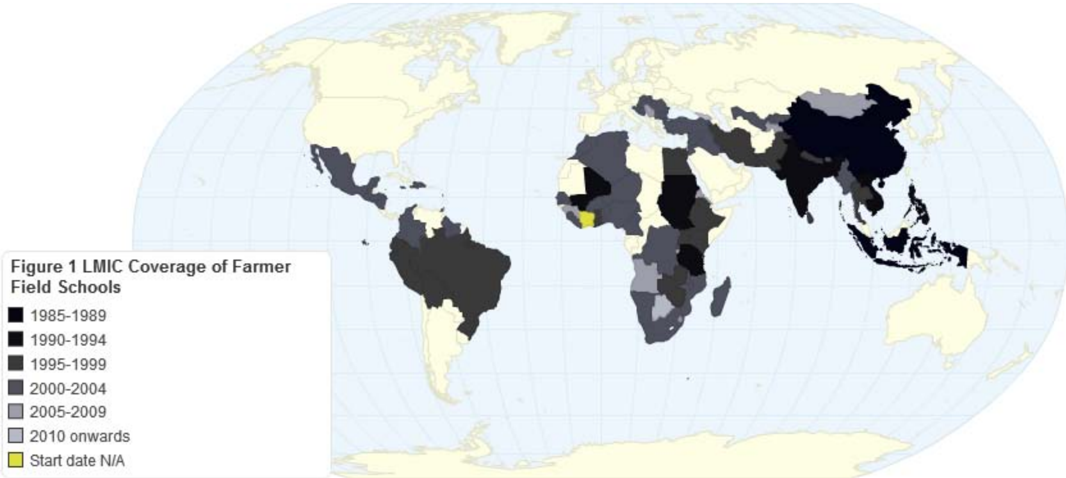
Finally, it is also possible that the technologies promoted by FFS do not act to change yields (the amount of crop produced per unit of land area), but still act to improve income and net revenues (value of production less input costs) by reducing pesticide costs, provided these are not offset by any net increases in other costs such as labour in applying the new technologies. Moreover, in contexts where pesticides and pest management are not necessarily the key constraints to production, improvements in productivity may not necessarily arise from reduced pesticide use but as a result of adoption of the other practices being promoted, such as soil management.

1.4 WHY THIS REVIEW IS NEEDED

Since the 1980s there has been a decline or stagnation in public expenditure on agriculture in most developing countries (Akroyd & Smith, 2007). Likewise, the proportion of official development assistance (ODA) going to agriculture is estimated to have declined from around 20 per cent in 1979 to a low of 3.7 per cent in 2006, and has remained around 5 per cent since (Cabral & Howell, 2012). As noted in the World Development Report on Agriculture, "extension services, after a period of neglect, are now back on the development agenda... [but] more evaluation, learning, and knowledge sharing are required to capitalize on this renewed momentum" (World Bank, 2007, p. 175). Poverty reduction strategies in 24 African countries also listed extension as a top agricultural priority (InterAcademy Council, 2004; cited in Davis, 2006). Nevertheless, age-old questions in agriculture remain, including how to raise yields and farmer incomes, how to ensure environmentally sustainable development, and how to empower the poorest farmers and particular groups such as women farmers in developing skills in adoption and resilience to shocks. There is increasing criticism as to whether extension services are capable of achieving these broad objectives, or whether a more intensive approach is required such as that provided by the farmer field school initiative.

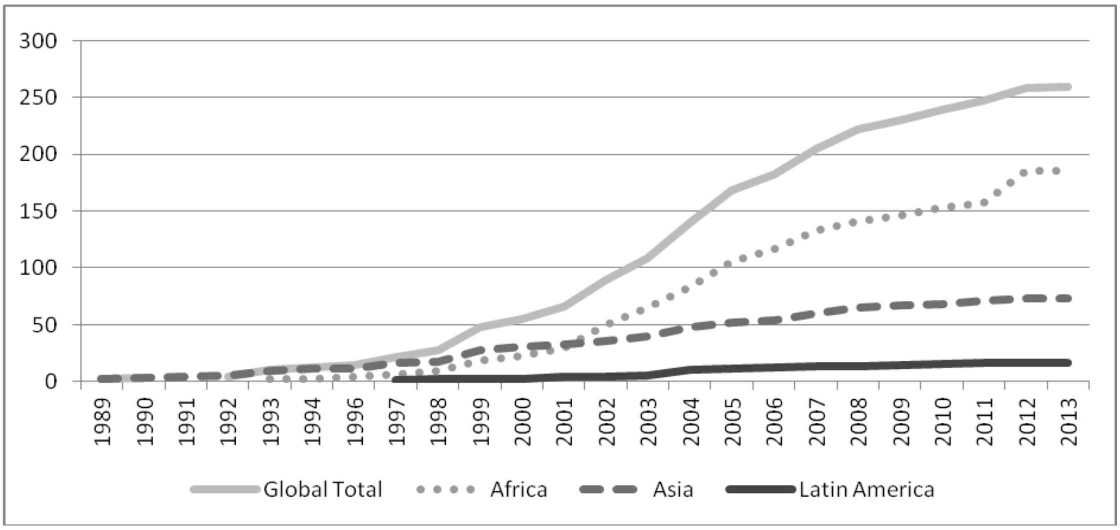
Originally developed for rice crops in Indonesia in the 1980s by the FAO, farmer field schools have been introduced to at least 90 countries worldwide (Figure 5), by a range of organisations, producing 10–15 million field school graduates by 2008 (Appendix A). They are largely funded by multilateral development agencies and implemented by developing country governments and non-governmental organisations. Over half of all FFS projects have been based in Africa; however, the majority of beneficiaries (around 60%) have been Asian, indicative of the fact that some Asian FFS programmes have been implemented on a national scale. Figure 5 presents the growth in implementation of the FFS approach since the early 1990s, illustrating a marked increase in the number of projects in Asia and especially in Africa since 2000.

Figure 5 Coverage of farmer field schools in low- and middle-income countries (LMICs)



Source: Review of FFS project reports, conducted by the authors and documented in Appendix A .

Figure 6 Cumulative number of farmer field school projects implemented



Note: The trend calculated here is based on project start dates and includes data for the 99 per cent of projects for which a start date could be established. Source: Review of FFS project reports, conducted by the authors and documented in Appendix A.

Hundreds of studies have evaluated farmer field schools. These studies provide conflicting conclusions on effectiveness. One particularly influential impact evaluation of the National IPM-FFS Programme in Indonesia concluded that "[t]he analysis, employing a modified 'difference-in-differences' model, indicates that the program did not have significant impacts on the performance of graduates and their neighbors" (Feder et al. 2004a, p. 45). The study appears to have been highly influential in the policy community, including contributing to the World Bank pulling out of the Global IPM Facility multi-donor trust fund (Kelly, 2005).

Reviews drawing on evaluations from more than a single context have tended to be rather more positive. Van den Berg (2004) synthesised 25 IPM-FFS evaluation studies, concluding that, "Studies reported substantial and consistent reductions in pesticide use attributable to the effect of training. In a number of cases, there was also a convincing increase in yield due to training … Results demonstrated remarkable, widespread and lasting developmental impacts" (p. 3). Van den Berg and Jiggins (2007) also argued that FFS have had additional benefits to those of IPM, including facilitating collective action, leadership, organisation and improved problem-solving skills.

However, Tripp et al. (2005) noted the lack of rigorous evidence on the effectiveness of the approach, despite the sizeable investments in FFS in Asia. Reviewing seven studies, they concluded that while "the FFS approach has undoubtedly succeeded in lowering insecticide use in a number of Asian rice examples, judgments on its overall impact await further study" (p. 1,711). They also found little evidence to suggest effective diffusion of IPM knowledge between FFS participants and non-participants, nor sufficient evidence to conclude that FFS groups continue on their own.

In addition to the debate about effectiveness, the scalability and financial sustainability of FFS has also been questioned. FFS are a particularly intensive intervention, with high costs in terms of both facilitation and opportunity costs of beneficiaries' time. Leading authors from the literature have therefore noted that FFS are unlikely to be a solution to problems of extension delivery, and only scalable under certain circumstances (Braun et al., 2006; Davis, 2006). Quizon et al. (2001) noted the lack of fiscal sustainability as a generic problem affecting large-scale public extension services, concluding that FFS face the same issues as other approaches. The cost per farmer is likely to be high compared with agricultural extension approaches and the evidence from Indonesia suggested a low rate of informal diffusion from direct beneficiaries of the schools to neighbours.[6] The authors suggested that as the situation for farmers, in terms of political power, governance systems and day-to-day interactions among farmers, is quite similar in many other developing countries in Asia and Africa, the results were relevant for discussions of similar extension activities in these areas. They also warned that, while pilot projects might indicate the viability of the FFS approach in certain circumstances, the issue of fiscal sustainability becomes particularly relevant when scaling up.

However, Braun and Duveskog (2008) argued that the relative cost-effectiveness of FFS should be put in the context of rural adult education rather than extension "when FFS are regarded as a form of public investment in farmer education to tackle rural poverty – and hence as a tool for achieving the Millennium Development Goals" (p. 19). Van den Berg and Jiggins (2007) also noted that discussions on the fiscal sustainability of FFS should take into consideration who will pay for the externalities of pesticide use.

The existing reviews provide some suggestive evidence of the effects of FFS, but come to widely different conclusions in a hotly debated, policy- and operations-oriented literature.

[6] In Bangladesh, Ricker-Gilbert et al. (2008) estimated per capita costs of farmer field schools (including opportunity costs of farmer and trainer time) at over ten times those of agricultural extension approaches including demonstration field days and extension agent visits.

However, while single studies are unable to provide a complete picture of the evidence, none of the existing reviews draws on a systematic search for all available quantitative and qualitative studies, or applies inclusion criteria or approaches to critical appraisal sufficiently transparently. In addition, the conclusions of these reviews are based on significance-based vote counting, rather than sample-weighted meta-analysis of effects.[7] This systematic review thus aims to provide a systematic and exhaustive search, together with a comprehensive and unbiased synthesis of the existing evidence on FFS.

[7] There are meta-analyses on the effects of agricultural extension more generally, notably Alston et al. (2000). However, these studies frequently draw on economic appraisals based on weak counterfactuals.

2 Aims and Report Structure

The primary objective of the review is to synthesise evidence on the effectiveness of interventions identified as “farmer field schools” and conducted in low- and middle-income countries. The review aims to provide an integrated synthesis based on analysis of two main research questions:

- **Review question (1):** What are the effects of farmer field schools on final outcomes such as yields, net revenues and farmer empowerment (review question 1a), and intermediate outcomes such as knowledge and adoption of improved practices (e.g. reduced use of pesticides) (review question 1b) in low- and middle-income countries? What are the effects on non-participating neighbouring farmers (review question 1c)?
- **Review question (2):** What are the enablers of and barriers to FFS effectiveness, diffusion and sustainability?

We followed Campbell and Cochrane Collaboration approaches to systematic reviewing (Shadish & Myers, 2004; Hammerstrøm et al., 2010; Becker et al., n.d.; Shemilt et al., 2008; Higgins & Green, 2011), and drew on theory-based impact evaluation (White, 2009).[8] To answer review question (1), we systematically collected and synthesised all relevant and available quantitative evidence from impact evaluations of FFS programmes. We used narrative review and, where possible, statistical meta-analysis, presenting outcomes along the theory of change (Figure 4), from intermediate outcomes such as capacity building, technological adoption and diffusion to indirect beneficiaries, to final outcomes such as agricultural yields, household income and other indicators of wellbeing in the areas of health, environment and self-esteem, examining heterogeneity in findings narratively and in meta-regression. Studies that measured outcomes at any point along the causal chain were eligible for inclusion, and evidence is presented outcome by outcome for all studies that reported each particular outcome.

Farmer field schools are complex interventions implemented using different methods of delivery in a range of different contexts. For the review to be useful to a broader group of decision-makers, we extended it by including qualitative studies to address review question (2), focusing on underlying factors that determine or hinder the effectiveness of FFS,

[8] 3ie’s approach to systematic reviewing is provided in Waddington et al. (2012b) and Snilstveit (2012).

following Noyes et al. (2011).[9] Most quantitative impact evaluations do not include research addressing this question so, as outlined in the following chapter on Approach, we adopted different inclusion criteria for studies addressing this question. We conducted the two syntheses in parallel, before integrating the findings in a narrative synthesis using the theory of change (Figure 4) as a framework for the analysis.

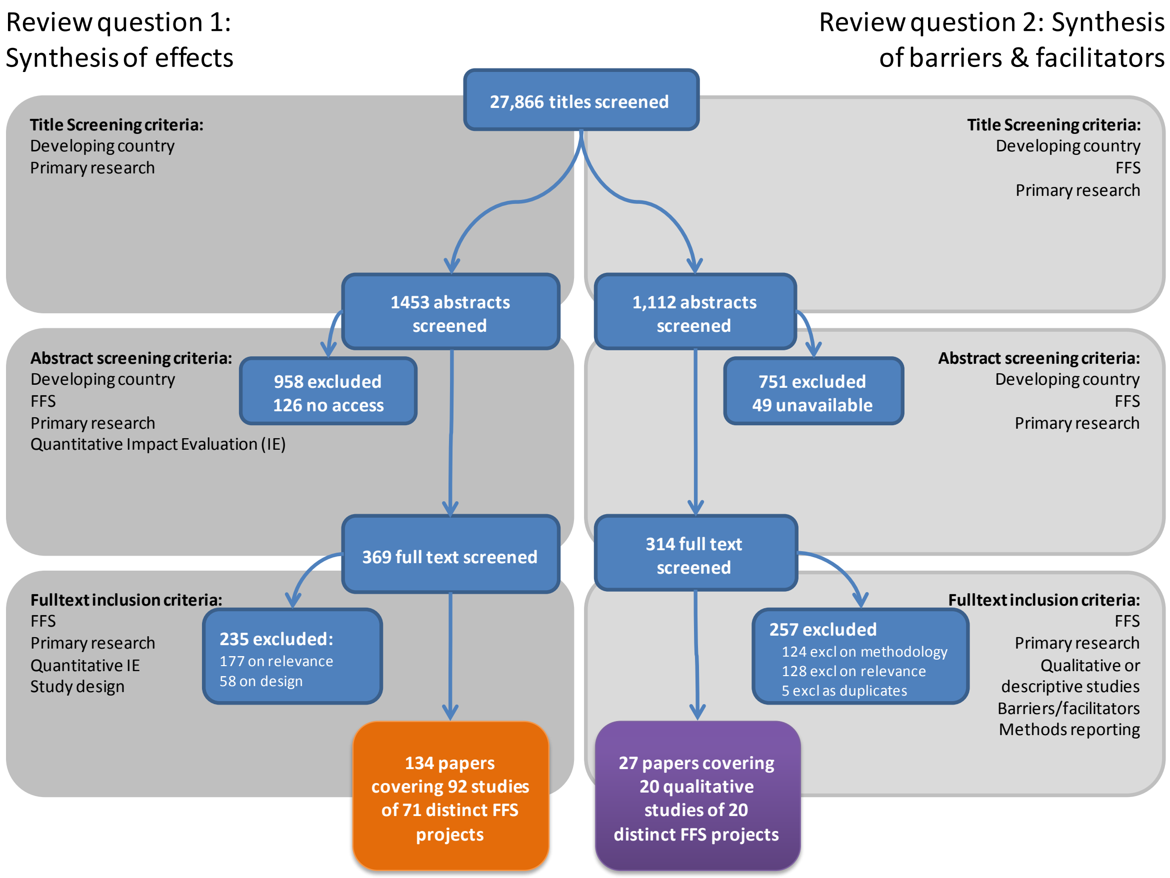
We also reviewed FFS project documentation to provide a global portfolio review of implementation experiences (Appendix A).[10]

Figure 7 provides a detailed outline of the review process for review questions (1) and (2). The strategy for systematic searches and synthesis, elaborated in Chapter 3, was published in the study protocol (Waddington et al., 2012a). As is standard in reviews of development topics, a large number of initial search results were returned. Of the 28,500 potentially relevant papers identified, over 9,000 were identified from databases, 18,000 from Google or Google Scholar, 65 from bibliographic searches of reviews and 29 from contact with organisations and researchers. After applying inclusion criteria, 92 distinct impact evaluation studies (from 134 papers) and 20 qualitative studies (27 separate papers) were included in the review. A total of 337 FFS interventions were included in the portfolio review (Appendix A).

[9] Our methodology was also informed by Chapter 20 in the Cochrane Handbook (Noyes et al, 2011), the additional guidance developed by the Cochrane Qualitative Methods Group (Hannes, 2011; Noyes & Lewin, 2011) and the increasing number of examples of systematic reviews in international development based on or incorporating qualitative evidence (e.g. Munro et al., 2007; Williamson et al., 2009; Berg & Denison, 2012).

[10] We also conducted an additional systematic review of data on targeting contained in the full text studies we obtained for the systematic review research questions detailed in this report. We synthesised a small part of the information on targeting in the moderator meta-analysis section of this report, although readers are encouraged to access the report of the systematic review of targeting for the full analysis (Phillips et al., 2014).

Figure 7 Review process



The remainder of the report is structured as follows. Chapter 3 on Approach summarises the review methodology. Chapter 4 presents the results from the synthesis of impact evaluative evidence, including quantitative meta-analysis, indicated on the left-hand side of Figure 7. Chapter 5 presents the results of the synthesis of barriers and enablers based on qualitative evidence, indicated on the right-hand side of Figure 7. Chapter 6 then presents the results of the integration of the two syntheses. Chapter 7 provides implications for policy, practice and research.

3 Approach

3.1 STUDY SELECTION CRITERIA

Studies included in the review met the following selection criteria.

Types of interventions

Studies needed to report specific "farmer field school" interventions. Interventions were identified as farmer field schools if they contained both of the following components:

- Involved intensive, facilitated group training, normally involving season-long weekly meetings and use of control plots farmed using standard farmer practices.
- Provided information on holistic techniques to inputs use, such as reducing use of pesticides and insecticides, improved use of fertiliser, or other production practices and disease control methods such as integrated pest management, integrated production and pest management, integrated crop management and integrated disease management.

It was often difficult to identify the exact components of the FFS, so the approach we took involved including interventions identified as "farmer field school" in the report, even where the FFS may have been designed or implemented differently. Studies were eligible that investigated provision of FFS alone or combined FFS with other intervention components, such as input or marketing support.

Types of participants

The review included farmers growing arable crops ("temporary" crops including food and cash crops) and permanent crops (such as cocoa, coffee and tea), living in developing (low- or middle-income) countries, as defined by the World Bank, at the time the intervention was carried out. Studies were included which collected and reported on data at the farm or household level. The review excluded programmes for livestock farmers, who received different types of training than crop farmers, and those for farmers based in high-income countries where the challenges faced in terms of poverty, land size, crops, and agro-ecological and environmental contexts are usually very different.

The review examined effects on two groups of beneficiaries: the farmers who participated directly in the field school and non-participating neighbour farmers who lived in the same communities as field school graduates and may have been exposed to the approach through their interactions with FFS-trained farmers (spillover effects) or more formal dissemination methods; effects for FFS farmers and neighbour farmers are analysed separately. We report information from studies that assessed outcomes for either type of beneficiary.

Types of comparisons

If farmers in low- and middle-income countries do have access to sources of information about agricultural practices, it is usually through visits from government or private-sector agricultural extension agents, through observation of public agricultural demonstration plots, or through agricultural extension provided by the private sector. Public extension may take the form of centralised or more decentralised systems (Birner et al., 2006). We included studies which compared farmers receiving FFS education with comparison groups who received no intervention, or agricultural extension services from another source, including IPM (or equivalent) training. We collected relevant information on the intervention received by comparison groups, and where possible calculated FFS effects across appropriate groups. To take one example, in Godtland et al. (2004), FFS farmers were chosen from among farmers who had previously received another extension implemented by a non-governmental organisation (NGO) – the Andino programme. Godtland and colleagues compared FFS plus Andino with farmers receiving the Andino programme only and with farmers not receiving either extension programme. We therefore used the FFS–Andino versus Andino comparison to calculate the net impact of FFS. Where we did suspect differential access to another relevant agricultural intervention in the comparison group, we conducted sensitivity analysis.

We would have preferred to limit the review to studies with comparison groups which were separated geographically from treatment groups to avoid possibilities of spillover (contamination). However, many studies reviewed did not report sampling procedures in sufficient detail to assess the geographic separation of groups. Thus, we included separate and non-separate comparisons, and assessed the likelihood of spillover effects in risk of bias analysis. We also conducted sensitivity analysis for potential spillover effects (contamination).

Types of outcome measures / data collected

Intermediate and final outcomes

We included all eligible studies to answer review question (1), irrespective of whether they reported impacts on intermediate or final outcomes. The review focused primarily on agricultural outcomes, including agricultural yields (production per unit of land), and net revenues (profits per unit of land) as indicated in the study protocol (Waddington et al., 2012a). We examined secondary intermediate outcomes including farmer knowledge and capacity and adoption of new approaches (e.g. reduction in pesticide use). We also examined secondary final outcomes including health, environment and empowerment outcomes such as feelings of self-esteem. Table 1 shows the different ways of measuring outcomes reported in included studies. Data on outcomes along the theory of change are reported outcome by outcome, for all studies reporting that particular outcome. Unless otherwise specified, outcome data are not reported along the theory of change by individual study.

Other data

To answer review question (2) we included evidence on barriers to and enablers of FFS effectiveness, diffusion and sustainability. This included process and implementation information together with measures of beneficiaries' attitudes and experiences with FFS.

Table 1 Outcomes reported in effectiveness studies

Outcome type	Detailed outcome variables collected for FFS participants and neighbours
Intermediate outcomes:	
Knowledge	Test score: mean value across farmers Probability: percentage of farmers with improved knowledge Number of technologies known: average number of specific knowledge reported
Adoption: pesticides	Pesticide use: volume/weight per unit of land area; average number of sprays per season; percentage of farmers using pesticides Pesticide costs: monetary value per unit of land area
Adoption: other practices	Percentage of farmers using beneficial techniques Index of adoption: mean score across farmers Number of beneficial techniques adopted: mean across farmers Time spent undertaking field observation
Final outcomes:	
Agricultural outcomes (primary outcomes)	Yield: weight of production per unit of land area; monetary value of yield (monetary value of production per unit of land area) Total income: monetary income, sales (quantity of production sold at market) Net revenue: profits per unit of land area (monetary value of yield less input costs per unit of land area)
Health outcomes	Incidence of respiratory difficulties, eye irritation, stomach ache, blurred vision Probability of pesticide poisoning Annual expenditure on health per household
Environmental outcomes	Environmental impact quotient (EIQ) score Soil fertility measurement
Empowerment outcomes	Indices of self-esteem: feeling capable of solving problems, comfortable giving opinion, participating in community, collective action, making demands on extension staff Perception of empowerment

Study design and methods of analysis

Review question (1): What are the effects of farmer field schools on intermediate and final outcomes, for FFS particiants and neighbour farmers?

Studies eligible for inclusion in the quantitative synthesis used experimental or quasi-experimental study designs. Study designs which collected longitudinal data at baseline and endline and those using cross-sectional (endline) data only were included. In addition, data needed to be collected at the farm or household level contemporaneously in both groups. Studies that used the following methods of allocating FFS to participants were eligible:

- allocation rules based on prospective randomised or quasi-randomised (e.g. alternate) assignment (randomised controlled trials or RCTs, and quasi-RCTs);
- assignment based on other known allocation rules, including a threshold on a continuous variable (regression discontinuity designs or RDDs) or exogenous variation in the treatment allocation ("natural experiments");
- assignment based on other rules, including self-selection by programme planners or participants, provided data were collected contemporaneously in a comparison group (non-equivalent comparison group design), or where at least three data points were collected for FFS participants both before and after a discrete intervention (six-period interrupted time series or ITS[11]).

We included studies which used statistical matching (e.g. propensity score matching or PSM, or covariate matching), regression adjustment (e.g. difference-in-differences or DID, and single difference regression analysis, instrumental variables or IV, estimation and Heckman selection models), as well as other cross-sectional or longitudinal designs which used less rigorous approaches. Given the breadth of designs included, we conducted rigorous assessment of internal validity based on risk of bias categories (see below).

Excluded studies are those which did not use a comparison group design, or employed less than a six-period ITS design. For example, Tin (2009) used a pre-test post-test design with no comparison group, and Armen et al. (2009) collected post-test data among field school participants only (see Appendix B).

Review question (2): What are the enablers of and barriers to FFS effectiveness, diffusion and sustainability?

We included qualitative studies and studies using descriptive statistics which met the following criteria:

[11] We followed Effective Practice and Organisation of Care (EPOC, n.d.) in adopting these criteria, based on the logic that at least three data points either side of the cut-off are needed to identify a trend.

1. reported on interventions as identified as "farmer field schools", although not necessarily the same interventions as those included in the review of effects (review question 1);

2. assessed determinants of service delivery quality, knowledge acquisition, adoption of technological improvements, diffusion, or sustainability (either directly or indirectly – for example, studies that were relevant to addressing barriers to and enablers of FFS effectiveness);

3. were based on primary data collected from clients, FFS facilitators, extension agents or experts analysed using qualitative methods or descriptive statistics;

4. reported some information on all of the following: the research question, procedures for collecting data, sampling and recruitment, and at least two sample characteristics.

We adopted a two-stage approach to inclusion of the qualitative studies, which, in addition to removing studies based on the usual relevance criteria (intervention, population, relevance to research question, study type and location), removed studies of particularly low quality in the first round (Thomas et al., 2003; Spencer et al., 2003), using the criteria set out in point 4 above. We then assessed the quality of the included studies using a detailed quality appraisal checklist in the second round, as described below.

Given the limited reporting of programme and contextual characteristics in the impact and qualitative evaluation literature, in the final stages of the review we systematically searched for implementation documentation (see Appendix A for details), collecting data on project, programme and implementation characteristics which we linked to the impact evaluations in order to conduct more in-depth analysis of moderators. This analysis was conducted a posteriori.

3.2 SEARCH STRATEGY

Searching the social science literature can be challenging as it is not as well indexed as the medical literature. We developed the search strategy based on the guidance provided in Hammerstrøm et al. (2010) and using "pearl harvesting" methods (Sandieson, 2006).

We searched a range of different databases, including general social science databases, agriculture subject-specific databases and libraries, as follows: AgEcon, CAB Abstracts, Web of Knowledge (Social Sciences Citation Index and Social Science Conference Proceedings), International Bibliography of the Social Sciences, EconLit and the US National Agricultural Library (Agricola). For the updated searches, we additionally searched an EBSCO multifile group of databases: Academic Search Research and Development, Africa-Wide Information, Business Source Complete, SocIndex. The list of databases, together with the time of original search and update is provided in Appendix B. Detailed search strategies, together with the number of hits for each database, can be provided by the authors on request.

We used the following basic search strategy, adapted for each database to include thesaurus terms where these were available:

“farmer* field* school*” OR ((“integrated” AND “management”) AND (“field* school*” or “farmer* field*”))

The following example of a full search strategy is for CAB Abstracts using the Ovid platform incorporating both text words and thesaurus terms:

1. (integrated control or integrated pest management or crop management).sh.

2. (((integrated adj (production or management or pest or nutrient)) or crop management).ti,ab.

3. 1 or 2

4. on-farm training.sh.

5. (field school* or farm* school* or farmer* field* or (farmer* adj field* adj school*)).ti,ab.

6. (practical education or extension education or education programmes or community education or agricultural education or inservice training or vocational training or innovation adoption).sh.

7. extension/

8. (participatory extension or agricultural advisory or agricultural extension or rural extension).ti,ab.

9. 6 or 7 or 8

10. exp developing countries/ or exp africa/ or exp asia/ or exp south america/ or exp central america/ or exp latin america/ or exp pacific islands/ or exp middle east/ or mexico/

11. 3 and 9 and 10

12. 5 and 9 and 10

13. 4 or 11 or 12

To ensure maximal coverage of unpublished literature, we searched JOLIS, BLDS, IDEAS, the Networked Digital Library of Theses and Dissertations, Index to Theses, the ProQuest dissertation database and the 3ie impact evaluation database, adapting the search strategy above for each database. We also searched Google Scholar, screening the first 1,000 hits. In addition, we searched the websites of a large number of international organisations, development agencies and non-governmental organisations active in the sector. Details about the procedures followed when searching each website, together with the number of hits for each database, can be provided by the authors on request.

We screened the bibliographies of included studies and existing reviews for eligible studies. We also handsearched development journals and identified and contacted key researchers and organisations working in the field of agricultural extension, as specified in the study protocol. All searches were updated in October 2012. Further details are provided in Appendix B, which presents the full search strategy and dates of searches. In the final stages of the review we also conducted a systematic search for project implementation documentation, documented in Appendix A. Titles and abstracts were screened against the inclusion criteria and relevant records were downloaded into the reference management software EndNote. The initial records search was conducted by two reviewers, who were over-inclusive to ensure relevant studies were not omitted because sufficient information was not reported in title or abstract. Two reviewers independently reviewed the downloaded abstracts in more detail to determine which papers should be retrieved and reviewed at full text, and included in the review.

3.3 DATA COLLECTION AND ANALYSIS

Selection of studies and data extraction

Two independent reviewers assessed the full text papers against the inclusion criteria. Discrepancies were resolved by consensus or by a third author if needed. Owing to the broad study design eligibility for impact evaluations, there was only one disagreement on inclusion, relating to a participatory agricultural extension project reported in Smale et al. (2010), which was judged as ineligible due to lack of relevance. Five reviewers extracted data from included studies.

JH extracted data from included papers and then two reviewers (JH and HJW) made risk of bias assessments and effect size calculations referring to the original papers. For studies assessed as having medium risk of bias, effect sizes were calculated by bother reviewers using Microsoft Excel. In all other instances, JH extracted and calculated effect sizes and HJW reviewed a random selection of ten papers. There were no disagreements on risk of bias status or effect size calculation for medium-risk-of-bias studies. A Campbell Collaboration peer reviewer disagreed with the positive assessment of ‘other risk of bias’ for many studies due to lack of blinding of outcome assessors and data analysts, which we subsequently amended by downgrading this risk of bias criterion for relevant studies. There were five effect size disagreements in total (from three papers) for the high-risk-of-bias studies. Disagreements were resolved through an audit of data extraction spreadsheets by the lead reviewer (HJW).

Two reviewers (BS and MV) independently conducted the critical appraisal of studies included in the qualitative synthesis using an adapted version of the CASP checklist as described below, with any disagreements resolved by a third author (PD). We used the FFS programme theory, as well as Rogers' theory of diffusion (2003) to develop a data extraction sheet for the studies included in the qualitative synthesis a priori. The data extraction sheet is provided in Appendix B. Three reviewers (BS, DP and MV) extracted information from included studies, using NVivo and Excel. Two reviewers then checked the coding of all the included studies, extracting any additional information missed by the first coder.

Critical appraisal

Review question (1): Critical appraisal of studies of effects

Studies were critically appraised according to risk of bias in internal validity and external validity (generalisability), and publication bias. The assessment of risk of bias was based on: 1) quality of attribution methods (addressing confounding and sample selection bias); 2) the possibility of spillovers to farmers in comparison groups;[12] 3) outcome and analysis reporting biases; and 4) other sources of bias (Appendix C). Risk of bias was assessed on both study design and implementation of the evaluation methodology. "Low-risk-of-bias" studies were identified as those in which clear measurement of and control for confounding was made, including selection bias; there were no sources of unobserved confounding which were likely to affect our degree of confidence in the findings; intervention and comparison groups were described adequately (in respect of the nature of the interventions being received) so that risks of spillovers or contamination were small; and where reporting biases and other sources of bias were unlikely. We rated the likelihood of spillover effects as low when comparison farmers were living in a different village from the farmer field school participants.

Studies were identified as "medium risk of bias" when there were moderate threats to validity of the attribution methodology, or likely risks of spillovers or contamination (arising from inadequate description of intervention or comparison groups or possibilities for interaction between groups such as when they are from the same community), or possible reporting biases.

"High risk of bias studies" were all other studies, including those where the study design was of questionable internal validity (such as those where comparison groups were not matched on observables, differences in covariates were not accounted for in multivariate analysis or where there were serious threats to the validity of the statistical procedure used to deal with attribution), or where there was evidence for spillovers or contamination, and reporting biases were evident. Two reviewers (JH and HJW) undertook the critical appraisal, the results of which are presented in Appendix F.[13]

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[12] Note that, in contrast, spillovers to non-participant neighbour farmers are desirable for the intervention, and are assessed by the measured effects reported on these groups, in separate meta-analysis.
[13] Full details of the critical appraisal assessment are available on request from the authors.

The assessment of external validity of studies (generalisability) was based on two sources of information. Firstly, data were collected on the sampling methodology to assess whether the whole population or a random or purposive sample of FFS farmers and neighbours were covered. Second, the socioeconomic and demographic characteristics of farmers in the included studies were compared to average characteristics of farmers to assess whether FFS farmers were more or less representative of farmers in developing countries. We attempted to reduce publication bias by searching for and including unpublished studies in the review. However, we also assessed the likelihood of file-drawer effects resulting from selective outcome reporting and conducted statistical tests for under-reporting of small sample studies with negative or insignificant findings using funnel plots and Egger's (Egger et al., 1997) tests for those outcomes with more than ten observations.

Review question (2): Critical appraisal of studies examining barriers and enablers

We assessed the quality of included studies using an adapted version of the Critical Appraisal Skills Programme checklist (CASP, 2006), making judgments on the adequacy of reporting, data collection, presentation, analysis and conclusions drawn. The checklist is presented in Appendix C. In accordance with our inclusion criteria we filtered out studies of particularly low quality (Hannes, 2011) and studies where questions 1–5 on the checklist were assessed as "No" were excluded at this stage. The critical appraisal was conducted by two reviewers independently (results reported in Appendix F). Any discrepancies were resolved through discussion, with a third person acting as an arbitrator.

Measures of treatment effect

Calculation of effect size

We calculated effect size estimates, standard errors and 95 per cent confidence intervals using data provided by included studies, where possible. We report two types of effect sizes in this review. All outcomes were measured using continuous variables. We calculated response ratios to measure effects, which are expressed as the difference in outcome in the intervention group as a proportion of the outcome in the comparison group. The response ratio (RR) is centred around 1, which is the point of "no effect"; the distance above and below the no-effect point are translatable as percentage changes in the outcome in the treatment group over the comparison, giving the same interpretation as a risk ratio. Thus, an RR of 1.10 translates as a 10 per cent average increase in the treatment condition, while an RR of 0.90 would translate as a 10 per cent average reduction.

The response ratio has the twin advantages of ease of interpretation and ease of calculation, since it requires less information than the standardised mean difference to compute. However, the use of the response ratio is subject to limitations for some variables, since it is only meaningful when the outcome is measured on a true ratio scale that has a natural zero point, although is unlikely to be equal to zero in practice (Borenstein et al., 2009). Thus, we calculated RR for some of the outcomes, including pesticide use, environmental measures estimated from pesticide use, production yield and revenues, and variables measuring probabilities such as disease incidence, and empowerment. In the cases of knowledge test scores and indices of adoption of practices, we estimate the Hedges' g (sample size corrected) standardised mean difference (SMD) which measures the effect size in units of standard deviation of the outcome variable.

We have used appropriate formulae to calculate zero-order and partial effect sizes, respectively, from (unadjusted) bivariate and (adjusted) multivariate specifications. Appendix D provides details of all effect size calculations.

However, caution is needed regarding the synthesis since most of the studies included in the review of effects, including all of the studies assessed as being of medium risk of bias, have used multivariate specifications in their analyses. As such, the meta-analysis synthesises both partial and bivariate effect sizes. However, effect sizes are only strictly comparable in studies employing a common model, meaning that "suitable proxies for the same constructs [i.e. the outcome variable, treatment variable and covariates] are included in all the studies being synthesized" (Keef & Roberts, 2004, p. 103). This is due to the degree of correlation between the variables included in the model, over and above any problems due to model misspecification. In other words, the partial effect size based on the regression coefficient measures the treatment effect "holding all other variables constant". It is therefore measuring a different quantity to the bivariate relationship where the treatment effect is correlated with the other explanatory variables. The partial and bivariate effect sizes are equal only where coefficients of explanatory variables are the same in treatment and comparison groups (the "constant slopes" assumption), as would be indicated, for example, by insignificant interaction terms between treatment variable and covariates (ibid.).

As indicated in Appendix D, several solutions have been proposed to address this problem. Becker and Wu (2007) notably propose drawing on the variance–covariance matrix from the included studies to estimate generalised least squares meta-regression analysis. However, there are several problems in applying Becker and Wu's solution. First, not all multivariate models control for the same covariates, nor should models estimated for different study designs using data collected in different contexts necessarily do so. And where they do use common covariates, the variance–covariance matrices are seldom reported and difficult to obtain. Indeed, we were not able to identify any included studies in this systematic review which reported the full variance–covariance matrix.

We have opted not to eliminate studies which did not report bivariate effect sizes from the synthesis, due to the loss of information this would entail and the likely high risk of bias in included studies which did not use multivariate specifications (since none of the studies used randomised assignment or similar design-based methods to reduce biases). While the risk of bias assessment evaluated likely specification errors, included studies did not report diagnostic test statistics for multicollinearity or results of models estimated with full interaction terms. Our RR and g effect size calculations therefore implicitly assume zero correlation between treatment effect variable and other covariates in the model. However, many of the commonly used covariates (socioeconomic status, demographic characteristics and location) in the farmer field schools literature are likely to be correlated with the treatment, violating the constant slopes assumption. With the aim of partially ameliorating this problem, where different studies did report bivariate and partial effect sizes for a particular outcome, we have conducted sensitivity analysis to examine evidence for systematic differences (with the corollary that these are indirect comparisons across studies, not direct comparisons of bivariate and partial effect sizes within the same study).

Dependent effect sizes

We only included one effect estimate per study in a single meta-analysis. Where multiple outcomes were reported from alternate specifications, we selected the specification according to likely lowest risk of bias in attributing impact, for example the most appropriately specified regression equation, which may in some instances be the least parsimonious. In some cases, where studies reported multiple dependent effect sizes, for example according to different outcome sub-groups (such as the paper by Ricker-Gilbert et al., 2008, which reported simple, intermediate and complex knowledge), we calculated a "synthetic effect size" based on the sample-weighted average, using appropriate formulae to recalculate variances according to Borenstein et al. (2009, chapter 24), making covariance assumptions as necessary (more information is available in Appendix D). We used the same approach where studies reported multiple effect sizes according to different follow-up periods, although we also discuss in the report differences in reported follow-ups for those studies which did so. Where studies reported multiple effect sizes according to sub-groups of participants, we report data on relevant sub-groups separately (as in the case of FFS participants and neighbours).

We report data in the meta-analysis according to the paper in which the effect size originated. However, we attempted to avoid synthesising dependent effect sizes from multiple studies in any single meta-analysis by linking papers prior to analysis, and conducting sensitivity analysis as necessary. This was deemed necessary in the case of Feder et al. (2004) and Yamazaki and Resosudarmo (2008), which replicate analysis of the same data. In a number of cases, information has been collected on the same programme at the same or different periods of time, but in most cases this did not cause problems for the analysis since the papers either reported data on different outcome constructs which are eligible for inclusion in separate meta-analyses, or they did not report sufficient information on standard deviations or outcome means to extract effect sizes.

For example, David and Asamoah (2011) reported knowledge outcomes based on a survey of farmers in 2007-08 in Ghana, while Gockowski et al. (2010) reported on adoption and yields for farmers in the same programme in 2005; David (2007) and Wandji et al. (2007) also reported outcomes in Cameroon for the same multi-country programme in West Africa as Gockowski et al. (2005), although the latter only reported impacts on adoption and yields in the project areas of Nigeria. Chi et al. (1999) and Murphy et al. (2002) both collected data on the FAO National IPM Programme in Vietnam, but only Murphy reported sufficient information to estimate the effect size. Mutandwa and Mpangwa (2004) and Maumbe and Swinton (2003) both reported on cotton IPM-FFS in Sanyati District, Zimbabwe, but only Mutandwa and Mpangwa presented statistical information. Dankyi et al. (2005) and Carlberg et al. (2012) reported different outcomes for the same programme, as did Reddy and Suryamani (2005) and Pananurak (2010) for the same Indian programme; DANIDA (2011) and Islam et al. (2006) reported data on the same Bangladesh programme but for different outcomes and different years. Similarly, Friis-Hansen and Duveskog (2012) and Friis-Hansen et al. (2004) collected data on empowerment and adoption outcomes, respectively, for the FAO's East African IPPM-FFS Pilot Project in Uganda, while Davis et al. (2012) collected data on agricultural outcomes for the expansion phase of the same project. Torrez et al. (1999) reported on the pilot of the IPM programme for potatoes in Bolivia evaluated in Bentley et al. (2007), although Bentley and colleagues do not report sufficient information on sample distribution to calculate effect sizes.

There are cases, however, where effect sizes were likely to be dependent.[14] Hiller et al. (2009) and Waarts et al. (2012) both reported on the same outcomes for a pilot and up-scaled tea IPPM project in Kenya, and Pananurak (2010) and Wu (2010) reported, respectively, short-term (one-year follow-up) and medium-term (three-year follow-up) outcomes from the same survey of households in China for yields. In these cases we included results for the scaled-up project (Waarts et al., 2012) and longer-term follow-up (Wu, 2010) in meta-analysis, discussing differences by follow-up time period in the report narratively.[15] In the case of the Indonesian National IPM Programme, two papers reported analyses of the same data (Feder et al., 2004a; Yamazaki & Resosudarmo, 2008). Given the prominence of these papers in the literature, in this case we opted to assess sensitivity of meta-analysis findings to inclusion of these studies rather than calculate a synthetic effect size (Appendix G reports results from sensitivity analysis excluding these studies; results are not affected).

Rejesus et al. (2010) and Huan et al. (1999) estimated impacts on the National IPM Programme in Vietnam, collecting data at different points in time. Only a subset of observations appeared to be from the same province of Long An. However, we used the results from Rejesus on the grounds of preference according to risk of bias, dropping the higher-risk-of-bias observations in Huan et al. (1999). Finally, there were two instances of studies which reported two measures of the same adoption construct – Yang et al. (2005) and Khan et al. (2007), which both reported pesticide use and cost outcomes – in which we included only pesticide costs in the pooled meta-analysis of pesticide adoption.

[14] There were a few cases where it was not clear whether studies referred to the same programme. Cole et al. (2007) and Mauceri et al. (2007) reported impacts of FFS in the same region of Ecuador, but seemingly for different interventions. Yang et al. (2005) and Wu (2010) appeared to estimate impacts on the same programme but not the same samples, Yang referring to data in a single province only. It was not clear whether Palis (1998) and Price (2001) referred to the same intervention conducted in Central Luzon Philippines; however, the studies measured different outcomes so there is no risk of violation of the independent effect size assumption.
[15] Results were not sensitive to the choice of outcome.

We have identified effect sizes in the meta-analysis forest plots by author citation and country location in the main text. However, we also show the same forest plots identified by programme name in Appendix G, so that readers can see which FFS programmes are included within each meta-analysis.

Unit of analysis

We provided an assessment of the unit of analysis error for the included studies based on whether the included studies account for differences in demographic and socioeconomic household and village characteristics across individuals in different clusters (Appendix F). For those studies that reported moderate or high probability of relevant unit of analysis error, corrections were applied to the standard errors and the confidence intervals of the effect size using the following formula (Higgins & Green, 2011):

$$SE_{corrected} = SE_{uncorrected} * \sqrt{[1+(m-1)*ICC]}$$

where *m* is the number of observations per cluster and *ICC* is the intra-cluster correlation coefficient, which we assume to be 0.05.[16] We used this formula to correct for likely unit of analysis errors in four studies (Bunyatta et al., 2006; Palis, 1998; Rejesus et al., 2010; Ricker-Gilbert et al., 2008). The nature of reporting on cluster assignment in the original studies in the majority of cases meant that we were not able to reach firm conclusions about unit of analysis errors. We therefore conducted sensitivity analysis in which additional studies assessed as being of "unclear risk" were corrected for unit of analysis errors (Appendix G).

Missing data

Where possible, we contacted primary study authors to obtain missing information in order to facilitate effect size extraction and risk of bias analysis. Given the large number of studies included in the review, we limited contact to authors of studies which were originally assessed as of medium risk of bias (no studies were originally assessed as of low risk of bias).

Moderator analyses

The coding sheet contained in the protocol (Waddington et al., 2012a) indicated the variables we expected to include in moderator analysis a priori. We identified effect moderators according to likely contextual factors which could affect outcomes, such as geographical region, crop type, implementation characteristics and length of follow-up period. Some moderator variables based on intervention and farmer characteristics were determined a posteriori following the review of qualitative literature. We used programme name and country to link across quantitative, qualitative and project portfolio

[16] Unfortunately, to the best of our knowledge, no previous studies have reported ICC for similar interventions and outcomes. Campbell et al. (2000) suggested that, overall, the ICC for outcome variables is not bigger than 0.05 in cluster randomised controlled trials and 0.02 is the mean.

implementation documentation to enhance the analysis of moderators. We report all moderator analyses conducted.

Methods of synthesis

We synthesised quantitative data on effectiveness in order to assess the direction and magnitude of effects in particular contexts, and mixed methods (quantitative and/or qualitative) data on barriers and enablers.

Review question (1): Effectiveness synthesis and sensitivity analysis

We synthesised quantitative information on impacts using inverse-variance weighted statistical meta-analysis. We implemented random effects meta-analysis because we can reasonably expect effect sizes to differ across studies due to a range of factors including contextual variation (e.g. relating to the location, type of crop, beneficiary groups, intervention design and implementation process and follow-up period) and study design, over and above the effects of chance alone on findings. Random effects meta-analysis produces a pooled effect size with greater uncertainty attached to it, in terms of wider confidence intervals than a fixed effect model.

We reported effect sizes on predefined sub-groups of interest, including FFS participants and neighbouring farmers potentially exposed to knowledge, to assess the extent of spillovers. We also investigated sources of effect heterogeneity according to contextual moderators and factors relating to study design. As noted above, there are important issues relating to comparability of bivariate and partial effect sizes (Keef & Roberts, 2004; Becker & Wu, 2007; Aloe & Thompson, 2013), due to likely collinearity between treatment variable and commonly used covariates such as socioeconomic status and demographic characteristics. We therefore conducted sensitivity analyses to examine whether there were any systematic associations with effect size magnitude.

Effect sizes shown using forest plots were synthesised in inverse-variance weighted random effects meta-analysis, estimated using Stata software (Stata Corporation, College Station, TX, USA). All response ratio analyses were conducted using the natural logarithm of the effect size, with results exponentiated back to the response ratio metric for forest plots and discussion.

Review question (2): Barriers and enablers synthesis

For the synthesis of evidence relating to question (2), we conducted the synthesis in two stages, using the hypothesised programme theory as our overall framework throughout. After having completed the detailed coding of all of the included studies we re-reviewed the coding and identified descriptive findings which remained close to the findings in the primary studies (following Thomas & Harden, 2008). We summarised the descriptive findings across studies, using headings corresponding to the key stages of the FFS programme theory (and the categories used for data extraction) to structure our synthesis. The full text of this synthesis is provided in Appendix H.

The descriptive synthesis provided the basis for a more analytical synthesis. We analysed the descriptive findings across studies in detail, and identified themes relating to potential barriers and enablers of FFS effectiveness. We then reviewed and compared the original FFS programme theory with the emerging evidence on barriers and enablers, and revised the theory and assumptions to reflect the findings of our synthesis.

Integrated synthesis (review questions 1 and 2)

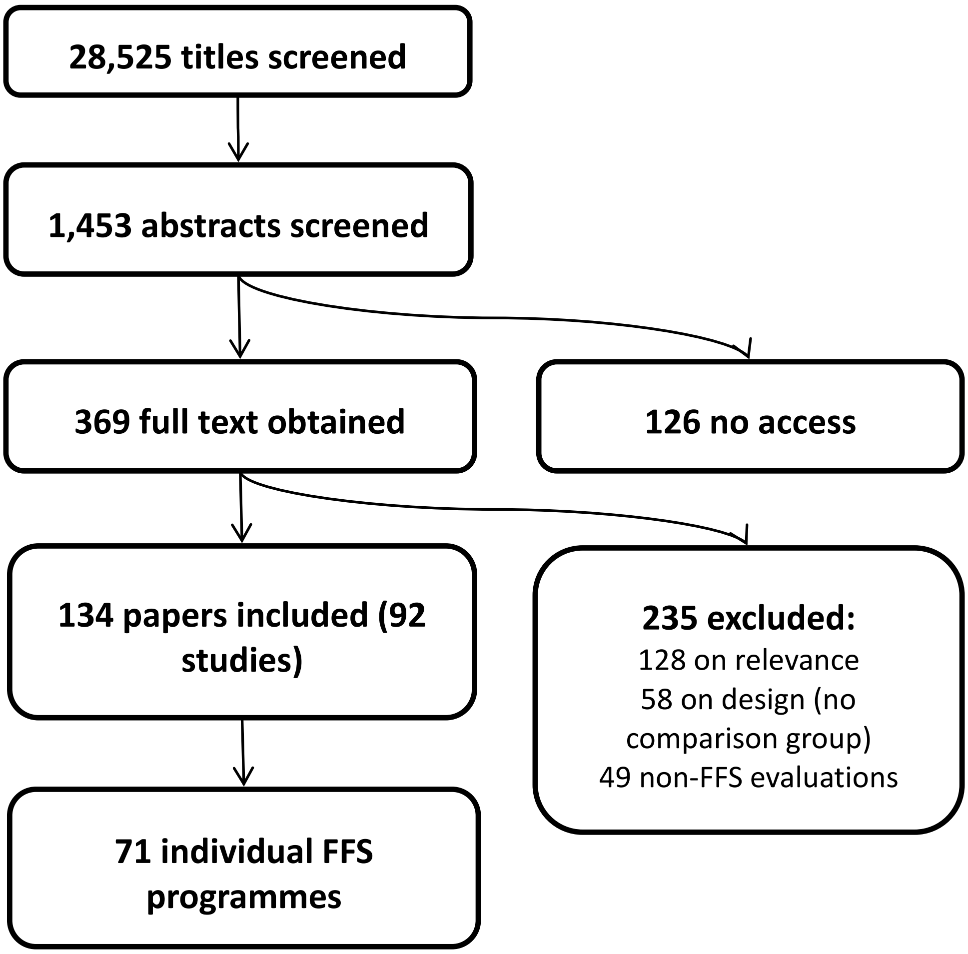
We used the programme theory (Figure 4) as a framework for integrating the findings from the two syntheses (Noyes et al., 2011) with the aim of providing an integrated narrative synthesis along the causal chain addressing the objectives of the review. We used an iterative approach, in which the intermediate outcomes and assumptions underlying the causal chain were further developed as part of the analytical approach. We used programme names to link studies included in quantitative, qualitative and project portfolio analyses to facilitate moderator analysis. We discuss the implications of the findings for policy, implementation and research.

4 Results of Effectiveness Synthesis

4.1 SEARCH RESULTS

This section reports the results of the synthesis of quantitative studies addressing review question (1) on the effects of farmer field schools on intermediate and final outcomes for FFS participants and non-participating neighbour farmers. We discarded 28,156 search records from the quantitative synthesis at the title or abstract stage, as they did not meet the inclusion criteria, being irrelevant to the topic (Figure 8). Of the 369 potentially relevant full text copies which we were able to obtain, 92 evaluation studies were included in the review of effects representing 71 FFS interventions conducted in 25 countries. All studies reported in English except one in Spanish (Orozco Cirilo et al., 2008). Studies reported on any intermediate or final outcomes along the causal chain, some reporting only findings for single outcomes, others reporting findings on multiple outcomes.

Figure 8 Quantitative synthesis search results



4.2 STUDY DESCRIPTIVE INFORMATION

Table 2 summarises descriptive information (reported in full in Appendix E) on the 92 included impact evaluation studies measuring effectiveness on a range of intermediate and final outcomes across the causal chain. Studies were identified from all global regions: 24 in East Asia, 25 in South Asia, 11 in Latin America, 1 in Central Asia and 31 in Sub-Saharan Africa. Most studies evaluated integrated pest management (IPM) and, particularly in Africa, integrated production and pest management (IPPM) farmer field school curricula, although a number implemented training on other intensive input management approaches, such as integrated crop management (ICM), integrated disease management (IDM) and integrated soil management (ISM).

FFS was provided as part of a multi-component intervention package alongside additional intervention components in 11 studies, which included support in procuring inputs and/or marketing produce (Table 2). Sixteen studies collected data from two treatment groups, the FFS participants and the non-participating neighbour farmers living in close proximity to participants (usually in the same villages) who may benefit from knowledge spillovers via contact with FFS farmers.

The studies collected data on a range of outcomes. Intermediate outcomes were collected for knowledge (32 studies) and adoption (59 studies). Agricultural outcomes were frequently measured (45 studies), usually in terms of physical measures of production (yields) and monetary measures of production which factor in prices (yields value) or take account of input costs (net revenue). A few studies reported other outcome dimensions, such as environmental risk factors (6 studies), self-reported health outcomes (4 studies) and empowerment (5 studies). For all outcomes, we attempted to calculate effect sizes and 95 per cent confidence intervals. However, as explored in Section 4.3 on study quality, in over one-third of cases (35 out of 92 FFS programmes) insufficient information was provided on sample distribution in order to estimate standard errors and therefore statistical precision of the effect sizes; these studies were therefore excluded from statistical meta-analysis. While many studies report multiple outcomes, no single study reported data on all intermediate and final outcomes along the theory of change.

Table 2 Included impact evaluation studies: summary descriptive information by region

Region	Intervention	Countries	Crop	Study design	Risk of bias assessment	Outcome data collected (effect size calculable)						Cost data provided
						Knowledge	Adoption	Agriculture outcome	Health outcome	Environment outcome	Empowerment outcome	
East Asia & the Pacific: 24 intervention studies	IPM-FFS (23 studies), IPM-FFS+input support+marketing support (1 study)	China, Indonesia, Myanmar, Thailand, Philippines, Vietnam	Cotton (6 studies), rice (13 studies), potato/vegetable (5 studies)	Longitudinal DID-regression (6 studies), longitudinal (6 studies), cross-section IV regression (1 study), cross-section regression/PSM (3 studies), cross-section (8 studies)	Low risk of bias (0 studies), medium (7 studies), high (17 studies)	5 studies (3 effect sizes)	16 studies (11 effect sizes)	12 studies (8 effect sizes)	1 study (0 effect sizes)	1 study (1 effect size)	0 studies	2 studies
Latin America & the Caribbean: 11 intervention studies	IPM-FFS (6 studies), IPPM-FFS (1 study), "Integrated management"-FFS (1 study), FFS+input support+marketing (3 studies)	Bolivia, Ecuador, Nicaragua, Peru, Mexico	Cereal (1 study), coffee (1 study), potato (7 studies), vegetable (2 studies)	Cross-section IV-regression (2 studies), cross-section PSM (3 studies), longitudinal (1 study), cross-section regression (1 study), cross-section (5 studies)	Low risk of bias (0 studies), medium (3 studies), high (9 studies)	5 studies (4 effect sizes)	7 studies (6 effect sizes)	6 studies (6 effect sizes)	1 study (1 effect size)	0 studies	1 study (1 effect size)	3 studies
Central Asia: 1 study	Unclear FFS type (1 study)	Iran	Rice (1 study)	Cross-section (1 study)	Low risk of bias (0 studies), medium (0 studies), high (1 study)	1 study (1 effect size)	1 study (1 effect size)	1 study (1 effect size)	0 studies	0 studies	0 studies	1 study

Region	Intervention	Countries	Crop	Study design	Risk of bias assessment	Outcome data collected (effect size calculable)						Cost data provided
						Knowledge	Adoption	Agriculture outcome	Health outcome	Environment outcome	Empowerment outcome	
South Asia: 25 intervention studies	IPM-FFS (16 studies), ICM-FFS (2 studies), IDM-FFS (1 study), ISNM-FFS (1 study), FFS+input support (1 study), FFS+input support+marketing (2 studies)	Bangladesh, India, Nepal, Pakistan, Sri Lanka	Cotton (13 studies), rice (8 studies), potato/vegetable (2 studies), cereal/groundnut (1 study), unclear (1 study)	Longitudinal DID (2 studies), cross-section IV-regression (1 study), cross-section PSM (2 studies), cross-section regression (1 study), longitudinal (8 studies), cross-section (10 studies)	Low risk of bias (0 studies), medium (2 studies), high (22 studies)	7 studies (4 effect sizes)	18 studies (10 effect sizes	16 studies (9 effect sizes)	1 study (0 effect sizes)	4 studies (2 effect sizes)	0 studies	6 studies
Sub-Saharan Africa: 31 intervention studies	IPM-FFS (8 studies), IPPM-FFS (13 studies), ICM-FFS (1 study), ICPM-FFS (2 studies), IDM-FFS (1 study), ISM (1 study), "Integrated management practices"-FFS (1 study), FFS+input support (1 study), FFS+marketing (1 study), FFS+input support+marketing (2 studies)	Benin, Cameroon, Ethiopia, Kenya, Ghana, Nigeria, Sudan, Tanzania, Uganda, Zimbabwe	Cocoa (5 studies), cotton (3 studies), potato/vegetable (14 studies), cereal/groundnut (5 studies), tea (2 studies), "diverse crops" (1 study), unclear (1 study)	Longitudinal DID-PSM (1 study), longitudinal covariate matching (3 studies), cross-section IV-regression (1 study), cross-section regression (6 studies), cross-section (20 studies)	Low risk of bias (0 studies), medium (3 studies), high (28 studies)	14 studies (9 effect sizes)	17 studies (9 effect sizes)	10 studies (7 effect sizes)	1 study (1 effect size)	1 study (1 effect size)	4 studies (0 effect sizes)	1 study

Notes: FFS type: IPM=integrated pest management; IPPM=integrated production and pest management; ICM=integrated crop management; ICPM=integrated crop and pest management; IDM=integrated disease management; ISM=integrated soil management; ISNM=integrated soil nutrient management. Study design: DID=difference-in-differences; IV=instrumental variables; PSM=propensity score matching.
Source: based on data reported in Appendix E and Appendix F.

The 92 included studies covered 71 distinct FFS programmes (see Section 3.3 for a discussion of dependent effect sizes). The activities forming the components of included FFS interventions are summarised in Figure 9.[17] In most cases detailed information on the intervention activities was not recorded clearly. For example, although one-third of programmes did mention training-of-trainers, almost all of these did not clarify the training used and it was clear in only three cases that the training approach was inadequate.

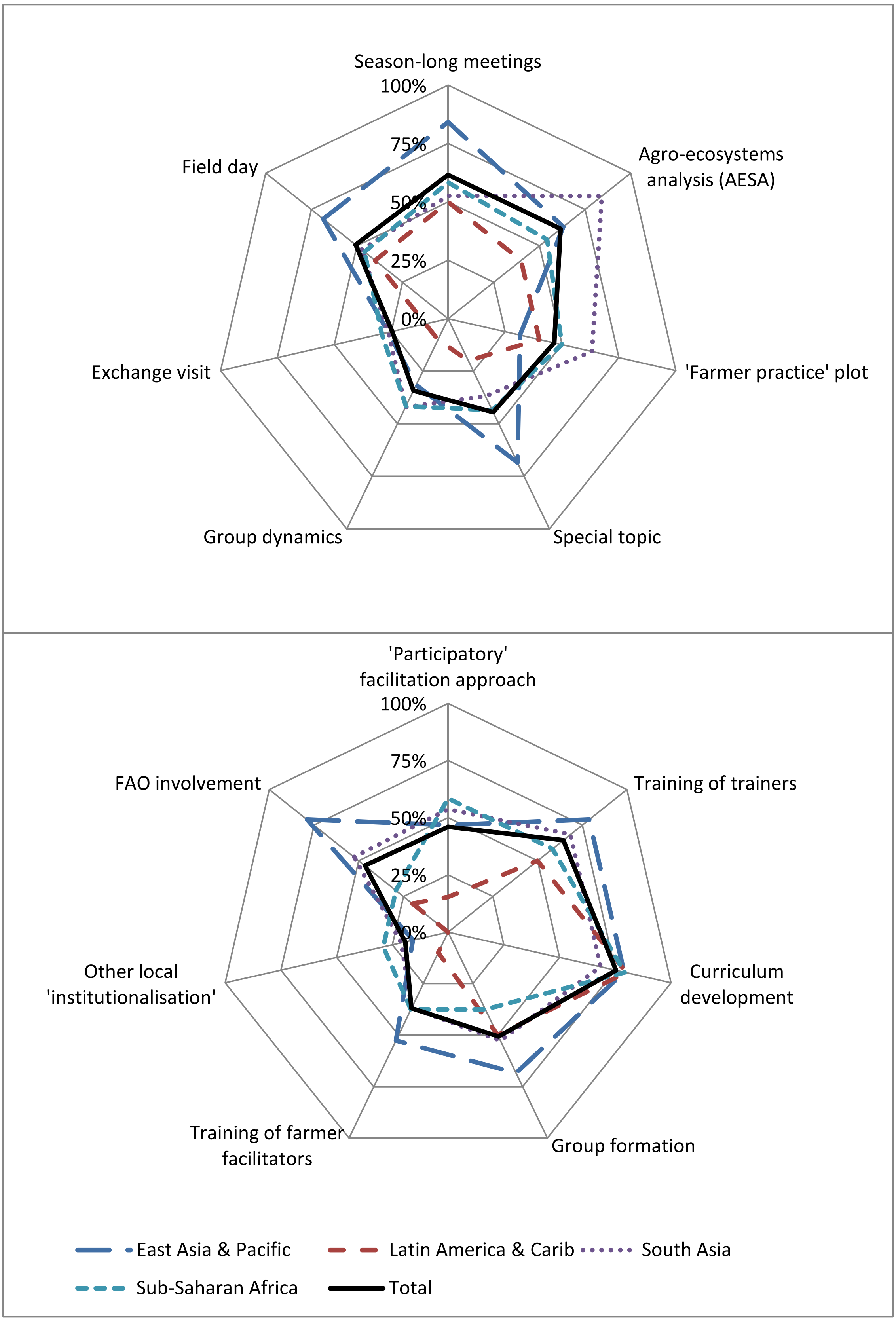
The extent to which FFS adapted to different contexts are based on the same process, both in the design and implementation of the programmes, varies (Davis et al., 2012). There appear to be two main types of FFS programme implemented in practice. About half of FFS impact evaluations were implemented by (or in partnership with) the FAO based on a participatory facilitation approach. Several studies appeared to implement a top-down transfer of technology approach based on “lecturing” (Todo & Takahashi, 2011; Yang et al., 2008). However, in a large number of cases it was simply unclear how the intervention was designed or implemented. Thus, while half clearly indicated that they used participatory facilitation, it was not clear in most of the remaining half which teaching pedagogy was used. Schools were usually preceded by development of specific curricula relevant to the context in which schools were being implemented. Farmer group formation and facilitator training for extension workers or other field school staff were usually also carried out prior to FFS training. In some cases training of facilitators appeared to be limited to attendance at a workshop (e.g. Erbaugh et al., 2010), rather than season-long theoretical and practical training, while in other cases facilitator training was judged unnecessary given existence of previously trained facilitators as, for example, in Kenya and Tanzania (Friis-Hansen & Duveskog, 2012).

Most schools held weekly season-long sessions, although in a few cases arable crop meetings were held fortnightly rather than each week (e.g. Erbaugh et al., 2010). In the case of permanent crops, such as tea and cocoa, meetings were often held fortnightly over the course of several months (Hiller et al., 2009; David & Asamoah, 2011) or years (e.g. Endalew, 2009). The activities implemented by the schools appeared to include agro-ecosystem analysis and “farmer practice” control plots in 50 per cent of cases each, while group dynamics, special topics and exchange visits were less common or were not reported.

The extent to which diffusion of IPM practices is assumed to occur informally through FFS graduates’ social networks, rather than needing to be formally encouraged through training-of-trainer programmes for alumni, varies from programme to programme. Follow-up activities to foster dissemination such as field days, training-of-trainer programmes for farmer facilitators and other means of community institutionalisation were only reported in a minority of cases (see also Appendix A).

[17] Data were coded on intervention design not implementation, which was usually unavailable.

Figure 9 Characteristics of programmes included in review of effects



Notes: data from included studies and portfolio project documentation (Appendix A). Due to under-reporting it is likely that the figures underestimate characteristics of programmes implemented.

4.3 ASSESSMENT OF STUDY VALIDITY

Risk of bias assessment

Designing impact evaluations of agricultural programmes is complicated by the wide range of factors that influence agricultural outcomes and by biases caused by self-selection of individuals and communities into programmes. Thus, differences in outcomes between participants and non-participants might result from pre-existing differences rather than being attributable to the programme under evaluation (Romani, 2003).

These problems arise in attempts to attribute the impact of farmer field school programmes on agricultural (or other 'final') outcomes. For instance, where "the selection of participants into the training is done with strong community involvement through its established leadership and existing social structures" (Feder et al., 2010, p. 10), certain farmers, such as community leaders or those of relatively high socioeconomic status, may be more likely to benefit from the intervention than others. Other programmes, particularly those in Africa, aimed to target disadvantaged farmers such as women (see Appendix A). In addition, pilot programmes may be explicitly placed where they are likely to have the greatest impact. And in the case of IPM field schools, explicit programme objectives were that benefits spill over from FFS participants to non-participating neighbour farmers. In other words, the unit of assessment should be at the community rather than the household level.

In the case of evaluating impacts on agricultural outcomes, such as yields and incomes, the likelihood of serious confounding, particularly by weather and market prices, means that appropriate methods of addressing the attribution challenge necessarily involve equivalent or matched comparison groups. One might argue that impact evaluations drawing on less causally rigorous standards of evidence would be appropriate for intermediate outcomes of interest, such as knowledge or adoption of new technologies, particularly where it is unlikely that beneficiaries would otherwise know about the technologies, especially in the case of complex messages.

In the case of adoption, farmer behaviour is influenced by a range of factors, including policy changes, which are likely to confound impact estimates. Removal of subsidies and banning of certain pesticides, as happened in Indonesia in the late 1980s (Braun & Duveskog, 2008), are examples of factors that would likely influence farmers' pesticide (dis-)adoption behaviour. In such contexts, a "before versus after" evaluation (pre-test post-test with no comparison group) would not enable researchers to attribute changes to any specific extension interventions. Similarly, farmers might gain knowledge from several places, including public information campaigns, other farmers and other extension interventions. For instance, in Vietnam a "no early spray" media campaign was run at the same time as FFS, and a study comparing neighbouring farmers who were exposed to the media campaign with those also attending FFS and a comparison group not exposed to either intervention found that beliefs about insecticide spraying changed among those exposed to both FFS and the media campaign and that the two interventions appeared complementary (Huan et al., 1999). In this case, a simple "before versus after" comparison would have overestimated the impact of the FFS programme on knowledge of simple practices (although not more complex knowledge).

During the period in which we conducted the analysis, we were unable to identify any completed experimental studies based on randomised assignment.[18] Despite the threats to validity being well known, and the feasibility of conducting cluster-randomised controlled trials (RCTs) for FFS interventions, the majority of FFS impact evaluations use designs of questionable internal and statistical conclusion validity, and therefore have high risk of bias in attributing final outcomes to the intervention. Treatment effects were usually estimated relative to a non-intervention comparison population, using contemporaneous cross-section data, although there are 30 studies of longitudinal design utilising panel data or group comparison (Table 2).

The summary risk of bias report by categories of selection bias and confounding, spillovers, reporting biases, and other sources of bias is provided in Figure 10 (individual assessment for each study is reported in Appendix F).[19] Of the included studies, 68 were classified as of high risk of bias, many of which were retrospective evaluations without baseline measurement, and, in a large number of cases, no attempt was made to match participant and non-participant covariates or control for such covariates in analysis. Twenty-four studies used more rigorous quasi-experimental approaches, including multivariate propensity score matching (e.g. Godtland et al., 2004) and covariate matching (Davis et al., 2012), multivariate instrumental variables regression (e.g. Ricker-Gilbert et al., 2008) and, where baseline and endline data were collected, multivariate difference-in-differences (or fixed effects) panel data regression (e.g. Feder et al., 2004; Wu, 2010). These studies adjusted for different covariates in the outcome equations, usually involving measures of household socioeconomic status and farmer demographics. However, our assessment also found many of these studies to be at serious risk of bias, usually due to problems of confounding (e.g. lack of tests for covariate balance or adjustment for unbalanced covariates in outcome equations, or inappropriate instrumental variables employed). Only 15 intervention studies were considered sufficiently rigorous to qualify as of medium risk of bias (Table 2), all of which used multivariate estimation methods, although none of these studies indicated that they used blinding either of outcome assessors or of data analysts. We were not able to identify any studies which could be described as having a low risk of bias in attributing outcomes to the intervention.

Another common weakness of the FFS impact evaluations was that they mostly relied on small samples. The median sample size is 185 farmers and samples range from 21 to 960.

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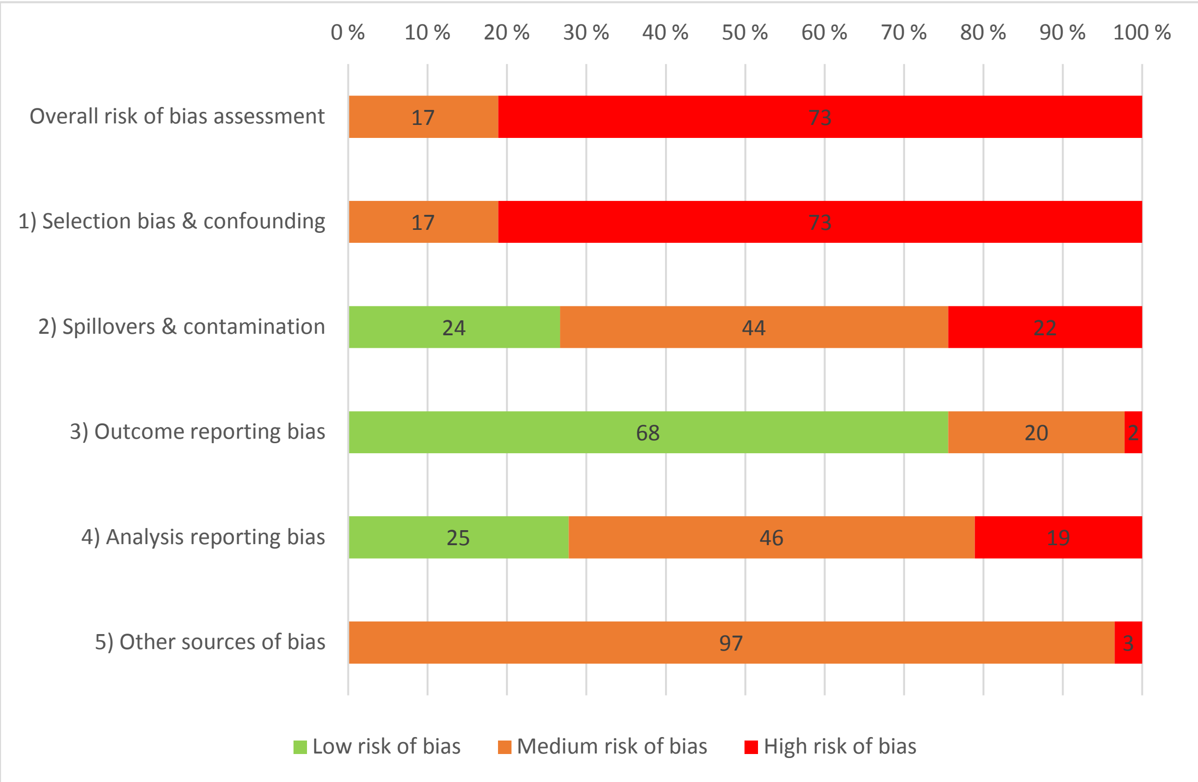
[18] We are aware of two on-going experimental studies (randomised assignment) of FFS in China (Rodriguez et al. : http://www.3ieimpact.org/en/evidence/impact-evaluations/details/206/) and the Philippines (Masset & Haddad, see http://www.ids.ac.uk/files/dmfile/CDI_EMasset_ParFARM_06jun13.pdf).

[19] Full details of the critical appraisal are available on request from the authors.

Often only a handful of primary sampling units are covered (median of 8 clusters or villages across treatment groups). Statistical power is thus limited.

Most studies appeared to assess pilot or small-scale projects rather than scaled-up programmes. There are two prominent exceptions: the Indonesia National IPM Programme (evaluated by Feder et al., 2004 and Yamazaki & Resosudarmo, 2008) and the Vietnam National IPM Programme evaluated by Rejesus et al. (2009). However, both have comparably small sample sizes (in the case of Feder et al., n=320; in the case of Rejesus et al., n=43 and there is only one commune primary sampling unit).

Figure 10 Summary of risk of bias appraisal for effectiveness studies



Source: authors based on Appendix F.

The availability of details on the intervention and comparison groups varied and was often limited. Most studies provided little information on the comparison group intervention apart from stating that the comparison farmers did not receive FFS training, or that there was no FFS intervention in the village; in a few cases, the studies indicated where comparisons had access to other sources of information about intensive input management approaches (e.g. Davis et al., 2012, in Uganda). We assessed whether there were any effects from these potentially contaminated comparisons in heterogeneity analysis by risk of bias status. In many cases, the comparison group was selected from among farmers living in the same village as the FFS (e.g. Carlberg et al., 2012; Dankyi et al., 2005; Islam et al., 2006; Kabir & Uphoff, 2007; Mutandwa & Mpangwa 2004; Pouchepparadjou et al., 2005; Price, 2001; Rao et al., 2012; Wandji et al. 2007), or included both non-FFS farmers from different locations and neighbouring farmers living in the same location (e.g. Rejesus et al., 2010; Ricker-Gilbert et al., 2008).

Given the voluminous impact evaluation literature on farmer field schools, our estimation has indicated that there are a number of high-risk-of-bias studies which are of very limited validity in attributing causal effects, particularly for final outcomes such as agricultural yields and revenue. We therefore interpreted the results of the synthesis with caution, reporting both pooled and stratified analyses based on risk of bias categories in meta-analysis, and making implications for policy in terms of effect sizes based only on those 15 studies regarded as being of medium risk of bias. Table 3 provides more detailed information on studies that we consider appropriate for informing policy due to their risk of bias assessment.

Of the full sample of studies, we estimated unit of analysis errors were “highly probable” in four studies, for which corrections were applied to all effect size standard errors. We also estimated unit of analysis errors to be “unclear” but possible in 47 studies, largely due to lack of clarity in responding on cluster sampling (Appendix F[20]). We therefore also presented sensitivity analyses for additional studies which were assessed as of “unclear” unit of analysis error (Appendix G), the results being broadly similar to the main findings for medium risk of bias studies, although the pooled effect sizes for high risk of bias studies tended to be of smaller magnitude for FFS participants.

[20] The assessment was reported as not applicable (N/A) mainly in those cases where we were unable to compute standard errors, as well as for a smaller number of studies which did not use cluster design.

Table 3 Detailed descriptive information on study design, method of analysis and sample size (high-risk-of-bias studies excluded)

Study	Location	Description of FFS intervention	Study arms	Study design; method of attribution	Follow-up time period[1]	Sample size[2] (num clusters)	Unit of analysis error assessment
Ali and Sharif (2012)	Pakistan	FFS providing training on IPM, cotton (programme name unclear)	(1) FFS-IPM (2) non-FFS comparison (intervention not stated)	Multivariate: cross-sectional data; propensity score matching	Not stated	325 (num village clusters not stated but data collected from 7 districts)	Possibility of relevant unit of analysis error: authors include district dummies but not village dummies
Cavatassi et al. (2011)	Ecuador	*Plataformas de Concertacion* NGO-implemented programme including training on IPM + farmer cooperatives organisation + new seeds, potato farmers	(1) FFS-IPM + farmer organisation and new seeds (2) non-FFS-plus comparison (intervention not stated)	Multivariate: cross-sectional data; propensity weighted least squares (weights calculated from propensity score matching regression)	1–4 years	835 of which 292 FFS, 543 non-FFS (35 communities, 18 FFS, 17 non-FFS)	Low probability of relevant unit of analysis error: the authors include controls for location-specific effects accounting for clustering
Davis et al. (2012)	Kenya	IFAD-FAO East Africa Programme for IPPM, maize, bean and vegetable farmers	(1) FFS-IPPM (2) non-FFS comparison (intervention not stated)	Multivariate: controlled before versus after (individual panel) data; covariate matching, bivariate difference-in-differences	2 years	398 of which 281 FFS and 117 non-FFS (20 villages of which 10 FFS)	Low probability of relevant unit of analysis error: authors include a village fixed effect
Davis et al. (2012)	Tanzania	IFAD-FAO East Africa Programme for IPPM, maize, bean and vegetable farmers	(1) FFS-IPPM (2) non-FFS comparison (intervention not stated)	Multivariate: controlled before versus after (individual panel) data; covariate matching, bivariate difference-in-differences	2 years	379 of which 272 FFS and 107 non-FFS (20 villages of which 10 FFS)	Low probability of relevant unit of analysis error: authors include a village fixed effect
Feder et al. (2004)	Indonesia	National IPM Programme, rice farmers	(1) FFS-IPM (2) FFS neighbours (3) non-FFS comparison (traditional public extension services)	Multivariate: controlled before versus after (individual panel) data; multivariate difference-in-differences estimation	3–5 years	320 of which 112 FFS, 156 FFS neighbours, 52 non-FFS (26 villages of which	Low probability of relevant unit of analysis error: authors use DID which accounts for

Study	Location	Description of FFS intervention	Study arms	Study design; method of attribution	Follow-up time period[1]	Sample size[2] (num clusters)	Unit of analysis error assessment
						21 FFS and 5 non-FFS)	clustering in the treatment allocation
Godtland et al. (2004)	Peru	NGO (CARE) FFS providing training on IPM, potato farmers	(1) FFS-IPM (+ Andino) (2) traditional public extension services CARE Andino programme	Multivariate: cross-sectional data; propensity score matching	<1 year	90 (45 FFS farmers, 45 control) (10 villages: 4 FFS, 6 Andino)	Possibility of relevant unit of analysis error: authors do not match on village-level characteristics
Pananurak (2010)	China	FAO-EU IPM Programme for cotton farmers	(1) FFS-IPM (2) FFS neighbours (3) non-FFS comparison	Multivariate: controlled before versus after (individual panel) data; multivariate difference-in-differences estimation	2 years	535 of which 177 FFS, 178 FFS neighbours, 180 non-FFS (18 villages, 9 FFS, 9 non-FFS)	Low probability of relevant unit of analysis error: authors use DID
Pananurak (2010)	Pakistan	FAO-EU IPM Programme for cotton farmers	(1) FFS-IPM (2) FFS neighbours (3) non-FFS comparison	Multivariate: controlled before versus after (individual panel) data; multivariate difference-in-differences estimation	2 years	190 of which 78 FFS, 59 FFS neighbours, 53 non-FFS (8 villages, 4 FFS, 4 non-FFS)	Low probability of relevant unit of analysis error: authors use DID
Praneetvatakul and Waibel (2006)	Thailand	Government of Thailand pilot IPM-FFS programme, rice farmers	(1) FFS-IPM (2) FFS neighbours (3) non-FFS comparison (intervention not stated)	Multivariate: controlled before versus after (individual panel) data; multivariate difference-in-differences estimation	3 years (3 period model used)	188 for 3 period model (241 for 2 period model, of which 107 FFS, 58 FFS neighbours and 76 non-FFS) (10 villages of which 5 FFS)	Low probability of relevant unit of analysis error: authors use DID
Rejesus et al. (2010)[3]	Vietnam	Vietnam National IPM Programme, rice farmers	(1) FFS-IPM (2) FFS neighbours (3) non-FFS comparison (intervention not stated but no IPM "no early spray" media campaign)	Multivariate: controlled before versus after (individual panel) data; multivariate difference-in-differences estimation	7 years	44 of which 11 FFS, 33 neighbours (1 commune)	High probability of relevant unit of analysis error: farmers from only one commune are

Study	Location	Description of FFS intervention	Study arms	Study design; method of attribution	Follow-up time period[1]	Sample size[2] (num clusters)	Unit of analysis error assessment
							included in the analysis
Todo and Takahashi (2011)	Ethiopia	FFS as part of a wider programme by Oromia Forest and Wildlife Enterprise and JICA to prevent deforestation and promote reforestation in the Belete-Gera Regional Forest Priority Area, cabbage, onion, carrot and beet farmers.	(1) FFS with a wide curriculum including learning of new agricultural technologies, such as farm management, seedbed preparation, proper spacing, new varieties, and sowing methods. Also the FFS teaches how to nurse trees and promote reforestation. Also, it seems that participants may have support to obtain certification for coffee. (2) non-FFS comparison.	Multivariate: controlled before versus after (individual panel) data; PSM and difference-in-difference estimation	1–2 years	269 of which 55 FFS and 214 non-FFS (8 FFS sub-villages and 16 non-FFS sub-villages)	Possibility of relevant unit of analysis error: it is not clear whether clustering has been taken into account in the regression analysis
Van Rijn (2010)	Peru	FFS + cooperative building + certification, coffee farmers	(1) FFS + cooperative + certification (2) non FFS-plus comparison	Multivariate: cross-sectional data: propensity-score matching	3–4 years	200 of which 93 FFS and 107 non-FFS (18 villages, 9 FFS and 9 non-FFS villages)	Low probability of relevant unit of analysis error: authors match on village characteristics accounting for clustering in the treatment allocation
Wu (2010)	China	FFS FAO-EU IPM Programme for cotton farmers in Asia	(1) FFS-IPM (2) FFS neighbours (3) non-FFS comparison (intervention not stated)	Multivariate: controlled before versus after (individual panel) data; multivariate difference-in-differences estimation	2 years	480 of which 155 FFS, 158 FFS neighbours, 167 non-FFS comparison (18 villages, 9 FFS, 9 non-FFS)	Low probability of relevant unit of analysis error: authors use DID
Yamazaki and Resosudarmo (2008)	Indonesia	National IPM Programme, , rice farmers	(1) FFS-IPM (2) FFS neighbours (3) non-FFS comparison (traditional public extension services)	Multivariate: controlled before versus after (individual panel) data; multivariate difference-in-	4 years	320 of which 112 FFS, 156 FFS neighbours, 52 non-FFS (26	Low probability of relevant unit of analysis error: authors use panel data

Study	Location	Description of FFS intervention	Study arms	Study design; method of attribution	Follow-up time period[1]	Sample size[2] (num clusters)	Unit of analysis error assessment
				differences estimation		villages of which 21 FFS and 5 non-FFS as per Feder et al.)	models
Yorobe et al. (2011)	Philippines	IPM-CRSP South-East Asia Regional Programme of USAID, onion farmers	(1) FFS-IPM (2) non-FFS comparison	Multivariate: cross-sectional data; two-step approach including instrumental variables and Heckman procedures	2 years	200 of which 69 FFS and 131 non-FFS (8 barangays, 4 FFS and 4 non-FFS)	Possibility of relevant unit of analysis error: authors include regional dummies but not barangay dummies

Notes: [1] Average years from start of implementation of intervention to endline survey. [2] Total number of farmers in treatment and comparison groups. [3] Comparison group in FFS effect estimates is FFS neighbour group.

External validity

Of the 92 impact evaluations covered by the quantitative review of effects, 42 provided descriptive information about FFS farmers (rather than characteristics of the farmers in the village as a whole) together with information on sampling methodology. Through this information we were able to say something about external validity (generalisability) for farmers who underwent FFS training in programmes covered by the effectiveness review, as well as for farmers in low- and middle-income countries more generally.

Table 4 provides an overview of the sampling approach used by these studies, most sampling either the entire population of FFS farmers or a random sample.

Table 4 Sampling approach used in studies providing data on FFS farmer characteristics

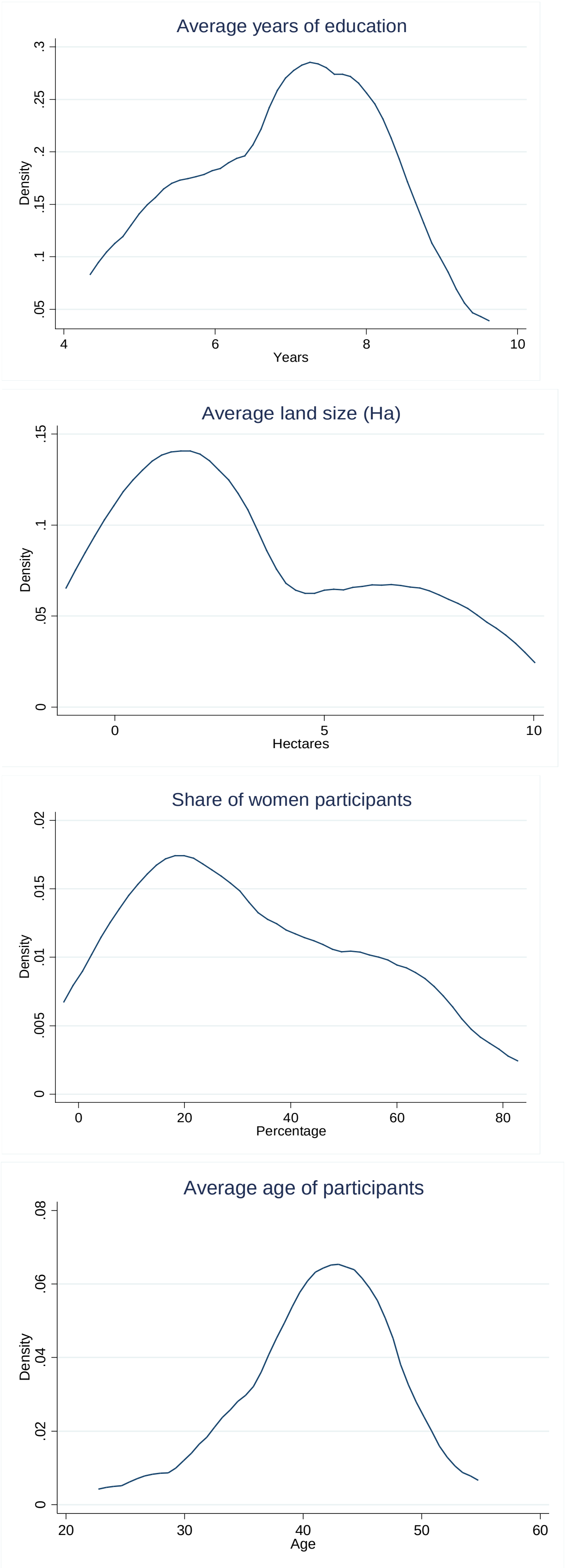
Studies	Sampling of field schools	Sampling of farmers
Haiyang, 2002 (China); Khan et al., 2007 (Pakistan); Lama et al., 2003 (Nepal); Palis, 1998 (Philippines); Rola et al., 2002 (Philippines); Van Rijn, 2010 (Peru)	All schools	All farmers
Davis et al., 2012 (Kenya, Tanzania, Uganda); Friis-Hansen and Duveskog, 2012 (Kenya, Tanzania, Uganda); Erbaugh et al., 2010 (Uganda); Islam et al., 2006 (Bangladesh); Kelemework, 2005 (Ethiopia); Naik et al., 2010 (India); Pananurak, 2010 (India); Pananurak, 2010 (Pakistan); Praneetvatakul and Waibel, 2006 (Thailand); Rejesus et al., 2010 (Vietnam)	Random	Random
Rao et al., 2012 (India); Zuger, 2004 (Peru)	Random	Unclear
Chi et al., 1999 (Vietnam); David, 2007 (Cameroon); Waarts et al., 2012 (Kenya)	Unclear	Random
Carlberg et al., 2012 (Ghana); Cavatassi et al., 2011 (Ecuador); Friis-Hansen et al., 2004 (Uganda); Ricker-Gilbert et al., 2008 (Bangladesh); Tripp et al., 2005 (Sri Lanka); Yang et al., 2008 (China); Yorobe et al., 2011 (Philippines)	Purposive	Random
Endalew, 2009 (Ethiopia); Khalid, n.d. (Sudan)	Purposive	Purposive
De Jager et al., 2009 (Kenya); Godtland et al., 2004 (Peru); Olanya et al., 2010 (Uganda); Van den Berg and Amarasinghe, 2003 (Sri Lanka); Yang et al., 2005 (China)	Purposive	Unclear
Feder et al., 2004 (Indonesia); Yanazaki and Resosudarmo, 2008 (Indonesia); Todo and Takahashi, 2011 (Ethiopia)	Unclear	Unclear

Six studies collected data on the entire population of FFS farmers, while a further 26 employed random selection either of field schools or villages or of participants, or both. Of those remaining, five reported that they had selected the FFS purposively, but were unclear how FFS farmers were sampled or whether the entire population of FFS farmers was included. Three reported that FFS farmers had been selected purposively with the goal of including either a balanced sample of male and female farmers (Endalew, 2009) or to ensure that full-time farmers that had attended FFS sessions regularly were included (Khalid, n.d.). The selection criteria of farmers in Todo and Takahashi (2011) was unclear, although the authors stated farmers were selected “as randomly as possible” (p. 11), and a final study drew on random sample household survey data in Indonesia, although it is not clear to what extent the sampling frame was representative of the population of field school farmers (Feder et al., 2004).

The included studies provided information on the characteristics (e.g. age, sex, education levels, size of landholdings) of participating and non-participating neighbour farmers for 48 of the 71 FFS interventions. As shown in Figure 11, the results suggested FFS farmers are on average more likely to be male, over 40 years of age, to have access to at least 1 hectare of land, and have completed primary education (attended seven years of education). However, analysis across the different programmes indicated that there are FFS interventions that involve a high degree of participation of poorer, younger and less-educated farmers, as well as those that include large numbers of educated and better-off farmers in terms of landholdings. FFS programmes employ a variety of targeting criteria to reach different groups, reflecting the often contrasting overarching aims and objectives of different programmes (Phillips et al., 2014). Some programmes included a majority of participants that can be considered the most capable farmers in a community – those who are well educated, well connected and organised, and have access to resources – with the explicit goal of ensuring that participants were those most capable of capitalising on the training. Other programmes explicitly set out to be pro-poor or inclusive of a range of different groups, including women and youth. Indeed, years of education varies between five and nine years (based on 20 observations), while the size of landholdings ranged between less than half a hectare and around nine hectares (based on 21 observations), reflecting the studies drawn from regions with different population densities. The average participation of women was 32 per cent, although the proportion of female participants ranged from as low as 8 per cent to as high as 72 per cent (based on 17 observations) (Figure 11).

In summary, while there are prominent examples where it is not clear how representative study participants are of the broader FFS programme (Feder et al., 2004; Yamazaki & Resosudarmo, 2009), in the majority of cases study participants appear to have been selected at random. On the other hand, the farmer groups of which FFS participants are representative vary according to the FFS project; some appear to involve more educated farmers, while others explicitly target women and marginalised groups.

Figure 11 Kernel density histograms showing farmer characteristics



File-drawer effects and publication bias assessment

A large number of studies reported data on intermediate and final outcomes. According to the risk of bias criteria reported in Figure 10, we did not consider studies with outcome reporting biases to outweigh those without. However, it is particularly difficult to assess file-drawer effects in retrospective studies where results-related choices can be made in selecting outcomes to report. No single study collected data on all outcomes along the theory of change. Some 27 studies did not provide information on yields or other agriculture outcomes despite collecting data on knowledge or adoption, which might suggest under-reporting of the former. But agriculture outcome data are notoriously more difficult to collect (yields, for example, requiring accurate information on both weight or value of produce and land size). These are usually study designs where causal inferences on final outcomes would in any case be challenged.

Nevertheless, as in many other areas of social science research, we believe there were potentially severe problems of file-drawer effects in the FFS impact evaluation literature. Studies used a wide range of different outcome definitions to measure similar constructs (Table 1 and Appendix E).[21] Moreover, sufficient information was only available to calculate effect sizes in 95 out of 151 cases in total, while insufficient information was provided to be able to estimate standard errors, and therefore statistical precision of the effect sizes, in one-third of cases (Appendix E), indicating serious problems in under-reporting.[22]

We conducted statistical analyses to assess likelihood of publication bias, including funnel graphs and meta-regression analysis incorporating the standard error of the effect size as an explanatory variable (Egger et al., 1997). Funnel graphs for those outcomes with ten or more observations (Figure 12) suggest under-reporting of small sample studies for knowledge, adoption of practices and yields. However, visual inspection is unreliable and, in any case, funnel plot asymmetry may be due to other factors such as methodological quality (smaller studies with lower quality may have exaggerated effect sizes), sources of artefactual variation such as heterogeneity in outcome measurement, and true heterogeneity due to intervention characteristics (Sterne & Egger, 2001).

Meta-regression analysis enabled the inclusion of additional covariates measuring these factors, including the summary risk of bias assessment, differences in outcome measurement and contextual factors such as intervention type, crops and region (Table 55 specifications 2). The meta-regressions suggested small study effects may be present using bivariate Egger's tests (Table 5 specifications 1). However, the small study effects are robust to inclusion of additional covariates in the case of yields only, providing evidence suggestive of

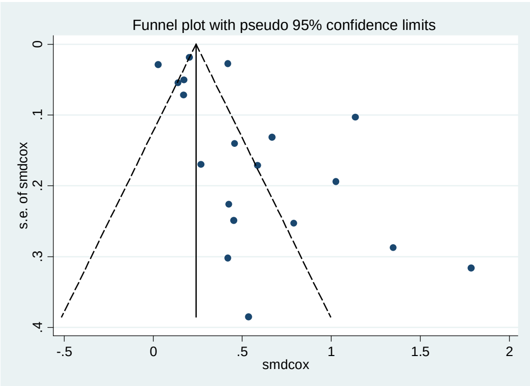
[21] This was not necessarily due to file-drawer effects. For example, in the case of Davis et al. (2012), the authors used monetary value of yields rather than the more conventional yields weight used in most other studies, which the authors noted is due to the extent of multi-cropping (farmers growing multiple crops on the same plot and growing season).

[22] In addition, seven studies did not provide sufficient information to calculate effect sizes for relevant comparison groups (Achonga et al., 2011; Bentley et al., 2007; Mangan & Mangan, 1998; Maumbe & Swinton, 2003; Olanya et al., 2010; Pouchepparadjou et al., 2005; Yang et al., 2008).

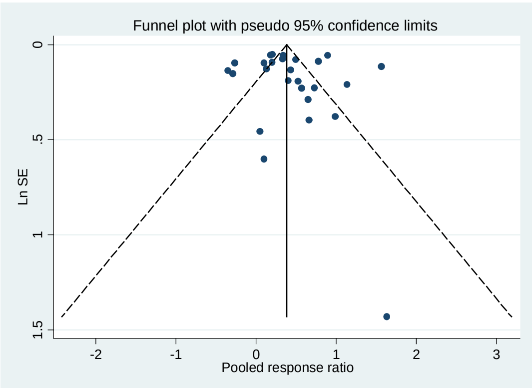
publication bias for that outcome variable. The significantly positive coefficient estimate on the dummy variable indicating whether the study was published in a peer-reviewed journal also provides further support for publication bias in favour of studies with larger effects for yields outcomes.[23]

Figure 12 Funnel graphs by outcome

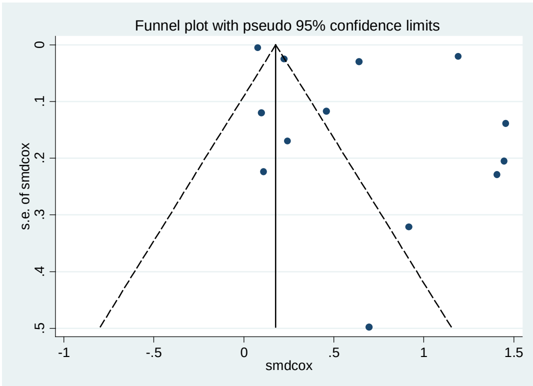
Knowledge



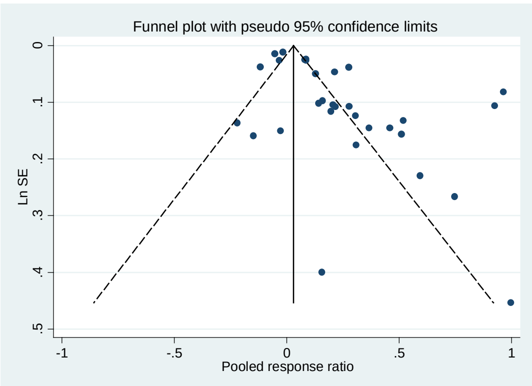
Pesticide use



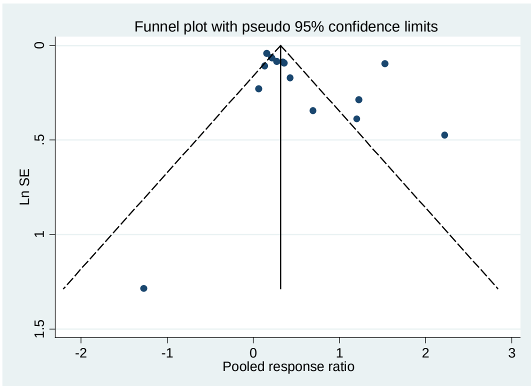
Adoption of other practices



Yields



Net revenue



[23] Results were not sensitive to inclusion of additional covariates, including categorical variables measuring outcome, global region and crop type (findings not reported). Results were not sensitive to exclusion of high risk of bias studies from the analysis: exponentiated coefficient on log standard error for yields=5.00, t-statistic=2.33, P-value=0.049.

Table 5 Meta-regression analysis of small study effects (Egger's test) for FFS participants

Outcome variable	Knowledge (SMD)		Pesticide use (RR)[1]		Adoption (SMD)		Yield (RR)[1]		Revenue (RR)[1]	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Standard error of effect size (Egger's test)[1]	2.16 (2.58)**	0.18 (0.13)	0.53 (0.89)	0.52 (0.93)	1.15 (0.85)	0.73 (0.37)	4.58 (2.17)**	6.02 (2.60)**	1.10 (0.10)	0.88 (0.14)
1=medium risk of bias study (dummy variable)		0.023 (0.12)		1.26 (1.07)		-0.33 (0.77)		0.86 (1.47)		0.90 (0.38)
1=Published in journal (dummy variable)								1.21 (1.79)*		
1=Cox-transformed SMD (dummy variable)		-0.49 (1.66)				-0.01 (0.03)				
1= "FFS-plus" intervention (dummy variable)										1.94 (2.43)**
Constant	0.20 (1.42)	0.69 (2.29)**	0.77 (1.68)	0.70 (2.01)*	0.40 (1.62)	0.53 (1.12)	1.10 (1.01)	1.01 (0.08)	1.58 (2.30)**	1.40 (1.78)
Tau-sq	0.08	0.06	0.20	0.19	0.33	0.38	0.06	0.06	0.20	0.14
I-squared res	92%	90%	94%	94%	99.5%	99.6%	89%	89%	93%	89%
Adjusted R-sq	36%	50%	-1%	4%	-1%	-14%	13%	24%	3.2%	30%
Sample size	18	18	22	22	15	15	29	29	14	14

Note: [1] Meta-regressions based on response ratio (RR) effect sizes are estimated using logged RR and logged standard errors; exponentiated coefficients reported. Absolute value of t-statistic reported in parentheses; *, **, *** indicates coefficient significant at <10%, <5% and <1% levels. Models estimated using inverse-variance weighted random effects analysis.

4.4 META-ANALYSIS RESULTS

This section reports the results of meta-analysis for effectiveness of farmer field school training for participants and non-participant neighbour farmers potentially experiencing diffusion effects through their interactions with beneficiaries. We present results using the theory of change (Figure 4), for intermediate outcomes (knowledge and adoption) and final outcomes (agriculture, health, environment and empowerment). The meta-analysis is reported by outcomes rather than study. No single study reported all outcomes along the causal chain, although we have attempted to link outcomes for individual studies in order to explain heterogeneity in findings.

The FFS were carried out using different intervention designs, for participants of different demographic and socioeconomic backgrounds, by different implementing bodies, and using different impact evaluation estimation methods, which we would reasonably expect to have an impact on effect size over and above sampling error. We therefore used random effects meta-analysis to synthesise the findings. We present effects for IPM/IPPM FFS and other FFS curricula, and also present results for diffusion to neighbours of IPM-FFS where these were reported in the original studies. We synthesised findings from bivariate and partial effect sizes, which are only strictly comparable under the assumption of constant slopes (there is no collinearity between treatment effect and covariates; see Appendix D). We therefore conducted and report extensive sensitivity analysis by evaluation design features, including whether effect sizes were estimated from bivariate or multivariate analyses. All medium-risk-of-bias studies, on which policy implications regarding effects are based, used multivariate estimation strategies producing partial effect sizes. However, not all used the same variable constructs and are therefore not strictly comparable where collinearity exists. Finally, we analysed heterogeneity according to context and implementation factors using moderator analysis and meta-regression.

Capacity building and knowledge dissemination (intermediate outcomes)

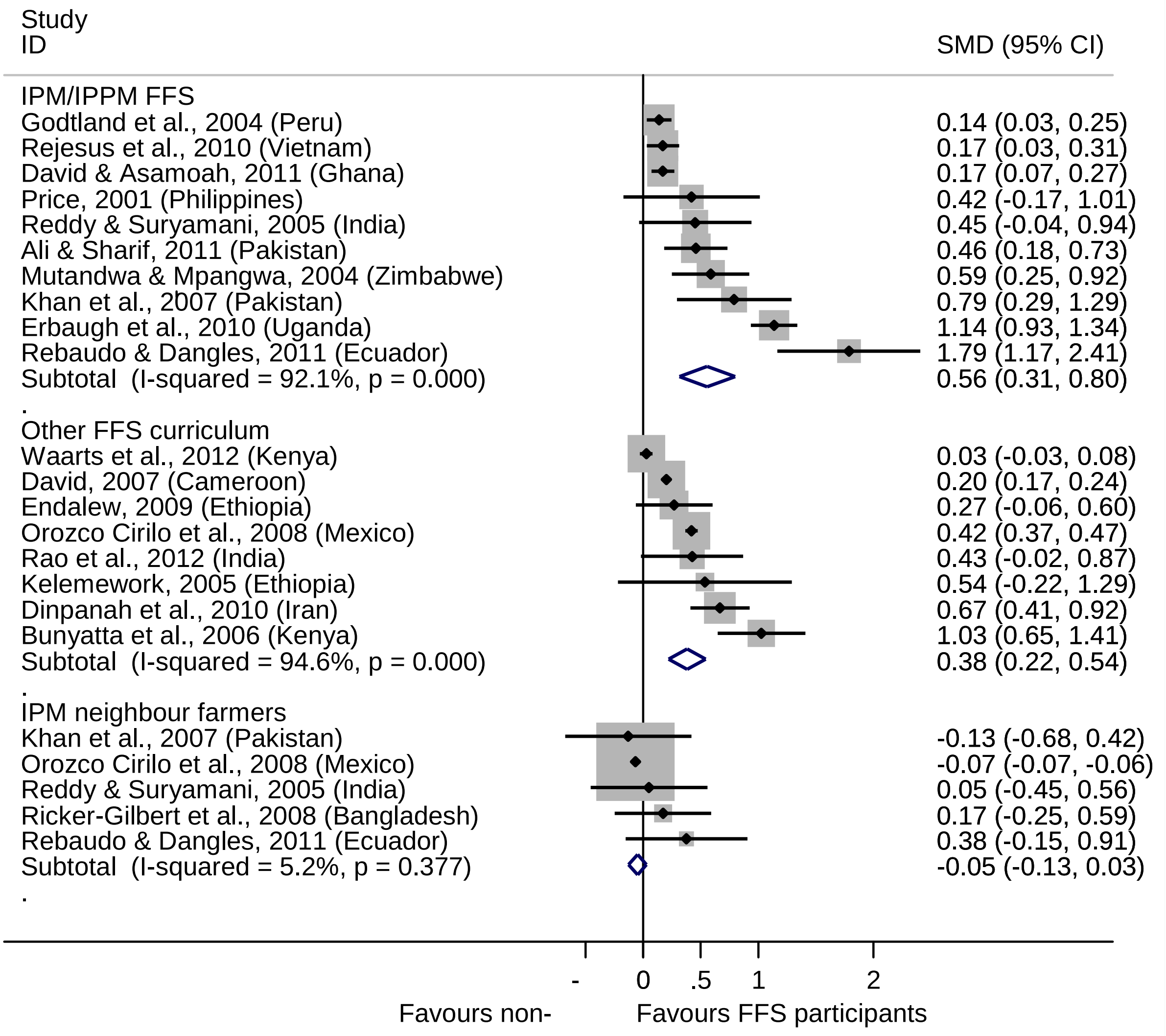
Effect sizes for knowledge are measured in terms of standardised mean difference (SMD), indicating the change in knowledge scores among FFS (or neighbour) farmers over the non-FFS comparison, measured in terms of standard deviations of the outcome variable. SMD scores are interpreted as the number of standard deviation changes in the outcome.

The studies presented a range of knowledge variables (Appendix E), the majority comparing beneficiaries to non-beneficiaries according to average points on a test score (or a knowledge index as in the case of Huan et al., 1999) across multiple categories of crop management. Evidence suggests farmer field schools lead to significant capacity building in farming techniques among FFS participants.

The meta-analysis of standardised mean differences (Figure 13) indicates positive effects of FFS training on knowledge of beneficial farming practices for both IPM/IPPM curricula (SMD=0.56, 95% confidence interval (CI)=0.31, 0.80; Q=114, Tau-sq=0.12, I-sq=92%; 10

observations) and curricula (SMD=0.38, 95% CI=0.22, 0.54; Q=131, Tau-sq=0.04, I-sq=95%; 8 observations), in comparison with untrained farmers.[24] While all observed studies showed positive impacts on participant knowledge for FFS farmers, there is significant variation in magnitude of impacts (as indicated by the value of I-squared).

Figure 13 Knowledge outcomes for FFS participants and neighbours versus non-FFS comparison



We attempted to explain the heterogeneity through sensitivity and moderators analysis. We examined whether the findings are sensitive to the types of studies included, risk of bias, effect size estimate and outcome measures, and length of follow-up (Table 6).[25] Results of the sensitivity analysis suggest that findings are not sensitive to choice of outcome measure. However, rigorous quasi-experimental studies (including double differences, propensity score matching and instrumental variables estimation) and multivariate regression studies

[24] The forest plots showing programme name rather than authors are in Appendix G.

[25] Exposure length is measured imprecisely in the original studies, so we have adopted cut-off values of up to one year, up to two years and greater than two years to distinguish longer- from shorter-term effects.

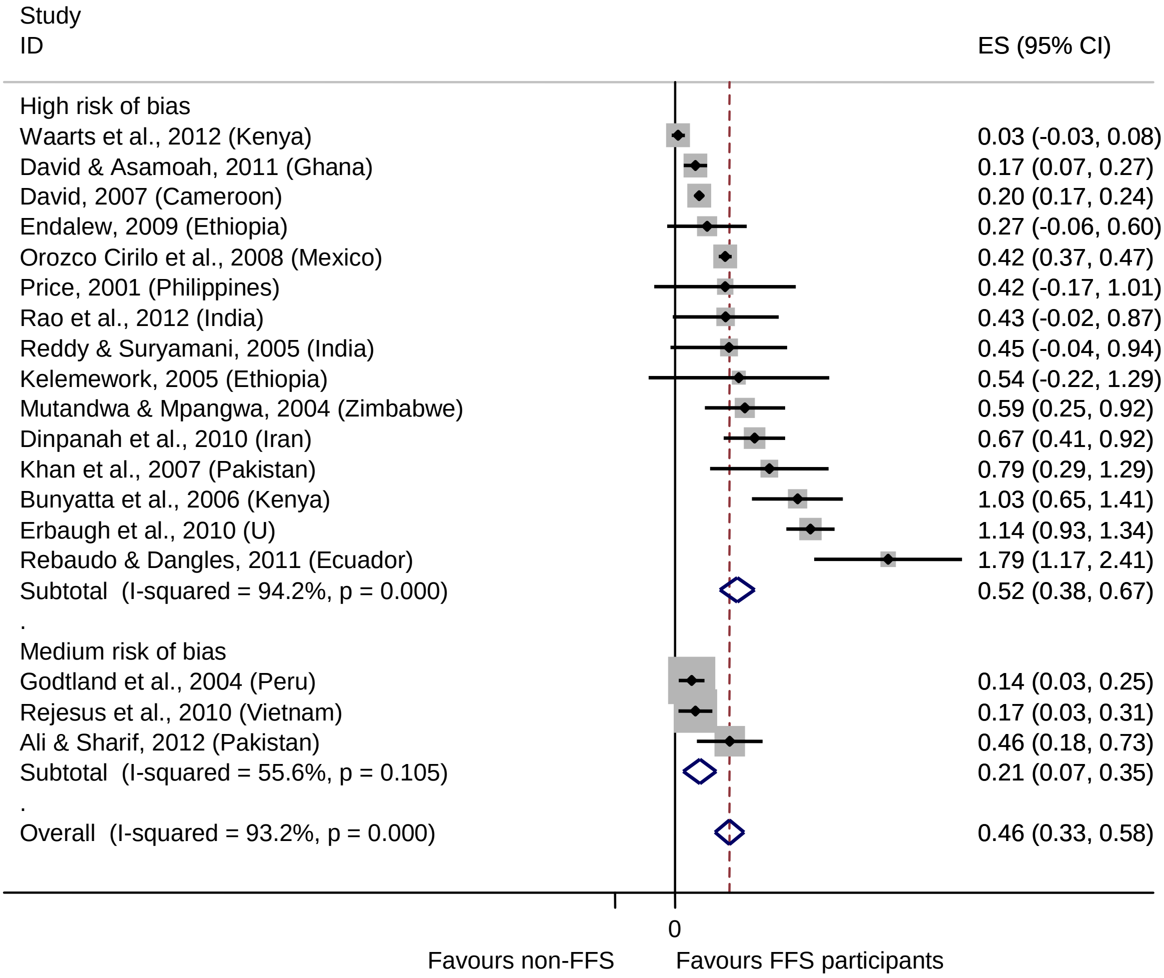
produce smaller effect sizes than other types of study designs using unadjusted analyses. Similarly, studies assessed as being of lower risk of bias also show smaller effects on average (SMD=0.21, 95% CI=0.07, 0.35; Q=5, Tau-sq=0.008, I-sq=55%; 3 observations) (Figure 14), as do SMD effect sizes which were calculated using Cox-transformed response ratios or odds ratios.

Table 6 Sensitivity analysis of knowledge outcomes for FFS participants: study design characteristics

	SMD	95% confidence interval		Q	Tau-sq	I-sq	P-value	Sample size
FFS participants: all studies	0.46	0.33	0.58	249	0.050	93.2%	0.000	18
Study type:								
Rigorous quasi-experimental study	0.21	0.07	0.35	5	0.008	55.6%	0.105	3
Cross-section regression (adjusted analysis)	0.09	-0.05	0.23	6	0.009	83.8%	0.013	2
Longitudinal data (unadjusted analysis)	0.43	0.37	0.48	2	0.000	0.0%	0.696	5
Cross-section data (unadjusted analysis)	0.73	0.37	1.10	134	0.243	94.8%	0.000	8
Risk of bias:								
Medium risk of bias	0.21	0.07	0.35	5	0.008	55.6%	0.105	3
High risk of bias	0.52	0.38	0.67	243	0.054	94.2%	0.000	15
Outcome measure:								
Knowledge test score	0.46	0.33	0.58	246	0.047	93.9%	0.000	16
Percentage with improved knowledge	0.47	0.21	0.73	0	0.000	0.0%	0.850	2
Num technologies known	No obs.							
Effect size calculation:								
SMD (standard calculation)	0.73	0.49	0.97	41	0.112	75.5%	0.000	11
SMD (Cox adjusted OR/RR)	0.46	0.18	0.73	106	0.022	94.4%	0.000	7
Length of follow-up data collection:*								
1 year or less	0.19	0.15	0.24	2	0.000	11.0%	0.325	3
2 years or less	0.43	-0.08	0.94	19	0.177	89.5%	0.000	3
More than 2 years	0.46	0.23	0.69	82	0.070	92.6%	0.000	7

Note: * indicates data incomplete due to missing observations.

Figure 14 Knowledge outcomes for FFS participants by risk of bias status



We also examined whether findings are moderated by characteristics of interventions and farmers (Table 7). Unfortunately, the information on FFS design and implementation was incomplete, both that reported in the impact evaluations themselves and other documents we were able to link with the impact evaluations such as those collected for the portfolio review (Appendix A). We were therefore only able to obtain evidence suggesting FFS interventions were more effective in improving knowledge where they used “farmer practice” control plots or made attempts at institutionalisation in the local community such as through dedicated training of farmer trainers. Results do not suggest that FFS in which women farmers were known to participate are systematically associated with larger or smaller effects on knowledge; and the same applies with other characteristics of participants such as years of education (Table 7). We did, however, find more robust evidence that FFS interventions promoting IPM, as opposed to other curricula, tend to have bigger effects on participant knowledge, while FFS for permanent crops (including coffee, tea and cocoa) tend to have smaller effects on knowledge. The latter may be due to the method of implementation for permanent crop field schools, which are conducted only fortnightly rather than weekly, but we were not able to test for this possibility due to insufficient data.

Table 7 Moderator analysis of knowledge outcomes for FFS participants: intervention and farmer characteristics

	SMD	95% confidence interval		Q	Tau-sq	I-sq	P-value	Sample size
FFS participants: all studies	0.46	0.33	0.58	249	0.050	93.2%	0.000	18
Curriculum:								
IPM	0.63	0.30	0.96	104	0.192	93.2%	0.000	8
IPPM	0.35	-0.06	0.75	5	0.070	81.4%	0.020	2
Other curricula	0.38	0.22	0.54	131	0.035	94.6%	0.000	8
FFS+input/marketing	No obs.							
FFS design:								
Local curriculum development*	0.38	0.25	0.52	207	0.041	94.7%	0.000	12
Training-of-trainers programme for facilitators*	0.24	0.13	0.34	56	0.015	83.9%	0.000	10
Group formation*	0.49	0.27	0.71	105	0.079	93.4%	0.000	8
Participatory method of tuition*	0.42	0.22	0.62	189	0.074	95.8%	0.000	9
FAO involvement*	0.44	0.21	0.67	11	0.042	64.7%	0.023	5
Local institutionalisation incl training farmer trainers*	0.35	0.20	0.49	128	0.030	94.5%	0.000	8
No local institutionalisation/training farmer trainers*	0.15	0.05	0.25	1	0.000	0.0%	0.469	2
FFS activities:								
Season-long weekly training*	0.24	0.14	0.33	22	0.009	67.9%	0.003	8
Uses “farmer practice” control plot*	0.29	0.17	0.42	26	0.015	77.2%	0.000	7
Does not use “farmer practice” control plot*	0.03	-0.03	0.08	0	0.000	n/a	n/a	1
Agro-ecosystems analysis*	0.44	0.27	0.61	107	0.054	91.6%	0.000	10
Group dynamics activities*	0.22	0.10	0.34	49	0.015	87.8%	0.000	7
Special topic*	0.46	0.34	0.58	132	0.119	95.5%	0.000	7
Exchange visits*	0.47	0.03	0.91	18	0.133	88.9%	0.000	3
Field day*	0.49	0.26	0.73	105	0.081	94.3%	0.000	7
Years of implementation of FFS programme:								
1 year or less	0.31	0.17	0.44	76	0.024	90.7%	0.000	8
2 years or less	0.51	0.30	0.73	64	0.074	89.1%	0.000	8
More than 2 years	0.65	0.37	0.93	0	0.000	0.0%	0.502	2
Region:								
Central Asia (CA)	0.67	0.41	0.92	0	0.000	n/a	n/a	1
East Asia (EA)	0.19	0.05	0.32	1	0.000	0.0%	0.423	2
Latin America (LA)	0.55	0.21	0.89	41	0.071	95.1%	0.000	3
South Asia (SA)	0.50	0.31	0.70	2	0.000	0.0%	0.670	4
Sub-Saharan Africa (SSA)	0.45	0.26	0.63	142	0.053	95.1%	0.000	8
Crop:								
Rice	0.41	0.11	0.71	11	0.062	73.7%	0.010	4
Other staples and vegetables	0.78	0.45	1.10	103	0.130	95.1%	0.000	6
Cotton	0.54	0.36	0.72	2	0.000	0.0%	0.679	4
Permanent (coffee, tea, cocoa)	0.15	0.03	0.26	27	0.010	89.0%	0.000	4
Farmer characteristics:								
Farmer education years exceeds national average*	0.45	0.22	0.68	87	0.067	94.3%	0.000	6
Women farmers participated in FFS*	0.44	0.02	0.85	75	0.168	96.0%	0.000	4

Note: * indicates data incomplete due to missing observations.

We conducted meta-regression analysis to assess robustness of variables which seem to explain differences in effect sizes in bivariate analysis (Table 8). Due to the limited sample size, we restricted the analysis to those variables which were associated with significant differences in effect sizes in bivariate analysis, and we included the log standard error (Egger's test coefficient) in specification 1, given possibilities for publication bias.[26] The analysis suggests variables significantly associated with smaller impacts on farmer knowledge included studies subject to medium risk of bias (as opposed to high risk of bias), measurements for neighbour farmers and FFS which targeted permanent crops. The results were not sensitive to exclusion of insignificant variables (Table 8 specification 2, conducted given the low number of observations and consequently limited power of the analysis). The test statistics suggest that the model explains substantial heterogeneity between studies (adjusted R-squared and Tau-squared), although unexplained heterogeneity remains (I-squared).

Table 8 Meta-regression analysis of knowledge outcomes

	(1)			(2)		
	Coefficient	t-statistic	P>t	Coefficient	t-statistic	P>t
1=Medium risk of bias	-0.50	-2.05	0.057	-0.49	-3.03	0.001
1=Cox-transformed SMD	-0.26	-1.13	0.277			
1=IPM-FFS	0.25	1.49	0.156			
1=Permanent crop	-0.38	-2.57	0.020	-0.57	-3.94	0.001
1=Neighbour farmers	-0.67	-4.37	0.000	-0.68	-4.23	0.000
Standard error (Egger coefficient)	-0.67	-0.64	0.530			
Constant	1.12	4.80	0.000	0.73	8.11	0.000
Number of obs	23			23		
Tau-squared	0.019			0.041		
I-squared	72.1%			82.7%		
Adjusted R-squared	84.7%			67.9%		
Model F(5,17)	6.91			8.73		
Prob > F	0.001			0.000		

Note: **Bold** indicates coefficients statistically significant at <10% level.

Few IPM-FFS studies included in our review assessed diffusion of IPM knowledge to non-participant neighbour farmers who were potentially exposed to the message; all of the studies which reported these outcomes were assessed as being of high risk of bias. The meta-analysis evidence does not suggest there are knowledge spillovers among the few studies which measured knowledge among neighbours (Figure 13) (SMD=-0.05, 95% CI=-0.13, 0.03; Q=4.2, Tau-sq=0.002, I-sq=5%; 5 observations). The values of I-squared and Tau-squared indicate that this finding is highly consistent across studies, and do not suggest

[26] In order to maximise sample size, we also excluded variables with insufficient observations such as FFS which incorporated local institutionalisation or training of farmer trainers.

there are contexts in which spillovers to neighbours are more likely. Moreover, as noted above, we also found evidence suggestive of file-drawer effects in terms of under-reporting of insignificant or negative findings. For example, despite reporting increases in knowledge among FFS participants over comparison farmers (RR=1.14), Rola et al. (2002) reported no difference in knowledge between exposed and comparison farmers (RR=0.99); however, they did not report on statistical precision of their findings. In a similar study which demonstrated knowledge improvements among FFS participants but did not present information to estimate statistical precision of findings, Tripp et al. (2005) reported limited knowledge among exposed farmers based on both insecticide knowledge test scores (RR=0.90) and number of natural enemies mentioned (RR=0.94). Feder et al. (2004) could not detect a statistically significant effect on knowledge diffusion to FFS-exposed farmers in Indonesia, and consequently did not report findings.

Some studies examined different types of knowledge diffusion. In the single study in Bangladesh which examined diffusion of "simple" and more "complex" practices, Ricker-Gilbert et al. (2008) found that non-participant neighbour farmers living in FFS villages were significantly more likely to have knowledge of simple IPM practices – such as placing branches in rice fields for birds to perch o – than comparison farmers living in non-FFS villages who were exposed to other sources of information on IPM (Appendix G). However, neighbours were not more likely than comparison farmers to have knowledge of intermediate or more complex IPM practices such as setting insect traps and using beneficial insects, which FFS farmers were shown to have, suggesting spillovers to neighbours may be possible for simple practices only, over and above IPM marketing information.[27]

As several studies noted, not all the knowledge in the FFS curriculum is observable or can be learned through self-study by non-participants and it is difficult to transmit complex knowledge such as agro-ecosystem concepts, analysis and decision-making principles through conversation alone (Feder et al., 2004; Pananurak, 2010; Wu, 2010). Due to the limited heterogeneity in findings for FFS neighbours, and limited reporting of sub-groups in primary studies, it is not possible to test whether there are systematic differences in spillovers across studies based on farmer characteristics.[28]

Adoption of improved practices (intermediate outcomes)

[27] Rejesus et al. (2010) found that there was greater acquisition for some aspects of knowledge (such as entomological knowledge) among farmers with lower initial levels of knowledge about IPM. The same study finds that the initial gains in knowledge observed in FFS graduates compared with exposed farmers do not persist over time. However, it is not possible to infer whether this was due to diffusion within communities, or erosion of the FFS graduate's knowledge over time, or indeed due to some other reasons such as changes in the implementation of the project over time, resulting in differing levels of effectiveness across the years that were included in the analysis.

[28] One study in Indonesia used statistical network regression analysis to find diffusion was maximised at an optimal level of social 'superiority' of opinion leaders, when opinion leaders who received intensive training are slightly superior to 'would-be followers' in terms of socioeconomic status and farming skill attributes, but not excessively so. In contrast, when the social or educational 'distance' between opinion leaders and followers was too large, their effectiveness in diffusing skills and knowledge fell (Feder & Savastano, 2006).

Adoption of practices is the most frequent outcome measure reported in the studies. We report two main types of adoption variables: variables measuring pesticide use for FFS programmes involving IPM and IPPM, and variables measuring adoption of other improved practices and labour costs (detail on outcomes variables is reported in Appendix E).

Pesticide use for IPM/IPPM farmer field schools

Measures of pesticide use usually took the form of the volume of pesticides used per unit of land area or the number of sprays per cropping season, or total pesticide expenditure. For these outcomes, we have estimated response ratio (RR) effect sizes. Reduced pesticide demand is considered a beneficial outcome, since all interventions included in this meta-analysis promoted IPM or IPPM farmer field schools (with or without complementary input and/or marketing interventions). Reductions in pesticide use – and therefore positive impacts of FFS training – are measured as values of RR between 0 and 1. Increases in pesticide use over the comparison group are measured as values of RR greater than 1. RR are interpretable as percentage changes over the comparison.

The meta-analysis suggests that demand for pesticides, measured in terms of amount sprayed or total expenditure, is estimated on average to be significantly lower among IPM/IPPM FFS graduates than comparison farmers (RR=0.68, 95% CI=0.57, 0.81; Q=172, Tau-sq=0.09, I-sq=90%; 18 observations), but not IPM/IPPM FFS interventions which included additional intervention components of input or marketing support (RR=0.77, 95% CI=0.30, 1.96; Q=158, Tau-sq=0.90, I-sq=98%; 4 observations) (Figure 15). Furthermore, and commensurate with the lack of knowledge gains reported above, we did not find evidence for diffusion to neighbouring farmers, estimating non-significant reductions in pesticide demand for this group on average (RR=0.91, 95% CI=0.66, 1.26; Q=47, Tau-sq=0.12, I-sq=85.2%; 8 observations).[29]

There is, however, substantial variation in effect sizes which appears to be in large part due to heterogeneity across studies (indicated statistically by high values of I-squared and Tau-squared). We therefore also conducted additional sensitivity and moderator analyses to explore the heterogeneity. Similarly to knowledge outcomes, we found that less rigorous study designs (Table 9) and high-risk-of-bias studies were likely to overestimate impacts on pesticide adoption (Figure 16 reports the forest plot excluding high-risk-of-bias studies). Indeed the best estimate of average effects on pesticide use for IPM/IPPM curricula FFS suggests a reduction in pesticide use of 23 per cent on average (RR=0.77, 95% CI=0.61, 0.97; Q=40, Tau-sq=0.07, I-sq=83%; observations=8). Impacts measured over shorter-term follow-up periods (up to two years) tended to be bigger than longer-term periods, as did studies which measured pesticide costs. The heterogeneity analysis for pesticide use by neighbouring farmers suggests results are not sensitive to dropping high-risk-of-bias studies (RR=0.95, 95% CI=0.64, 1.39; Q=45, Tau-sq=0.14, I-sq=91%, 5 observations). Results are also not sensitive to exclusion of the studies by Feder et al. (2004) and Yamazaki and

[29] The forest plot showing programme name rather than authors is in Appendix G.

Resosudarmo (2008) (see also forest plots in Appendix G).

Figure 15 Pesticide use for IPM/IPPM FFS participants and IPM neighbours versus non-FFS comparison farmers

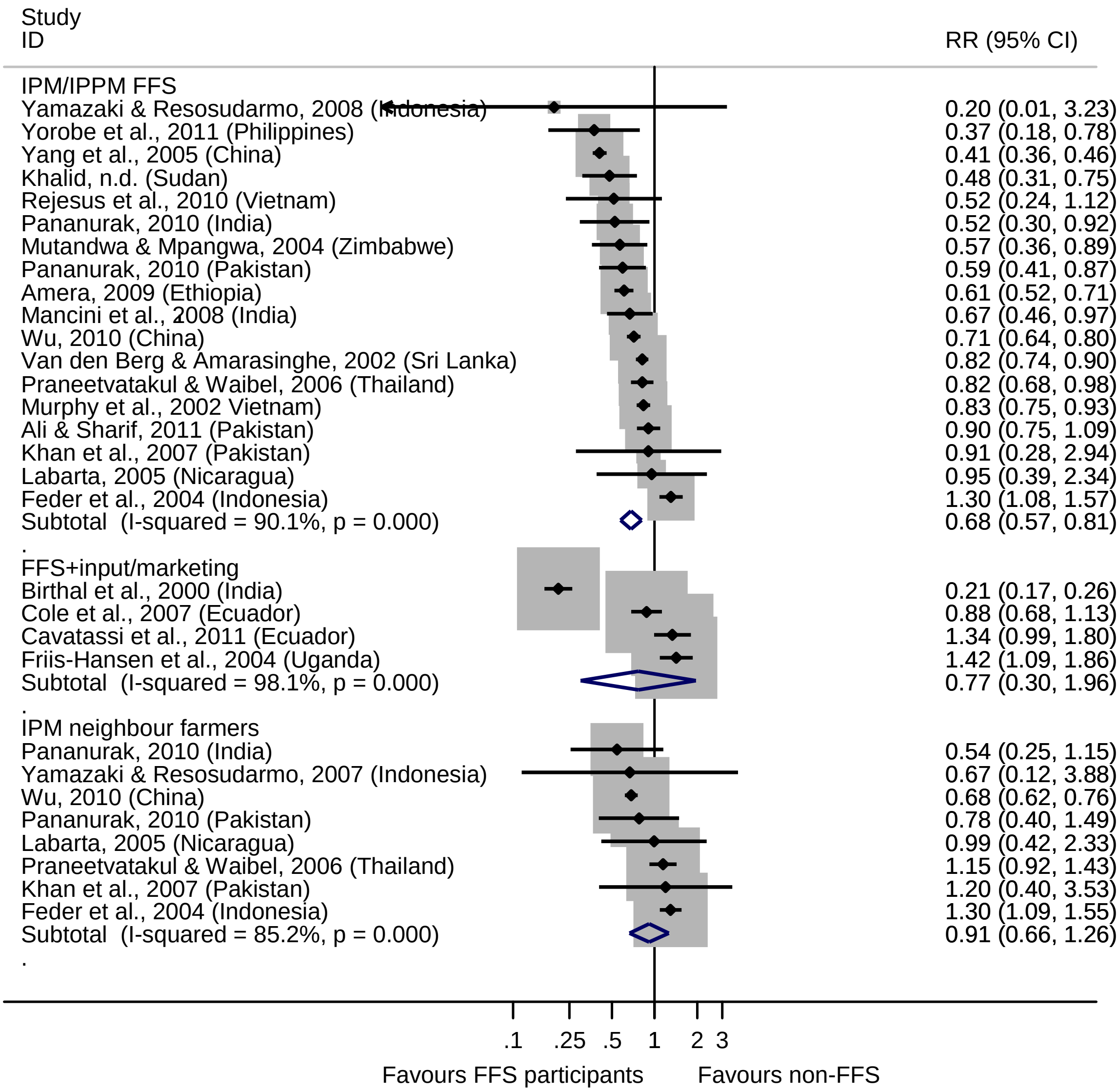


Table 9 Sensitivity analysis: pesticide use for IPM/IPPM FFS participants and neighbours

	RR	95% confidence interval		Q	Tau-sq	I-sq	P-value	Sample size
1. FFS participants: all studies	0.691	0.571	0.836	331	0.161	93.7%	0.000	22
Study type:								
Rigorous quasi-experimental study	0.804	0.650	0.994	53	0.077	81.1%	0.000	11
Cross-section regression (adjusted analysis)	No obs.							
Longitudinal data (unadjusted analysis)	0.687	0.482	0.979	0	0.000	0.0%	0.630	2
Cross-section data (unadjusted analysis)	0.614	0.45	0.839	243	0.210	96.7%	0.000	9

	RR	95% confidence interval		Q	Tau-sq	I-sq	P-value	Sample size
Risk of bias:								
Medium risk of bias	0.825	0.658	1.036	245	0.200	95.1%	0.000	13
Medium risk of bias (IPM/IPPM only)	0.772	0.613	0.974	40	0.069	82.7%	0.000	8
Medium risk of bias (excl. Feder, Yamazaki studies)	0.783	0.640	0.957	245	0.200	95.1%	0.000	11
High risk of bias	0.632	0.484	0.826	50	0.078	84.0%	0.000	9
Outcome measure:								
Pesticide use*	0.726	0.581	0.907	106	0.121	89.6%	0.000	12
Pesticide costs*	0.584	0.433	0.788	248	0.218	95.6%	0.000	12
Length of follow-up:*								
2 years or less	0.633	0.475	0.842	211	0.209	94.8%	0.000	12
More than 2 years	0.780	0.610	0.998	67	0.095	88.0%	0.000	9
2. FFS neighbours: all studies	0.913	0.663	1.257	47	0.123	85.2%	0.000	8
Study type:								
Rigorous quasi-experimental study	0.896	0.641	1.251	47	0.127	87.2%	0.000	7
Cross-section regression (adjusted analysis)	No obs.							
Longitudinal data (unadjusted analysis)	1.196	0.405	3.534	0	0.000	n/a	n/a	1
Cross-section data (unadjusted analysis)	No obs.							
Risk of bias:								
Medium risk of bias	0.945	0.644	1.388	45	0.136	91.2%	0.000	5
Medium risk of bias (excl. Feder, Yamazaki studies)	0.854	0.564	1.294	17	0.106	88.4%	0.000	3
High risk of bias	0.789	0.478	1.303	2	0.000	0.0%	0.407	3
Outcome measure:								
Pesticide use*	0.645	0.488	0.852	1	0.014	11.9%	0.287	2
Pesticide use (high risk of bias excluded)	No obs.							
Pesticide costs	0.905	0.644	1.272	47	0.129	87.3%	0.000	7
Pesticide costs (high risk of bias excluded)	0.945	0.644	1.388	45	0.136	91.2%	0.000	5
Length of follow-up:*								
2 years or less	0.691	0.624	0.765	2	0.000	0.0%	0.696	5
2 years or less (high risk of bias excluded)	0.687	0.619	0.762	0	0.000	0.0%	0.710	2
More than 2 years	1.231	1.073	1.413	1	0.000	0.0%	0.550	3
More than 2 years (high risk of bias excluded)	1.231	1.073	1.413	1	0.000	0.0%	0.550	3

Note: * 2 studies measuring both pesticide use and costs (Khan et al., 2007; Yang et al., 2005) are included in sub-group analysis by outcome measure.

We conducted additional analyses of moderators to explore the variation in findings across studies according to intervention and participating farmer characteristics (Table 10). The results suggest that the intervention characteristics which are associated with systematically smaller and insignificant impacts on pesticide use programmes implemented at national scale, programmes which involved complementary input or marketing components (as opposed to "pure" IPM/IPPM), and programmes in Latin America; in contrast, the results suggest impacts on pesticide use were biggest for cotton crops. We did not find differences for other variables describing intervention activities or length of implementation, with the exception of lack of impact for the single FFS for which it was clear that “farmer practice” control plots were not implemented (Labarta, 2005). However, the analysis by characteristics of participating farmers suggests socioeconomic status may affect pesticide adoption, as measured by education levels and landholdings. Field schools targeting women also seemed to have lower levels of adoption, although due to limited data available on many of the interventions and farmer characteristics variables, these results should be interpreted cautiously.

Figure 16 Pesticide use for FFS participants and neighbours excluding high-risk-of-bias studies

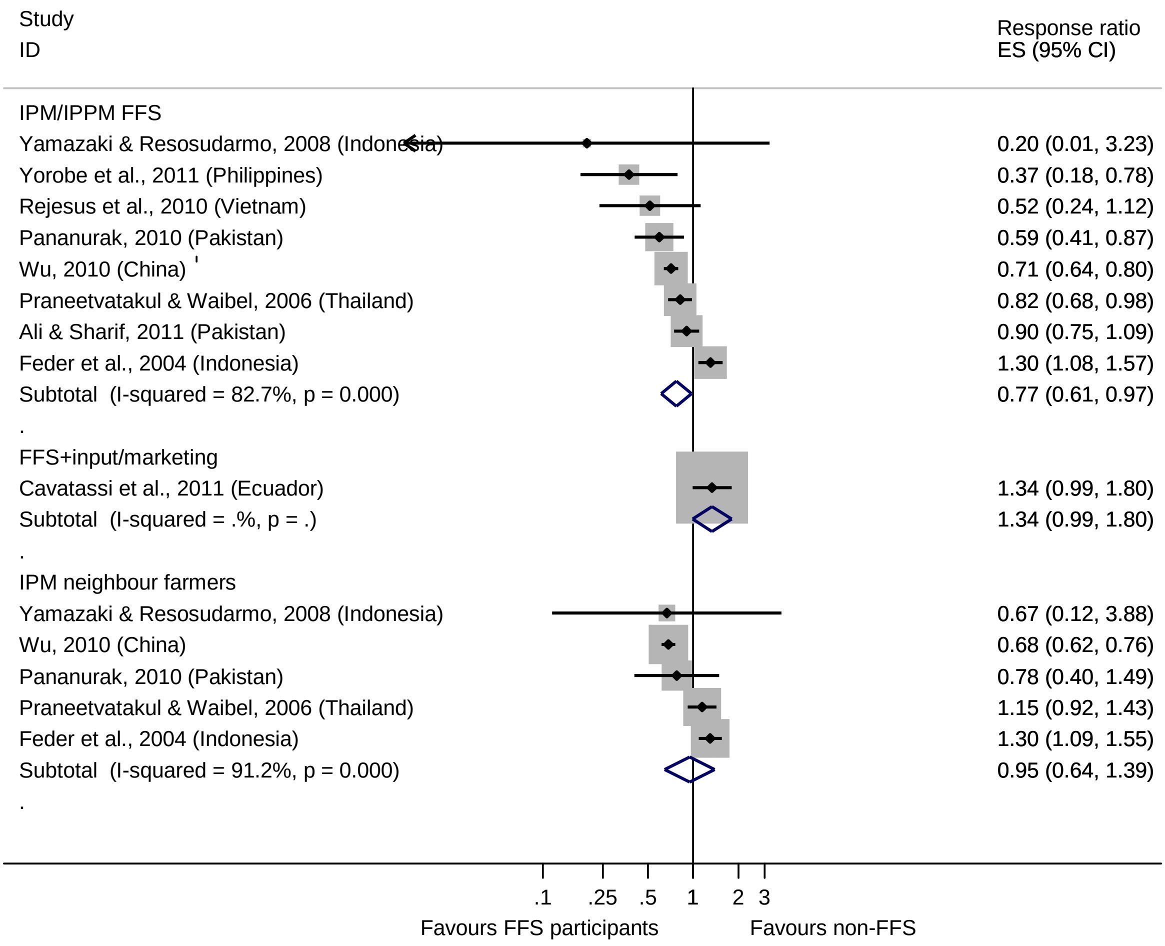


Table 10 Moderator analysis of pesticide use for IPM/IPPM FFS participants: intervention and farmer characteristics

	RR	95% confidence interval		Q	Tau-sq	I-sq	P-value	Sample size
FFS participants: all studies	0.691	0.571	0.836	331	0.161	93.7%	0.000	22
Curriculum:								
IPM-FFS	0.688	0.576	0.822	171	0.094	91%	0.000	17
IPPM-FFS	0.567	0.362	0.888	0	0.000	n/a	n/a	1
IPM/IPPM FFS+complementary inputs/marketing	0.767	0.300	1.958	158	0.897	98%	0.000	4
FFS design:								

	RR	95% confidence interval		Q	Tau-sq	I-sq	P-value	Sample size
Local curriculum development*	0.687	0.551	0.858	317	0.176	95%	0.000	18
Training-of-trainers programme for facilitators*	0.690	0.555	0.859	317	0.175	95%	0.000	18
Group formation*	0.725	0.587	0.894	175	0.116	93%	0.000	14
Participatory method of tuition*	0.838	0.626	1.122	43	0.108	84%	0.000	8
Local institutionalisation including training of farmer trainers*	0.695	0.549	0.882	302	0.168	96%	0.000	14
No local institutionalisation or training of farmer trainers*	0.576	0.230	1.441	2	0.264	60%	0.114	2
FAO involvement*	0.761	0.629	0.920	204	0.118	92%	0.000	17
FFS activities:								
Season-long weekly training*	0.631	0.496	0.803	134	0.137	91%	0.000	13
Uses “farmer practice” control plot*	0.729	0.553	0.962	163	0.168	94%	0.000	11
Does not use “farmer practice” control plot*	0.954	0.389	2.339	0	0.000	n/a	n/a	1
Agro-ecosystem analysis*	0.726	0.596	0.883	51	0.064	78%	0.000	12
Group dynamics activities*	0.754	0.609	0.934	45	0.064	85%	0.000	8
Special topic*	0.732	0.581	0.922	177	0.136	93%	0.000	13
Exchange visits*	0.815	0.758	0.876	3	0.000	0%	0.394	4
Field day*	0.767	0.619	0.952	184	0.113	94%	0.000	13
Years of implementation of FFS programme:								
2 years or less	0.672	0.527	0.856	283	0.188	95%	0.000	14
More than 2 years	0.691	0.571	0.836	39	0.121	82%	0.000	8
Scale of implementation of FFS programme:								
Programme implemented at national scale	0.779	0.322	1.887	7	0.374	71%	0.033	3
Pilot project or regional programme	0.675	0.556	0.819	286	0.149	94%	0.000	19
Region:								
Central Asia (CA)	No obs.							
East Asia (EA)	0.680	0.495	0.934	147	0.155	95%	0.000	8
Latin America (LA)	1.057	0.761	1.468	5	0.044	56%	0.105	3
South Asia (SA)	0.587	0.371	0.927	128	0.327	95%	0.000	7
Sub-Saharan Africa (SSA)	0.709	0.432	1.163	34	0.225	91%	0.000	4
Crop:								
Rice	0.887	0.677	1.161	23	0.056	82%	0.000	5
Other staples and vegetables	0.876	0.667	1.151	33	0.093	82%	0.000	7
Cotton	0.550	0.415	0.729	148	0.169	94%	0.000	10
Permanent crops	No obs.							
FFS farmer characteristics:								
Women farmers participated in FFS*	0.880	0.618	1.254	38	0.122	87%	0.000	6
Women farmers did not participate in FFS*	No obs.							
Farmer education years (greater than national average)*	0.647	0.454	0.922	122	0.208	93%	0.000	9
Farmer education years (not greater than national average)*	No obs.							
Farmer education years (greater than comparison)*	0.699	0.630	0.777	2	0.000	0%	0.659	4
Farmer education years (not greater than comparison)*	0.723	0.391	1.335	140	0.480	96%	0.000	6
Landholdings larger than comparison*	0.613	0.366	1.027	35	0.299	86%	0.000	6
Landholdings smaller than comparison*	0.814	0.442	1.499	17	0.282	82%	0.001	4

Note: * indicates data incomplete due to missing observations.

Sensitivity analysis for IPM-FFS neighbour farmers suggests that there may be diffusion in terms of reduced pesticide use for communities growing cotton over the short term (follow-up periods less than two years after FFS training), where FFS farmers are relatively highly educated. This finding is robust to exclusion of high-risk-of-bias studies (Table 11). The overall results also suggest diffusion effects among FFS communities in which participants had larger landholdings, although these findings are neither statistically significant nor robust to exclusion of high-risk-of-bias studies. It does not seem unreasonable to expect there to be diffusion of simple practices like reduced pesticide use due to interaction between FFS graduates and their communities, at least in the short term; indeed, as noted above, one study did find evidence for diffusion of "simple" knowledge (Ricker-Gilbert et al., 2008). However, those studies which examined sustainability found that any initial adoption among neighbouring farmers in terms of pesticide use fell within a few years (e.g. Wu, 2010, in China; Pananurak, 2010, in India). In addition, evidence from the one programme implemented at scale does not suggest any effects on diffusion (the Indonesia National IPM Programme evaluated by Feder et al., 2004 and Yamazaki & Resosudarmo, 2008). The findings in terms of diffusion should be interpreted with caution due to the limited sample size and problems of confounding in bivariate analysis. We also examined heterogeneity for FFS neighbour groups using intervention design variables which might reasonably be expected to foster diffusion (i.e. farmer exchanges and field days, efforts at local institutionalisation, FAO involvement, years of implementation of the programme), but did not find systematic differences across studies according to these characteristics, since many were poorly reported in the included studies and project documents we not available.

Table 11 Moderator analysis of pesticide use for IPM-FFS neighbours: intervention and farmer characteristics

	RR	95% confidence interval		Q	Tau-sq	I-sq	P-value	Sample size
IPM-FFS neighbours: all studies	0.913	0.663	1.257	47	0.123	85%	0.000	8
FFS design and activities:								
Local institutionalisation incl training of farmer trainers*	0.924	0.636	1.342	47	0.137	89%	0.000	6
No local institutionalisation or training of farmer trainers*	0.989	0.421	2.327	0	0.000	n/a	n/a	1
FAO involvement*	0.905	0.644	1.272	47	0.129	87%	0.000	7
Exchange visits*	0.848	0.505	1.425	0	0.000	0%	0.658	2
Field day*	0.966	0.688	1.357	46	0.126	87%	0.000	7
Years of implementation of FFS programme:								
2 years or less	1.147	0.920	1.429	0	0.000	n/a	n/a	1
More than 2 years	0.861	0.588	1.261	39	0.149	85%	0.000	7
Scale of implementation of FFS programme:								
Programme implemented at national scale	1.288	1.080	1.536	1	0.000	0%	0.462	2
Pilot project or regional programme	0.841	0.612	1.157	19	0.083	74%	0.002	6
Region:								
Central Asia (CA)	No obs.							
East Asia (EA)	0.980	0.637	1.507	45	0.145	93%	0.000	4

	RR	95% confidence interval		Q	Tau-sq	I-sq	P-value	Sample size
Latin America (LA)	0.989	0.421	2.327	0	0.000	n/a	n/a	1
South Asia (SA)	0.736	0.470	1.152	1	0.000	0%	0.488	3
Sub-Saharan Africa (SSA)	No obs.							
Crop:								
Rice	1.231	1.073	1.413	1	0	0%	0.550	3
Other staples and vegetables	0.989	0.421	2.327	0	0	n/a	n/a	1
Cotton	0.687	0.620	0.761	2	0	0%	0.675	4
Permanent crops	No obs.							
FFS farmer characteristics:								
Women farmers participated in FFS*	1.288	1.080	1.536	1	0.000	0%	0.462	2
Women farmers did not participate*	No obs.							
FFS farmer education years (greater than national average)*	0.879	0.537	1.440	4	0.173	92%	0.000	4
FFS farmer education years (greater than comparison)*	0.690	0.622	0.765	1	0.566	0%	0.000	3
FFS farmer education years (not greater than comparison)*	0.891	0.446	1.781	5	0.222	63%	0.069	3
FFS farmer education years (greater than comparison) (excluding high-risk-of-bias studies)*	0.687	0.619	0.762	0.1	0.000	0%	0.710	2
FFS farmer education years (not greater than comparison) (excluding high-risk-of-bias studies)*	1.288	1.080	1.536	0.1	0.000	0%	0.460	2
Landholdings larger than comparison*	0.613	0.366	1.027	35	0.299	86%	0.000	6
Landholdings smaller than comparison*	0.814	0.442	1.499	17	0.282	82%	0.001	4
Landholdings larger than comparison (excl high risk of bias)*	0.625	0.200	1.960	12	0.704	83%	0.003	3
Landholdings smaller than comparison (excl high risk of bias)*	0.578	0.411	0.812	0.1	0.000	0%	0.751	2

Note: * indicates data incomplete due to missing observations.

Finally, we explored robustness of effect size moderators in multivariate meta-regression analysis (Table 12). The analysis across the full sample (specification 1) suggests studies which were assessed as being of high risk of bias, which targeted cotton crops, were significantly associated with larger effects on pesticide use, while neighbour farmers had significantly smaller effects. We did not find significant correlations between effect size and whether studies measured outcomes by pesticide costs (rather than use), length of intervention and follow-up, or programme scale (results not reported). In a second meta-regression analysis for the subsample of studies in which education data were available (specification 2), we also tested for the association between years of education (continuous variable) and variation in effects on pesticide use. Due to the limited sample size we included only those variables found to be statistically significant in specification 1. The results suggest that FFS which targeted farmers with a relatively greater number of years of education, and those targeting cotton crops, were significantly associated with bigger decreases in pesticide use, both for FFS participants and IPM-FFS neighbours.

Table 12 Meta-regression analysis of pesticide use outcomes

	(1)	(2)

	Coefficient*	t-statistic	P>t	Coefficient*	t-statistic	P>t
1=Medium risk of bias	0.315	2.21	0.035	0.348	3.57	0.003
1=Cotton crop	-0.463	-3.64	0.001	-0.364	-2.44	0.028
1=Neighbour farmers	0.238	1.56	0.130			
1=Pesticide costs	-0.205	-1.48	0.149			
Average years of education				-0.147	-2.34	0.033
Constant	-0.147	-1.27	0.214	0.710	1.87	0.081
Number of obs		33			19	
Tau-squared		0.076			0.007	
I-squared		75.4%			37.0%	
Adjusted R-squared		58.3%			95.1%	
Model F		6.62			28.28	
Prob > F		0.001			0.000	

Notes: * coefficient estimates reported as natural logarithm. **Bold** indicates coefficient statistically significant at <10% level.

Other reported measures of practices adopted

Many studies, including those which were assessing field schools providing training in technologies other than IPM/IPPM, reported measures of numbers of improved practices adopted. Studies used a range of outcomes including indices of adoption and numbers of practices adopted, and probability of farmers adopting positive practices (Appendix E). Similar to the variables used to measure knowledge outcomes, given the lack of a natural scale in many such outcomes, we considered it appropriate to calculate standardised mean difference effect sizes.

The forest plot shows similar positive average impacts on adoption among FFS participants (SMD=0.63, 95% CI=0.32, 0.94; Q=3,192, Tau-sq=0.314, I-sq=99.6%; 14 observations) as compared with non-FFS farmers across the whole sample (Figure 17).[30] The findings do not suggest differences on average for IPM and other (non-IPM/IPPM) FFS curricula. No studies estimated effects on IPM-FFS neighbour farmers. The very high level of variability in effect sizes is likely to substantial between-study heterogeneity. Similar to other outcomes, we found medium risk of bias studies tended to produce effects of smaller magnitude (SMD=0.22, 95% CI=0.06, 0.38; Q=10, Tau-sq=0.02, I-sq=80%, 3 observations) than high risk of bias studies (Figure 18). Other factors relating to study design, effect size calculation and implementation appeared to be associated with variation in effects (Table 13), but we were unable to explain the variation in effects further using meta-regression analysis (results not reported).

[30] The forest plot showing programme names rather than authors is in Appendix G.

Figure 17 Beneficial practices adopted by IPM and other curricula FFS-participants

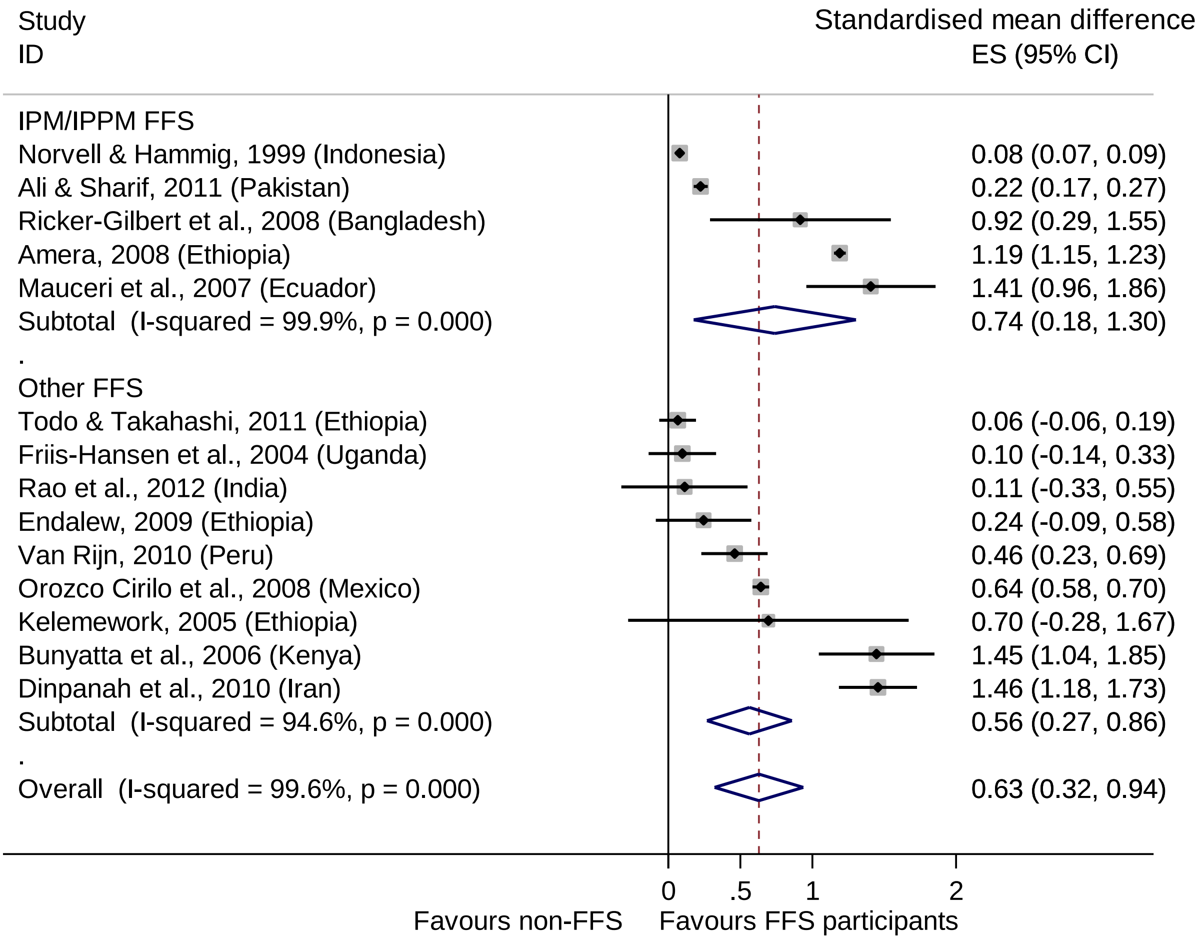


Figure 18 Beneficial practices adopted by risk of bias status

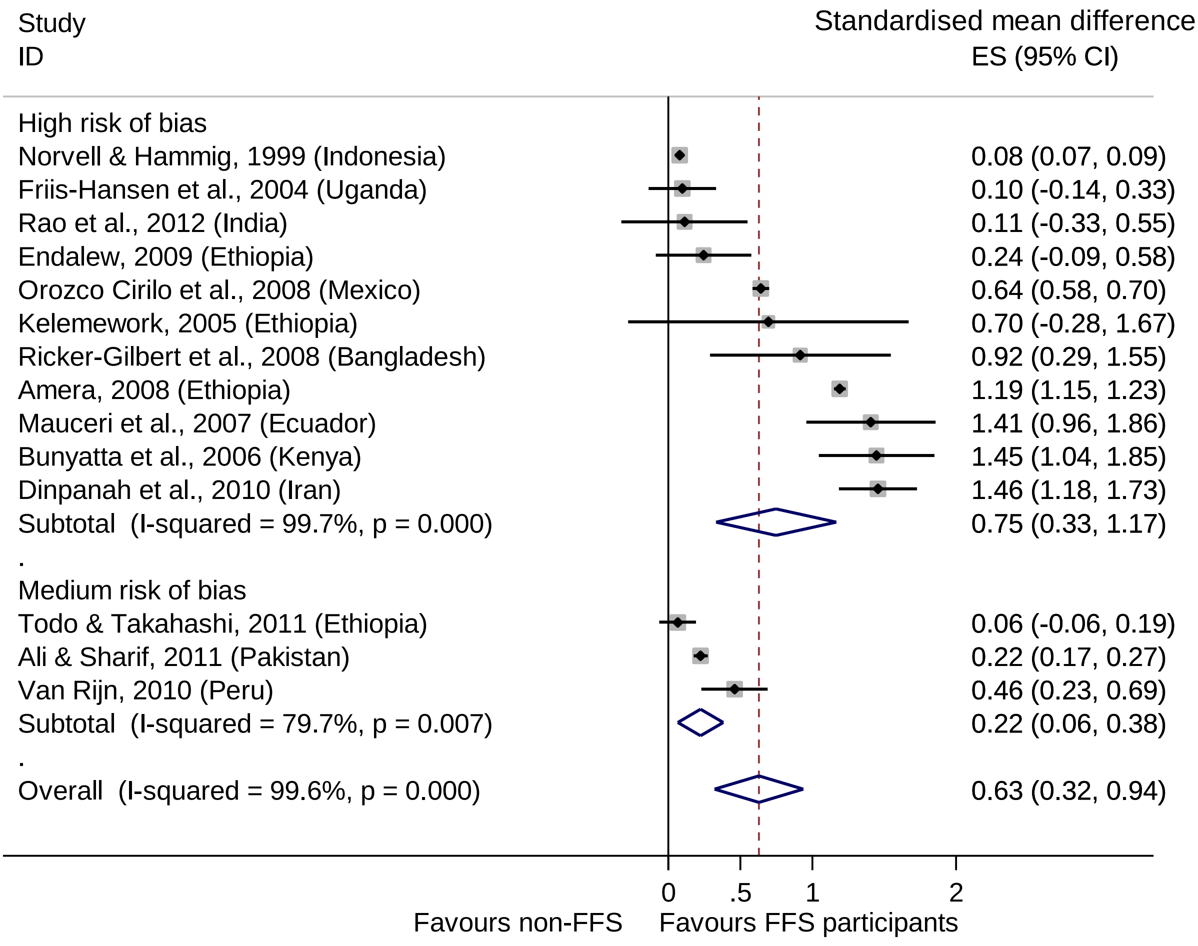


Table 13 Sensitivity analysis: other adoption measures

	SMD	95% confidence interval		Q	Tau-sq	I-sq	P-value	Sample size
FFS participants: all studies	0.630	0.321	0.938	3192	0.314	99.6%	0.000	14
FFS neighbours: all studies	No obs.							
Study type:								
Longitudinal data, DID analysis	0.064	-0.064	0.191	0	0.000	n/a	n/a	1
Longitudinal data (unadjusted analysis)	0.641	0.583	0.699	0.01	0.000	0%	0.913	2
Cross-section data, adjusted analysis	0.390	0.215	0.565	82	0.025	95.1%	0.000	5
Cross-section data (unadjusted analysis)	0.764	0.274	1.254	138	0.350	96.4%	0.000	6
Risk of bias:								
Medium risk of bias	0.223	0.064	0.381	10	0.015	79.7%	0.007	3
High risk of bias	0.748	0.330	1.166	3180	0.458	99.7%	0.000	11
Outcome measure:								
Index of adoption of practices	0.654	0.280	1.029	489	0.197	99.0%	0.000	6
Probability of adopting positive practices	0.575	0.072	1.078	1047	0.425	99.4%	0.000	7
Num positive practices adopted	0.917	0.287	1.546	0	0.000	n/a	n/a	1

	SMD	95% confidence interval		Q	Tau-sq	I-sq	P-value	Sample size
Effect size calculation:								
SMD (standard calculation)	0.789	0.261	1.317	135	0.519	94.8%	0.000	8
SMD (Cox adjusted OR/RR)	0.451	-0.006	0.907	3031	0.321	99.8%	0.000	6
Length of follow-up:*								
1 year or less	No obs.							
2 years or less	0.064	-0.664	0.191	0	0.000	n/a	n/a	1
More than 2 years	0.577	0.095	1.059	3057	0.446	99.8%	0.000	8
Curriculum:								
IPM (no IPPM observations)	0.740	0.176	1.304	2803	0.386	99.9%	0.000	5
Other curriculum	0.777	0.363	1.190	60	0.219	91.6%	0.000	6
FFS+complementary	0.196	-0.041	0.433	9	0.034	77.5%	0.012	3
Years of implementation of FFS programme:								
1 year or less	0.654	0.265	1.042	78	0.136	96.2%	0.000	4
More than 1 year	0.599	0.254	0.943	984	0.273	99.1%	0.000	10
Region:								
East Asia (EA)	0.077	0.066	0.088	0	0.000	n/a	n/a	1
Latin America (LA)	0.758	0.429	1.088	14	0.067	85.3%	0.001	3
Central Asia (CA)	1.456	1.184	1.728	0	0.000	n/a	n/a	1
South Asia (SA)	0.317	-0.007	0.642	5	0.050	59.2%	0.086	3
Sub-Saharan Africa (SSA)	0.615	-0.001	1.230	368	0.546	98.6%	0.000	6
Crop:								
Rice	0.795	-0.523	2.113	26	0.870	96.2%	0.000	2
Cotton	0.708	-0.240	1.656	877	0.468	99.9%	0.000	2
Coffee, tea, cocoa	0.386	0.186	0.586	1	0.002	8.8%	0.295	2
Other staples and vegetables	0.602	0.304	0.901	434	0.147	98.4%	0.000	8

Note: * indicates data incomplete due to missing observations.

Impacts on farmers' time use

A small number of IPM-FFS studies also measured the burden of labour time (Birthal et al., 2000; Tripp et al. 2005; Khan et al., 2007; Mancini & Jiggins, 2008; Wu, 2010), estimating increases with adoption in India (Birthal et al., 2000; Mancini & Jiggins, 2008). Birthal et al. (2000) noted that the increased time burden may be due to both time monitoring crops as well as harvesting bigger yields. The study found an increase of 25 per cent in labour time on IPM cotton farms as compared with farms using pesticides, only about one-tenth of which was borne by women handpicking insect larvae, while one-third was due to time harvesting larger yields on FFS farms. However, the study was classified as high risk of bias because the FFS had a larger average farm size and more irrigation than the comparison group, and these differences were not controlled in the analysis. Mancini and Jiggins (2008) noted the burden of time for plant protection shifted towards women household members in India, and suggested therefore that availability of women might be a factor determining adoption of

IPM. Indeed, the relative costs of pesticide and labour may be important factors determining adoption. One study with medium risk of bias which found modest effects on outcomes noted pesticide costs were not a high share of variable production costs and dwarfed by costs of labour (Praneetvatakul & Waibel, 2006). In this study, farmers with more farm area per household member were also more likely to drop out of field school training due to labour shortages and high opportunity costs of labour.

Agriculture outcomes (primary outcomes)

Agricultural outcomes were measured in terms of yields (production per unit of land area cultivated, or its monetary value) or net revenues (value of production less cost per unit area of land) (Appendix E). To take a few examples, Feder et al. (2004), Rejesus et al. (2010), Pananurak (2010) and Wu (2010) measured production per unit of land; Ali and Sharif (2012) measured total production; Davis et al. (2012) measured the monetary value of yields, which also captures output prices; Pananurak (2010) and Labarta (2005) measured net revenues, which capture both production but also (input and output) prices. We calculated the response ratio (RR) for agriculture outcomes, positive impacts being measured as values of RR significantly greater than 1.

Impacts on yields

Meta-analysis findings suggest that FFS training does on average lead to higher yields among FFS graduates as compared with non-FFS farmers, both for IPM/IPPM and other field school training (including other production techniques and/or additional input or marketing support) (Figure 19).

There appears to be substantial between-study heterogeneity (as measured by I-squared). Sensitivity analyses (Table 14) to explore possible sources of heterogeneity proceeded as per other outcomes. For IPM/IPPM FFS participants, we found average effects to be small but statistically significant for medium risk of bias studies, representing an estimated increase of 13 per cent in yields on average (RR=1.13, 95% CI=1.04, 1.22; Q=53, Tau-sq=0.008, I-sq=81%; 11 observations) (Figure 20). Similarly, we estimated average effects to be smaller for more rigorous quasi-experimental evaluation designs, and for outcomes measured in terms of yields as opposed to monetary measures of output. For outcomes measured at follow-up periods longer than two years (excluding high-risk-of-bias studies), there is no evidence for statistically significant effects on yields. Moderator analysis suggests FFS have been relatively more successful in boosting yields of staples and vegetables in Africa using IPPM curriculum. Outcomes for FFS neighbours were fairly homogeneous across studies and analysis does not suggest outcomes are sensitive either to risk of bias or length of follow-up.

We did not find evidence for spillovers to neighbour farmers living within FFS communities across all studies (RR=1.00, 95% CI=0.98, 1.03; Q=13, Tau-sq=0.000, I-sq=53%; observations=7) (Figure 19), when we exclude high-risk-of-bias studies (RR=1.02, 95% CI=0.97, 1.08; Q=9, Tau-sq=0.002, I-sq=66%; 4 observations) (Figure 20) or indeed for the majority of individual studies.[31]

[31] The forest plot showing programme names rather than authors is in Appendix G.

Figure 19 Yields for IPM/IPPM and other FFS farmers and IPM neighbours versus non-FFS comparison

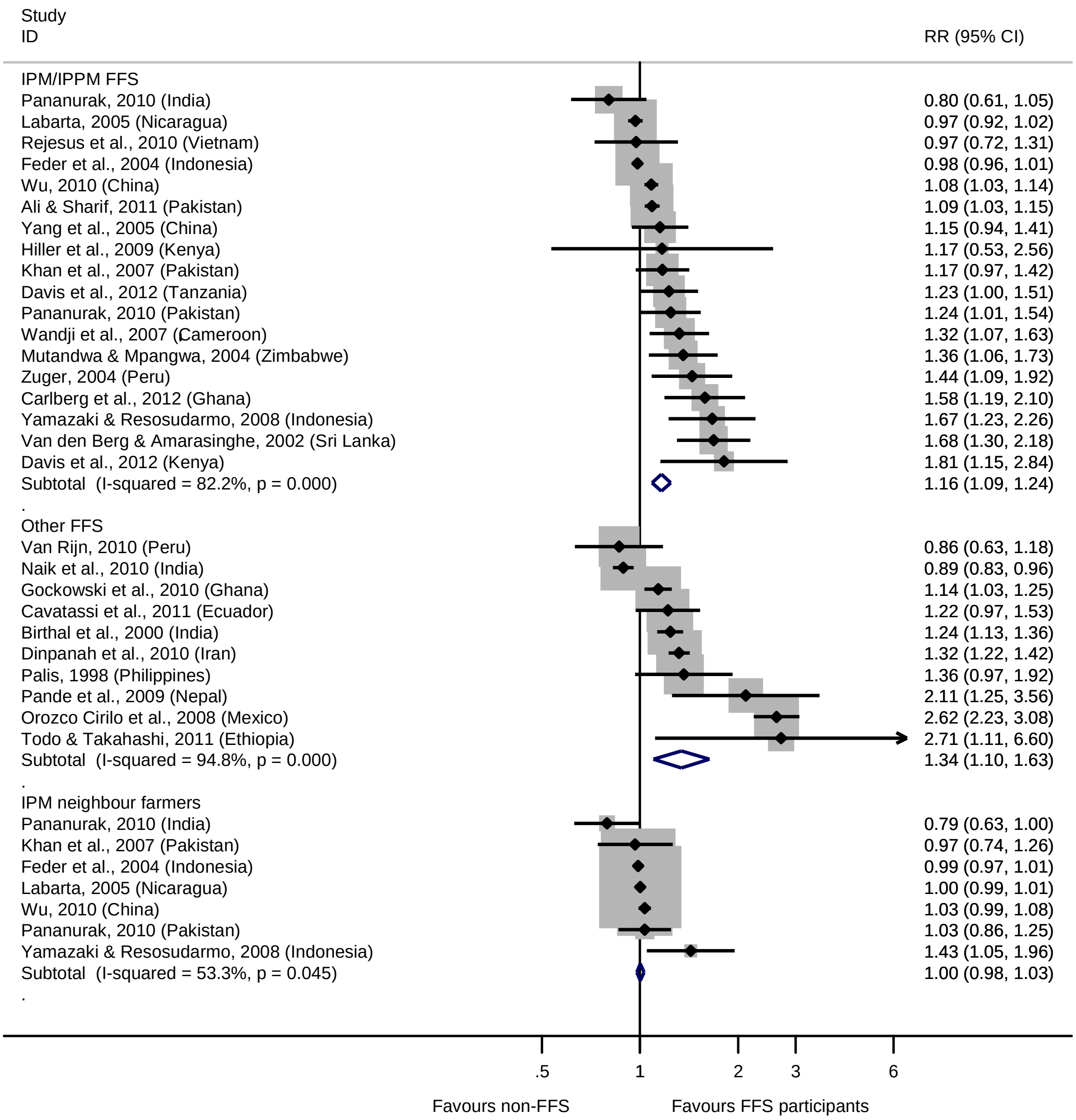
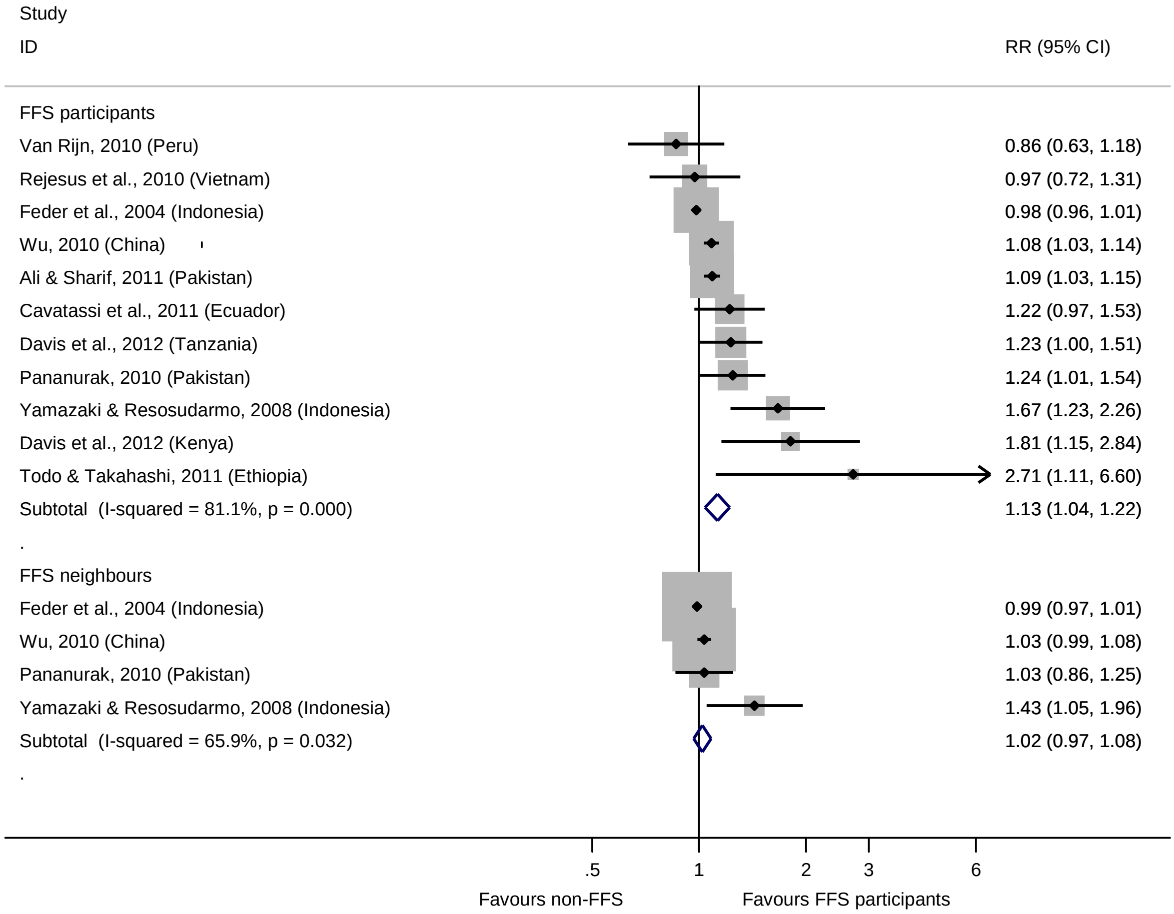


Figure 20 Yields for FFS participants and neighbours: excluding high-risk-of-bias studies



Notably, as indicated in Table 14, we did not find significant effects for FFS participants (nor neighbours – results not reported) for the two programmes implemented at national scale (Indonesia and Vietnam National IPM Programmes). Two studies replicated analysis of the Indonesian data (Feder et al., 2004 and Yamazaki & Resosudarmo, 2008), coming to different conclusions regarding effectiveness in terms of agricultural outcomes. Feder et al. (2004) found no effect of FFS on trained or exposed farmers' adoption of reduced pesticides or rice yields, mentioning poor implementation delivery as a possible explanation for poor performance (although not providing any evidence of this). They suggested scaling up of the programme may have had a negative effect on the average quality of trainers and their commitment to bottom-up approaches, given many of them may have been experienced extensionists trained to deliver using top-down methods in the past. Moreover, they noted that delays in transfers of funds to the field training organisers meant that FFS were not fully synchronised with the rice-growing season calendar and supplies of materials were irregular, and suggested that this may have had a negative impact on the quality of knowledge achieved by FFS graduates.

Table 14 Yields sensitivity analysis

	RR	95% confidence interval		Q	Tau-sq	I-sq	P-value	Sample size
1. FFS participants: all studies	1.233	1.145	1.326	315	0.026	91.4%	0.000	28
Study design:								
"High quality" evaluation design	1.098	1.026	1.175	66	0.007	81.9%	0.000	13
Cross-section regression	1.238	1.075	1.426	4	0.002	16.8%	0.307	4
Longitudinal data (unadjusted analysis method)	1.533	0.917	2.561	44	0.234	93.2%	0.000	8
Cross-section data (unadjusted analysis method)	1.280	1.069	1.532	77	0.047	92.2%	0.000	7
Risk of bias:								
Medium risk of bias	1.126	1.040	1.218	53	0.008	81.1%	0.000	11
Medium risk of bias (excluding Feder, Yamazaki)	1.124	1.046	1.207	15	0.004	47.6%	0.054	9
Medium risk of bias (excluding Feder, Yamazaki, Rejesus)	1.134	1.052	1.222	15	0.004	52.2%	0.041	8
High risk of bias	1.294	1.136	1.474	234	0.060	93.2%	0.000	17
Outcome measure:								
Yields (production per unit of land)	1.225	1.128	1.331	285	0.027	92.3%	0.000	23
Monetary value of production or sales*	1.442	1.172	1.775	50	0.055	89.9%	0.000	6
Length of follow-up:*								
2 years or less	1.173	1.089	1.264	57	0.012	73.8%	0.000	16
2 years or less (excl high risk of bias)	1.235	1.076	1.417	12	0.014	58.3%	0.035	6
More than 2 years	1.326	1.053	1.671	184	0.093	96.2%	0.000	8
More than 2 years (excl high risk of bias)	1.068	0.854	1.336	12	0.037	75.0%	0.007	4
2. FFS neighbours: all studies	1.003	0.978	1.028	13	0.000	53.3%	0.045	7
Risk of bias:								
Medium risk of bias	1.022	0.965	1.082	9	0.002	65.9%	0.032	4
High risk of bias	0.946	0.828	1.082	4	0.008	49.1%	0.140	3
Length of follow-up:*								
2 years or less	1.007	0.973	1.043	6	0.001	33.9%	0.196	5
More than 2 years	1.151	0.804	1.646	5	0.056	81.7%	0.019	2

Note: * indicates data incomplete due to missing observations.

Yamazaki and Resosudarmo (2008) re-analysed the data from Feder et al. (2004), but additionally controlled for time exposed to FFS prior to FFS training, since FFS were carried out in the same villages for different farmers over a number of seasons, and time after graduation. This was in principle a sensible approach, given the authors' hypothesis about bigger short-term rather than longer-term effects, and they did find that allowing for time variables produced positive impacts of FFS training on rice yields in the short term. However, like Feder et al. (2004), they did not find any significant impact on adoption as measured by changes in pesticide costs (as reported in Figure 15).[32] We examined sensitivity of our findings by excluding these studies from analysis, in part because of potential spillovers suggested by Van den Berg and Jiggins (2007). Our results were insensitive to their exclusion (Table 14), as well as exclusion of studies with possibilities for other studies

[32] Yamazaki and Resosudarmo (2008) used a number of different specifications including a "spatial lag model" maximum likelihood model, which found significantly positive impacts on reducing pesticide costs, although this model was rejected in favour of the coefficients reported here on risk of bias grounds.

with possible spillovers (Rejesus et al., 2010) and active control groups (Davis et al., 2012 in Uganda) (see forest plots in Appendix G).

We conducted additional moderator analyses to assess whether findings vary by FFS curriculum, length of implementation, crop, region and farmer characteristics (Table 15). Due to the important policy relevance of the outcome, we examined whether findings differed when we excluded high-risk-of-bias studies, and we limit the following discussion to these results. We were able to identify significantly positive impacts among FFS graduates on yields for IPM-FFS training (9% increase; 6 observations) and FFS with complementary input or marketing support (20% increase; 3 observations), growing cotton (9% increase; 3 observations) and other staples/vegetables (37% increase; 4 observations). In addition, FFS which had been implemented for longer than two years experienced more significant effects (17% increase; 6 observations) than those which had been operating for less (no significant difference; 5 observations). However, there was no evidence for effects in programmes operating at national scale (no significant difference; 3 observations). We also found that only field schools which involved farmers of relatively high education levels exhibited significantly positive impacts on yields (9% increase; 3 studies), although we did not find any significant differences for landholdings. We were not able to identify significantly positive effects on average for any other sub-groups, due to the limited numbers of studies available.

Consistent with the moderator analysis for adoption, we did not find significantly positive effects for rice FFS on yields. One study suggested that additional yield gain in technologically advanced rice production systems might be small and difficult to measure by recall surveys (Praneetvatakul & Waibel, 2006). In contrast, we estimated significant effects for cotton farmers in terms of both adoption and yields. Two of these studies based on evaluations of (genetically modified) Bt cotton programmes (Pananurak, 2010; Wu, 2010) found benefits of high yields and reduced pesticide use in incorporating improved seeds in the FFS curriculum.

Table 15 Yields moderators analysis for FFS participants: excluding high-risk-of-bias studies

	RR	95% confidence interval		Q	Tau-sq	I-sq	P-value	Sample size
1. FFS-participants: all studies	1.233	1.145	1.326	315	0.026	91.4%	0.000	28
Curriculum:								
IPM	1.117	1.045	1.194	72	0.008	83.3%	0.000	13
IPPM	1.373	1.206	1.563	4	0.000	0.0%	0.447	5
Other curriculum	1.446	0.895	2.335	159	0.176	98.7%	0.000	3
FFS+complementary inputs/marketing support	1.219	1.074	1.383	14	0.013	57.8%	0.027	7
Years of implementation of FFS programme:								
2 years or less	1.308	1.157	1.479	198	0.051	91.9%	0.000	17
More than 2 years	1.104	1.024	1.190	51	0.007	80.3%	0.000	11
Scale of implementation of FFS programme:								
Programme implemented at national scale	1.142	0.848	1.536	11	0.055	82%	0.004	3
Pilot project or regional programme	1.254	1.151	1.366	250	0.033	90%	0.000	25

	RR	95% confidence interval		Q	Tau-sq	I-sq	P-value	Sample size
Region:								
Central Asia (CA)	1.318	1.223	1.421	0	0.000	n/a	n/a	1
East Asia (EA)	1.103	0.999	1.217	28	0.008	82.2%	0.000	6
Latin America (LA)	1.314	0.838	2.062	141	0.251	97.2%	0.000	5
South Asia (SA)	1.155	1.010	1.321	60	0.027	88.3%	0.000	8
Sub-Saharan Africa (SSA)	1.322	1.168	1.495	12	0.012	44.0%	0.000	8
Crop:								
Rice	1.333	1.094	1.624	89	0.052	93.3%	0.000	7
Other staples & veg	1.412	1.113	1.792	180	0.110	95.5%	0.000	9
Cotton	1.133	1.063	1.208	17	0.004	58.1%	0.019	8
Permanent crops	1.133	0.975	1.316	5	0.009	39.4%	0.175	4
FFS Farmer characteristics:								
Women farmers participated in FFS*	1.308	1.110	1.542	55	0.039	87%	0.000	8
Women did not participate*	No obs.							
Farmer education years exceeds local average*	1.180	1.085	1.283	14	0.006	49.0%	0.057	8
Farmer education years does not exceed local average*	1.142	0.967	1.348	26	0.031	81.1%	0.000	14
Landholdings exceed local average*	1.060	0.877	1.282	19	0.033	78.6%	0.001	5
Landholdings do not exceed local average*	1.217	1.105	1.341	9	0.005	32.4%	0.181	7
FFS participants: excluding high-risk-of-bias studies	1.126	1.040	1.218	53	0.008	81.1%	0.000	11
Curriculum:								
IPM	1.090	1.005	1.182	35	0.006	85.8%	0.000	6
IPPM	1.413	0.981	2.036	2	0.044	57.8%	0.124	2
Other curriculum	No obs.							
FFS+complementary inputs/marketing support	1.198	0.793	1.810	7	0.085	71.5%	0.030	3
Years of implementation of FFS programme:								
2 years or less	1.084	0.936	1.256	8	0.012	47.9%	0.104	5
More than 2 years	1.166	1.045	1.302	37	0.011	86.6%	0.000	6
Scale of implementation of FFS programme:								
Programme implemented at national scale	1.142	0.848	1.536	11	0.055	82%	0.004	3
Pilot project or regional programme	1.134	1.052	1.222	15	0.004	52%	0.041	8
Region:								
Central Asia (CA)	No obs.							
East Asia (EA)	1.073	0.963	1.196	23	0.007	87.1%	0.000	4
Latin America (LA)	1.043	0.744	1.461	3	0.040	67.6%	0.079	2
South Asia (SA)	1.117	1.010	1.235	1	0.003	29.3%	0.234	2
Sub-Saharan Africa (SSA)	1.579	1.057	2.359	5	0.071	58.5%	0.090	3
Crop:								
Rice	1.142	0.848	1.536	2	0.055	82.3%	0.004	3
Other staples and vegetables	1.367	1.098	1.702	5	0.020	43.6%	0.150	4
Cotton	1.091	1.053	1.130	2	0.000	0.0%	0.465	3
Permanent crops	0.862	0.631	1.178	0	0.000	n/a	n/a	1
FFS farmer characteristics:								
Women farmers participated in FFS*	1.251	0.924	1.693	18	0.074	83.6%	0.000	4
Women did not participate*	No obs.							

	RR	95% confidence interval		Q	Tau-sq	I-sq	P-value	Sample size
Farmer education years exceeds local average*	1.091	1.029	1.157	2	0.000	4.5%	0.351	3
Farmer education years does not exceed local average*	1.220	0.911	1.632	15	0.055	86.3%	0.001	3
Landholdings exceed local average*	1.131	0.903	1.415	16	0.040	81.7%	0.001	4
Landholdings do not exceed local average*	1.247	0.938	1.658	5	0.039	61.8%	0.073	3

Note: * indicates data incomplete due to missing observations.

The positive estimated effects of FFS for shorter-term studies (and conversely insignificant effects for longer-term studies) were found for both adoption and yields outcomes. However, most data are from indirect comparisons over programmes in different contexts with different follow-up periods. Several studies directly compared impacts over short and longer time periods among the same farmers. Praneetvatakul and Waibel (2006) reported impacts at one and three years after the intervention for FFS farmers in the Philippines, while Pananurak (2010) and Wu (2010) reported impacts at one and four-year follow-ups in China. Neither found significant differences in impacts for yields (or adoption) over these time periods, and both concluded FFS graduates retained their knowledge and continued applying IPM practices over time. However, more long-term impact evaluations are necessary to assess whether benefits are indeed sustained over time as these authors suggest.

We also examined heterogeneity of diffusion from IPM field schools to non-participating neighbour farmers (Table 16). The only studies which measured diffusion did so for programmes which had been implemented for more than two years. An initial positive diffusion effect found in China was not sustained (Wu, 2010), with both yield and knowledge gains in the neighbouring farmer groups diminishing considerably over time.[33]

Table 16 Yields moderator analysis for IPM-FFS neighbours

	RR	95% confidence interval		Q	Tau-sq	I-sq	P-value	Sample size
FFS neighbours: all studies	1.003	0.978	1.028	13	0.000	53.3%	0.045	7
Years of implementation of FFS programme:								
2 years or less	No obs.							
More than 2 years	1.003	0.978	1.028	13	0.000	53.3%	0.045	7
Region:								
Central Asia (CA)	No obs.							
East Asia (EA)	1.023	0.959	1.092	9	0.002	77%	0.013	3
Latin America (LA)	1.002	0.992	1.011	0	0.000	n/a	n/a	1
South Asia (SA)	0.934	0.794	1.098	3	0.007	36%	0.210	3
Sub-Saharan Africa (SSA)								
Crop:								
Rice	1.151	0.804	1.646	5	0.056	82%	0.019	2

[33] Yamazaki and Resosudarmo (2008) also found initial productivity gains for rice yields in Indonesia diminished for both FFS graduates and neighbour farmers, as compared with non-FFS farmers.

	RR	95% confidence interval		Q	Tau-sq	I-sq	P-value	Sample size
Other staples and vegetables	1.002	0.992	1.011	0	0.000	n/a	n/a	1
Cotton	0.987	0.891	1.094	5	0.005	40%	0.170	4
Permanent crops	No obs.							
FFS farmer characteristics:								
Women farmers participated in FFS*	1.151	0.804	1.646	5	0.056	82%	0.019	2
Women did not participate*	No obs.							
FFS farmer education years exceeds local average*	1.033	0.990	1.077	0.2	0.000	0%	0.886	3
FFS farmer education years does not exceed local average*	1.013	0.802	1.278	9	0.032	78%	0.011	3
Landholdings exceed local average*	1.013	0.802	1.278	9	0.032	78%	0.011	3
Landholdings do not exceed local average*	1.012	0.869	1.178	0.2	0.000	0%	0.682	2

Note: * indicates data incomplete due to missing observations.

In the final analysis of yields, we attempted to explain the heterogeneity using meta-regression (Table 17). Specification 1, which includes the full sample of 35 studies reporting yields effect sizes, confirms much of the bivariate analysis, namely staples and vegetable crops tended to exhibit the biggest impacts, rigorous quasi-experimental studies tend to show significantly smaller impacts than other studies, and publication bias due to small study effects may be present (as indicated by Egger's regression test).

Table 17 Meta-regression analysis of agricultural yields

	(1)		(2)		(3)		(4)	
	Coeff*	P>t	Coeff*	P>t	Coeff*	P>t	Coeff*	P>t
1='Rigorous' quasi-exp study	-0.155	0.071	-0.225	0.026	-0.014	0.866		
1=Neighbour farmers	-0.083	0.410	-0.083	0.445	-0.081	0.244		
1=Rice crop	0.159	0.104	0.388	0.024	0.389	0.019	0.331	0.027
1=Other staples/vegetables	0.192	0.046	0.245	0.026	0.283	0.065	0.307	0.040
Length of follow-up (years)			-0.054	0.119	-0.088	0.040	-0.077	0.053
Average education (years)					0.116	0.018	0.116	0.009
Log of standard error (Egger coefficient)	1.280	0.028	1.427	0.025	1.204	0.102	1.119	0.089
Constant	0.070	0.437	0.187	0.146	-0.652	0.055	-0.677	0.019
Number of obs	35		31		18		18	
Tau-squared	0.037		0.039		0.007		0.004	
I-squared	86.6%		86.0%		53.5%		47.9%	
Adjusted R-squared	30.1%		33.1%		45.3%		69.8%	
Model F	3.80		3.39		2.58		3.31	
Prob > F	0.009		0.014		0.085		0.042	

Notes: coefficient estimates reported as natural logarithm. Bold indicates coefficient statistically significant at 10% level.

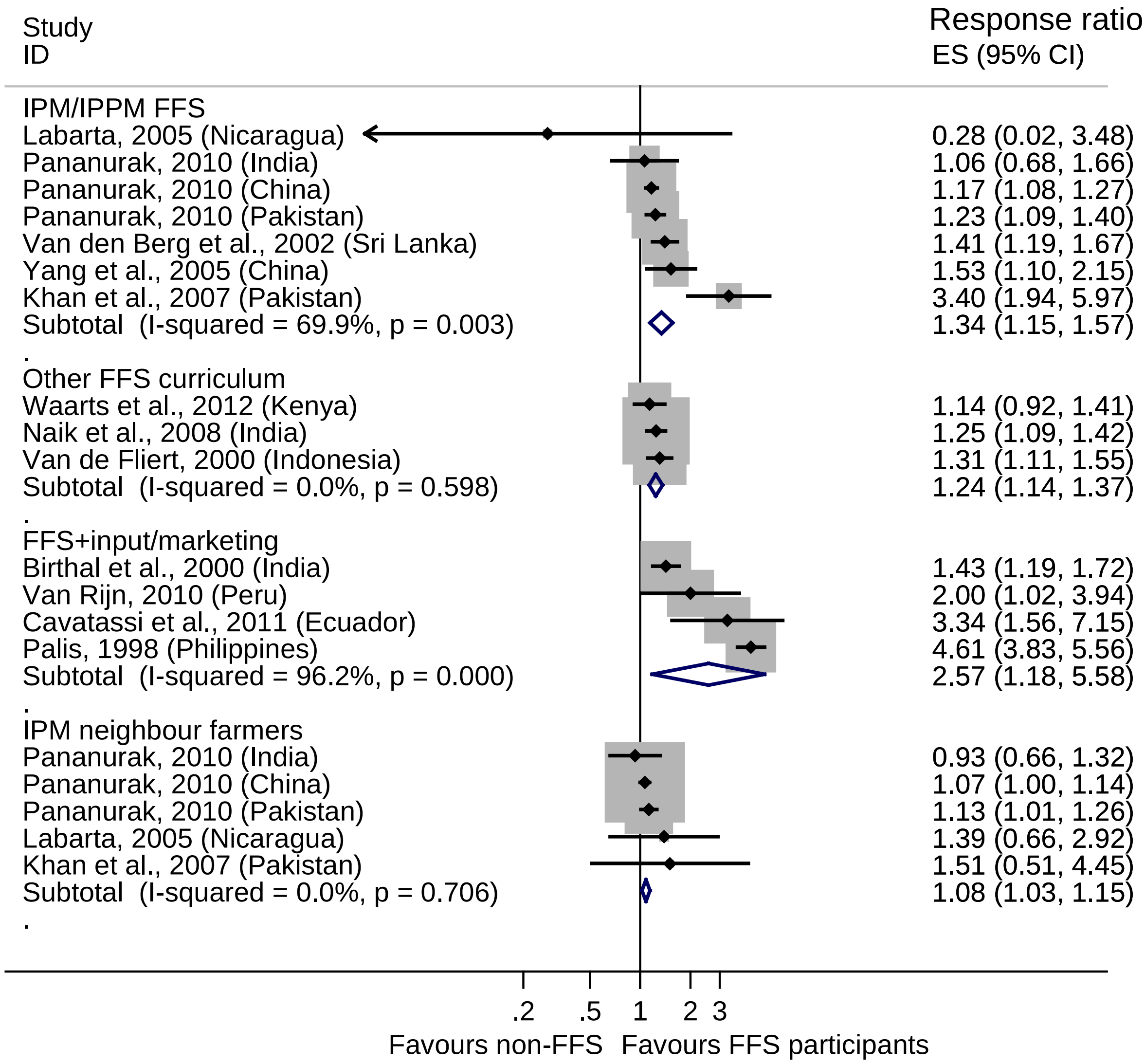
Specifications 2 adds follow-up period and specification 3 additionally includes average education of FFS-participants (both variables are measured in years); these specifications reduce the sample size due to missing observations. To conserve degrees of freedom, the fourth specification excludes variables which are not statistically significant in specification 3. The analysis suggests impacts measured over longer periods were generally smaller while impacts were significantly bigger for more educated farmer participants. As per other outcome variables, years of education significantly increased the explanatory power of the model, suggesting field schools which targeted better educated farmers were also more effective in improving yields. In addition, an interaction between FFS-participant education and the neighbour farmer dummy variable is not statistically significant (results not reported), suggesting that field schools targeting better educated farmers may also have been more effective in promoting diffusion to neighbours. However, given the small sample size and relative instability of coefficients over specifications, these results should be interpreted cautiously. Until further evidence becomes available on the relationship between programme effects and characteristics of participating farmers such as education, income and social standing, we will not be able to conclude whether targeting farmers of higher socioeconomic status does lead to bigger increases in agricultural outcomes for FFS participants or neighbours.

Impacts on net revenue

It is possible that the production technologies promoted in FFS may lead to improved net revenues or profits (monetary value of production less costs), even where they do not improve yields, due to reduced reliance on pesticides and other purchased inputs.[34] We differentiated FFS programmes providing only training in IPM and those providing training in other (non-IPM/IPPM) curricula, from “FFS-plus” programmes which provided additional components of support for inputs and/or marketing (Figure 21).[35] At least two points are worth noting here, the first being that the impacts on net revenues are larger in magnitude than yields, as we might also expect based on the bigger average impacts on pesticide expenditure than pesticide use. For the “FFS-plus inputs/marketing” farmer group in particular, we estimated revenues on average to be 150 per cent greater, although over a small sample size with wide dispersion in the pooled confidence interval (RR=2.57, 95% CI=1.18, 5.58; 4 observations) and substantial estimated heterogeneity due to contextual factors (I-squared=96%, Tau-squared=0.56). For IPM-FFS participants,[36] revenues increased by a lesser amount. The results were sensitive to exclusion of high-risk-of-bias studies (Figure 22 and Table 18); for medium-risk-of-bias studies we estimated revenues to increase by 19 per cent on average (RR=1.19, 95% CI=1.11, 1.27; Q=1, Tau-sq=0, I-sq=0%; 2 observations).

[34] Assuming, due to small farm size, any additional costs of labour are either met through in-kind contributions of family members or that costs of hired labour do not outweigh revenue gains.
[35] The forest plot showing programme names rather than authors is in Appendix G.
[36] We were not able to locate any studies of IPPM-FFS which measure revenues outcomes.

Figure 21 Net revenues for FFS farmers and neighbours versus non-FFS comparison



A second point of note is that the pooled effect size suggests that there may have been spillovers to non-participant neighbour farmers, although only partially in terms of magnitude of effect as compared with FFS graduates (RR=1.08, 95% CI=1.03, 1.15; Q=1, Tau-sq=0, I-sq=0%; 2 observations). However, the analysis excluding high-risk-of-bias studies (Figure 22) comprises only two interventions in China and Pakistan (Pananurak, 2010), both of which found positive effects in terms of revenues which were not reflected either in reductions in pesticide use or in improved yields, casting doubt on the credibility of the findings. In contrast, the increase in revenues for FFS participants in the same study was mirrored by improvements in both yields and pesticide reduction.

The sensitivity and moderators analysis (Table 18) suggests that there may be differences in impacts on net revenues by crop, region and curriculum, but there were simply too few rigorous studies to draw conclusions.

Figure 22 Net revenues excluding high-risk-of-bias studies

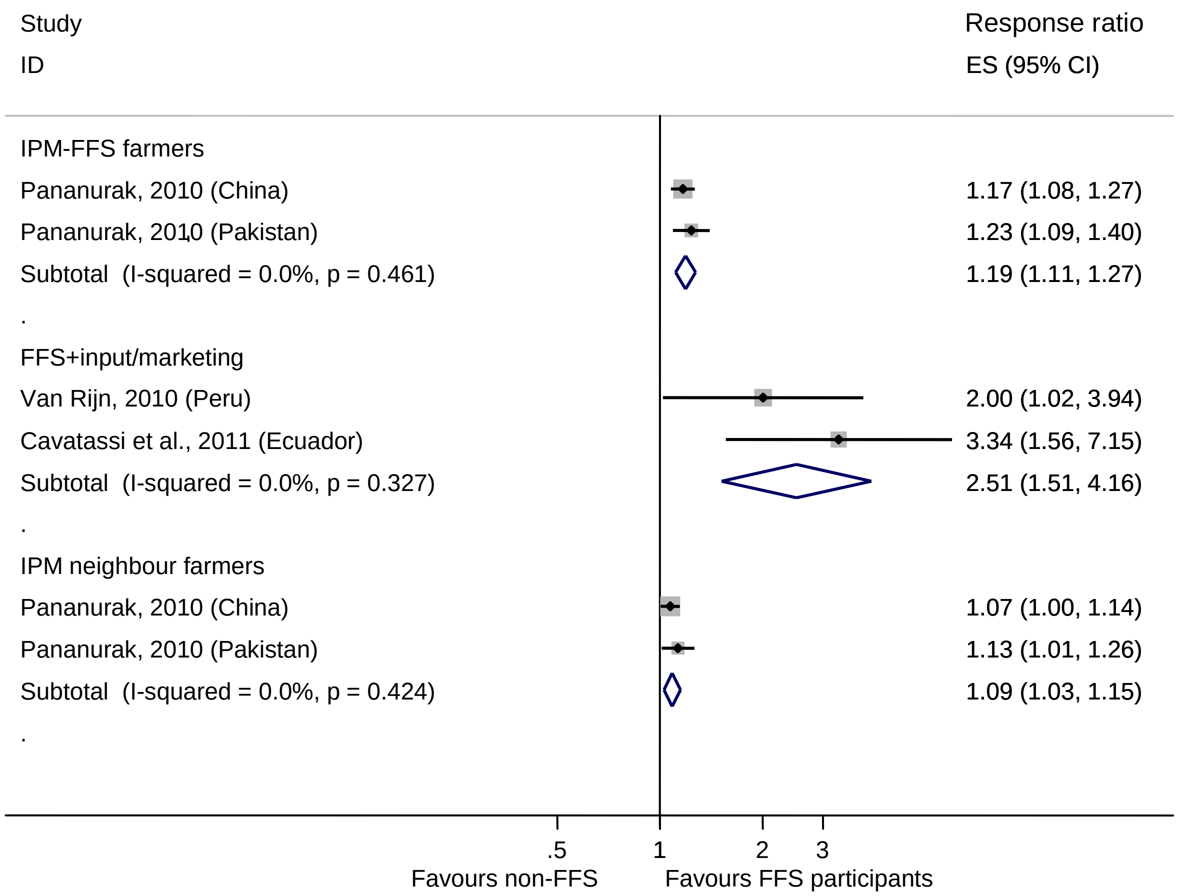


Table 18 Net revenues: sensitivity and moderator analyses

	RR	95% confidence interval		Q	Tau-sq	I-sq	P-value	Sample size
FFS participants: all studies	1.282	1.166	1.410	21	0.011	57%	0.013	10
FFS participants: medium risk of bias	1.187	1.109	1.270	1	0.000	0%	0.461	2
FFS participants: high risk of bias	1.345	1.166	1.550	17	0.020	59%	0.017	8
FFS-plus inputs/marketing participants: all studies	2.569	1.184	5.576	78	0.560	96%	0.000	4
FFS-plus participants: medium risk of bias	2.507	1.513	4.155	1	0.000	0%	0.327	2
FFS-plus participants: high risk of bias	2.568	0.815	8.093	77	0.677	99%	0.000	2
FFS participants: evaluation design								
Rigorous quasi-experimental study	1.183	1.106	1.265	2	0.000	0%	0.567	4
Cross-section regression (adjusted analysis)	1.243	1.088	1.419	1	0.000	3%	0.311	2
Longitudinal data (unadjusted analysis)	3.400	1.937	5.967	0	0.000	n/a	n/a	1
Cross-section data (unadjusted analysismethod)	1.324	1.196	1.465	2	0.000	3%	0.357	3
FFS participants: length of follow-up								

	RR	95% confidence interval		Q	Tau-sq	I-sq	P-value	Sample size
2 years or less	1.284	1.100	1.499	18	0.021	66%	0.007	7
More than 2 years	1.306	1.196	1.426	1	0.000	0%	0.538	3
FFS participants: curriculum								
IPM	1.343	1.147	1.572	20	0.023	70%	0.003	7
IPPM	No obs.							
Other curriculum	1.245	1.135	1.365	1	0.000	0%	0.598	3
FFS participants: years of implementation of programme								
2 years or less	1.293	1.195	1.399	4	0.000	0%	0.459	5
More than 2 years	1.303	1.053	1.610	15	0.029	74%	0.004	5
FFS participants: region								
Central Asia (CA)	No obs.							
East Asia (EA)	1.251	1.104	1.418	4	0.006	44%	0.169	3
Latin America (LA)	0.280	0.023	3.481	0	0.000	n/a	n/a	1
South Asia (SA)	1.358	1.143	1.613	14	0.023	71%	0.008	5
Sub-Saharan Africa (SSA)	1.141	0.925	1.409	0	0.000	n/a	n/a	1
FFS participants: crop								
Rice	1.408	1.187	1.670	0	0.000	n/a	n/a	1
Other staples and vegetables	1.267	1.144	1.404	2	0.000	0%	0.449	3
Cotton	1.347	1.114	1.629	16	0.027	75%	0.003	5
Cotton (excl high risk of bias)	1.187	1.109	1.270	1	0.000	0%	0.461	2
Permanent crops	1.141	0.925	1.409	0	0.000	n/a	n/a	1
FFS neighbours: all studies	1.084	1.026	1.145	2	0.000	0%	0.706	5
FFS neighbours: medium risk of bias	1.086	1.027	1.148	1	0.000	0%	0.424	2
FFS neighbours: high risk of bias	1.034	0.766	1.396	1	0.000	0%	0.491	3

Finally, we examined heterogeneity of revenues using meta-regression (Table 19). The meta-regression indicated that FFS which were provided alongside inputs and/or marketing support lead to significantly better outcomes, when controlling for crop type, study design, and farmer. Although heterogeneity remained high (I-sq=78%), the small sample size limited our ability to explore other sources of differences across studies. However, no evidence was found for publication bias or for significant effects for other variables such as FFS-participant education (results not reported).

Table 19 Meta-regression analysis of net revenues

	Coeff*	t-statistic	P>t
1='Rigorous' quasi-exp study	-0.098	-0.52	0.608
1=Neighbour farmers	-0.076	-0.36	0.726
1=Rice crop	0.385	1.57	0.138
1=FFS+input/marketing	0.557	2.68	0.018
Constant	0.269	2.10	0.054
Number of obs		19	
Tau-squared		0.067	

I-squared	77.8%
Adjusted R-squared	58.9%
Model F	4.56
Prob > F	0.014

Notes: coefficient estimates reported as natural logarithm. Bold indicates coefficient statistically significant at 10% level.

Other final outcomes (secondary outcomes)

Effects on environment

Five studies of IPM/IPPM farmer field schools reported effects on environmental outcomes; in three cases we were able to calculate effect sizes and standard errors (Appendix E). One study measured positive effects on soil fertility of IPPM-FFS among FFS participants in Uganda (RR=1.79, 95% CI=1.15, 2.78; Friis-Hansen et al., 2004). Four further studies measured impacts of five IPM-FFS interventions on environmental outcomes using the environmental impact quotient (EIQ) score (Kovach et al., 1992), which estimates changes in outcomes indirectly based on reported reductions in chemical pesticide use.[37] The findings of the meta-analysis for EIQ scores are suggestive of benefits to FFS graduates (Figure 23). Walter-Echols and Soomro (2005) also estimated reductions in EIQ in India (RR=0.68) and Pakistan (RR=0.58) but did not report information to calculate standard errors so are not included in the meta-analysis.

EIQ is the only outcome for which estimated effects on non-participant neighbour farmers were significantly positive across all studies regardless of risk of bias. However, given the EIQ is estimated from reported pesticide use, for which we did not find any impacts on neighbour farmers, it seems unlikely that these significant effects on average are common. Indeed, when we excluded high-risk-of-bias studies from the analysis (including results for neighbour farmers from Cavatassi et al., 2011, for which we have approximated standard errors) the results for FFS participants remained significant (RR=0.61, 95% CI=0.48, 0.78; Q=3, Tau-sq=0.01, I-sq=33%; 3 observations), while those for neighbours were no longer statistically significant (RR=0.70, 95% CI=0.43, 1.14; Q=0.5, Tau-sq=0.00, I-sq=0%; 2 observations) (Figure 24).

[37] Pananurak (2010) noted that EIQ scores were not calculated for China "due to lack of information about pesticide compounds" (p. 69).

Figure 23 Environment outcomes: environmental impact quotient (EIQ)

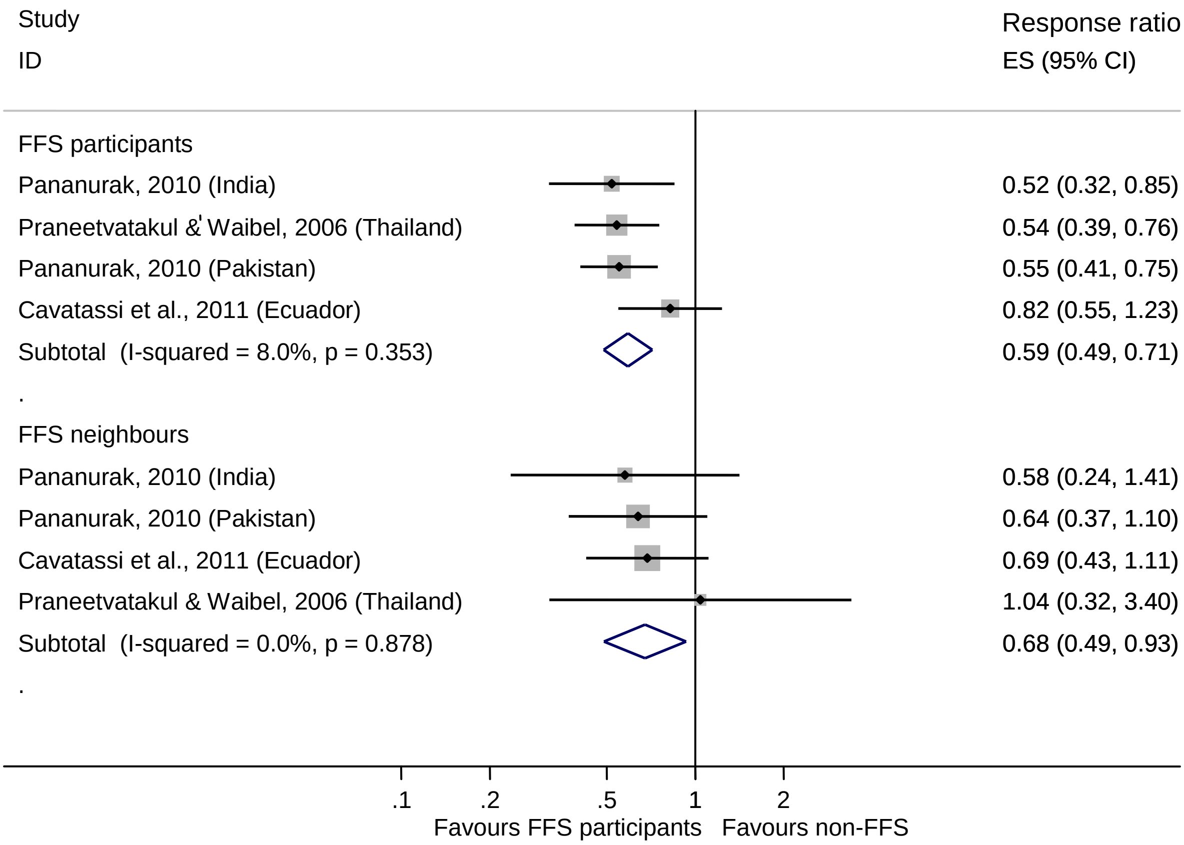
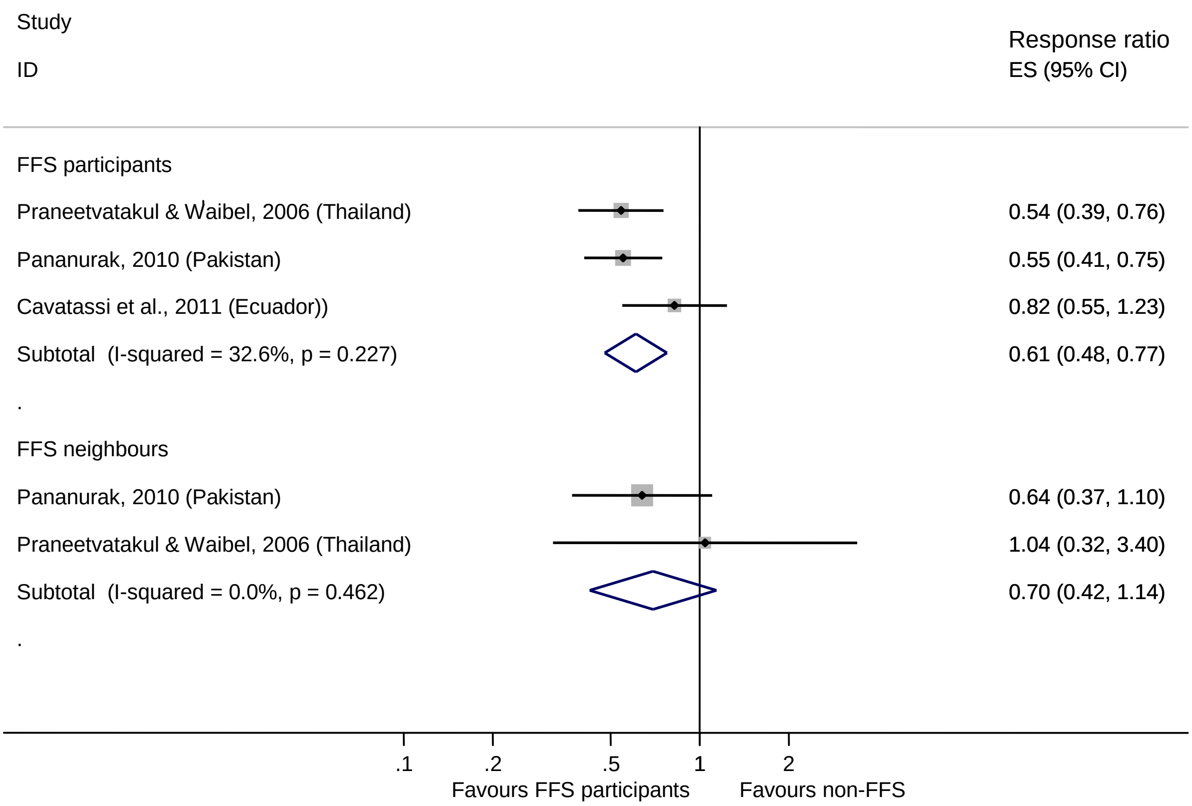


Figure 24 Environmental impact quotient (EIQ) excluding high-risk-of-bias studies

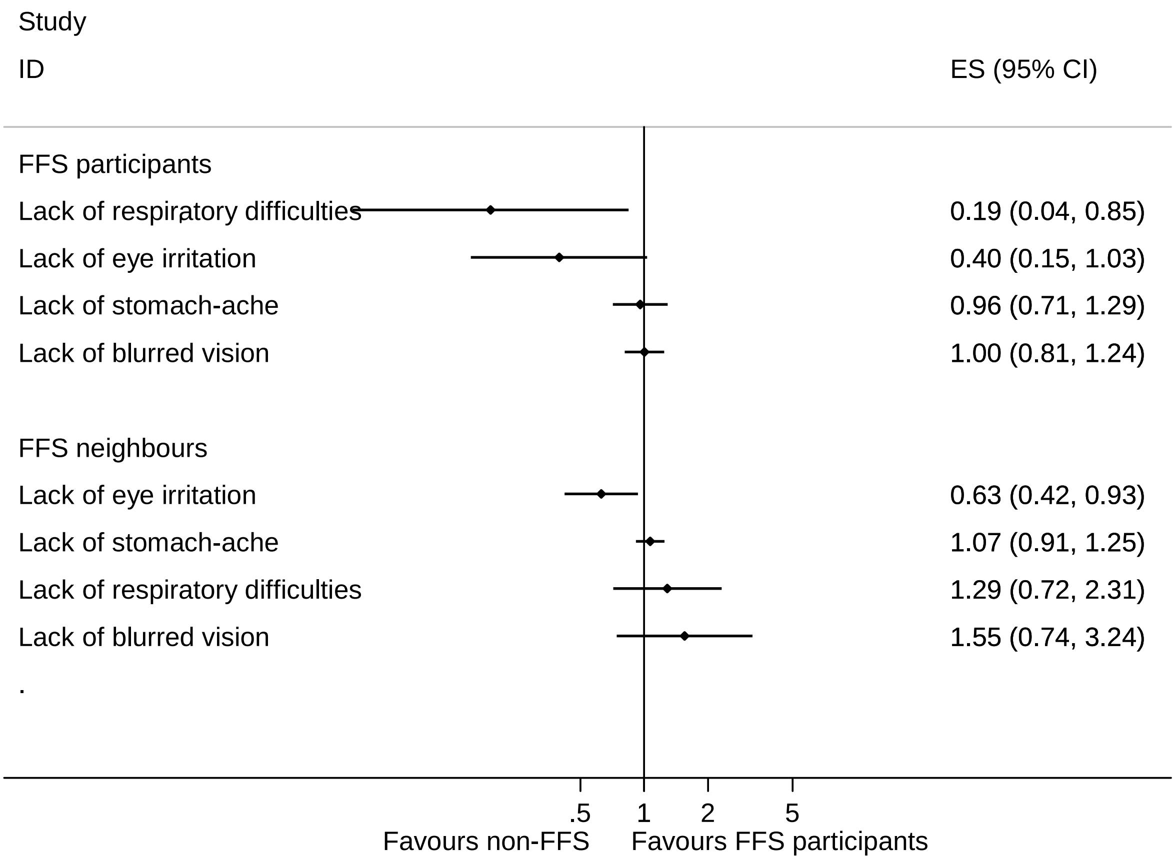


Effects on health

Health outcomes were measured in four studies, all of which were assessed as being of high risk of bias. We were able to calculate effect estimates and confidence intervals in two studies (Amera, 2009; Labarta, 2005) (Appendix E).[38] One study in Nicaragua compared self-reported health outcomes among FFS participants with those of non-participants (Labarta, 2005). The results, shown in Figure 25, suggest – counter-intuitively – that FFS beneficiaries experienced greater respiratory difficulties, though cases of eye irritation, stomach ache and blurred vision were not significantly different. In addition, neighbour farmers experienced greater eye irritation than non-FFS comparison farmers. However, the specifications used also found that the length of time after graduation from FFS significantly reduced the incidence of respiratory difficulties.

[38] DANIDA (2011) estimated reductions in health expenditure (RR=0.19) but did not report information to calculate standard errors. Zuger (2004) estimated increases in use of protective clothing and gloves during pesticide preparation and spraying, measures of adoption of practices which may affect health outcomes.

Figure 25 Health outcomes in Nicaragua (Labarta, 2005)



It appears that adoption of practices was a problem in Labarta (2005), as the authors indicated that 5 of the 13 FFS did not include a conventional "farmer practice" (control) plot; of the 8 that did, half observed lower yields in the IPM plot compared with the control plot, while 6 observed lower net revenue in the IPM plot compared with the conventional plot. In these cases, when comparative trials of IPM found higher revenues or yields in the IPM plot relative to the conventional plot, farmers were more likely to adopt the IPM practices included in the curriculum. A second study (Amera, 2009) reported perverse results in terms of pesticide poisoning in Kenya (RR=1.10, 95% CI=0.93, 1.30), despite significant estimated reductions in pesticide use (RR=0.61, 95% CI=0.52, 0.71).

It is difficult therefore not to conclude from these studies that reverse causality is driving the counter-intuitive outcomes, where farmers who most recently participated did so because of an existing respiratory problem for which analysis was unable to account.[39]

Effects on empowerment

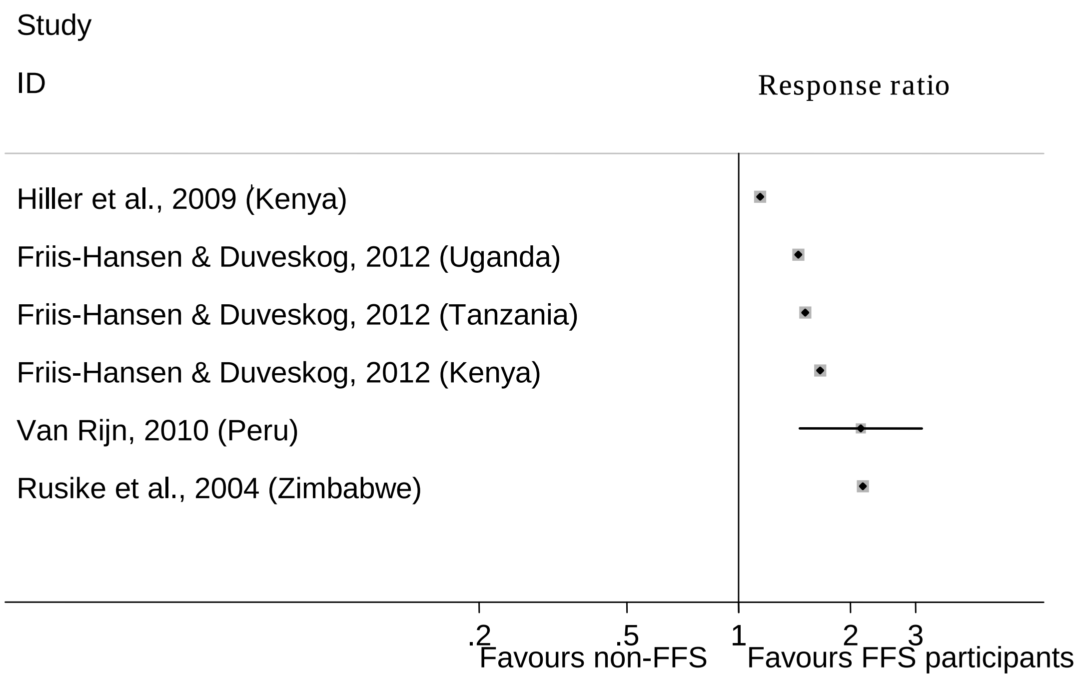
A total of four studies collected quantitative data on some measure of empowerment

[39] The effect sizes calculated from Labarta used in this analysis are from standard regression analysis (ordered probit) without control for possible endogeneity; Haussman tests were performed and the authors were unable to reject the null hypothesis of exogeneity of FFS participation.

(Appendix E). Some outcomes were reported more clearly than others, and in only one case were we able to calculate confidence intervals (Van Rijn, 2010). Thus, Rusike et al. (2004) reported “empowerment attitudes” and Hiller et al. (2009) measured change over time in farmers’ perceptions of empowerment; further details on the definition of empowerment were not reported. In contrast, Friis-Hansen and Duveskog (2012) reported empowerment indices for innovation uptake, access to services, engaging with markets and collective action/social relations, from which we calculated a pooled point estimate. In the case of Van Rijn (2010), we calculated a pooled variable measuring the probability that farmers felt improvements in self-esteem, including feeling capable of solving problems in the field, feeling comfortable in giving an opinion, and participating in the community (RR=2.13, 95% CI=1.46, 3.12). Figure 26 shows the forest plot for empowerment outcomes, including point estimates only for those studies where confidence intervals could not be calculated. The limited evidence suggests beneficial impacts, which is supported by qualitative evidence reported in Chapter 5, although further quantitative studies are needed to support the validity findings.

A study of the IFAD-FAO East African FFS programme examined impacts on production by gender (Davis et al., 2012). The study showed high rates of FFS participation by women, who comprised two-thirds of field school participants in Kenya and half of those in Uganda. While women did not seem to have problems attending the FFS, female FFS participants did not benefit significantly more than female non-participants in both of these countries in terms of improved income. While women form a large part of the agricultural labour force, they may not be the household or community decision-makers and therefore the agents of change in adoption of practices. However, women FFS participants did benefit more than women non-participants in Tanzania, where women’s participation made up one-third of the FFS programme intake. Davis et al. (2012) also found that increases in productivity for participants with no formal education were greater than for any other group of farmers, suggesting the experiential learning and demonstration focus of the FFS appears to allow low-literacy farmers to actively participate and learn.

Figure 26 Empowerment outcomes (includes studies without standard error estimates)



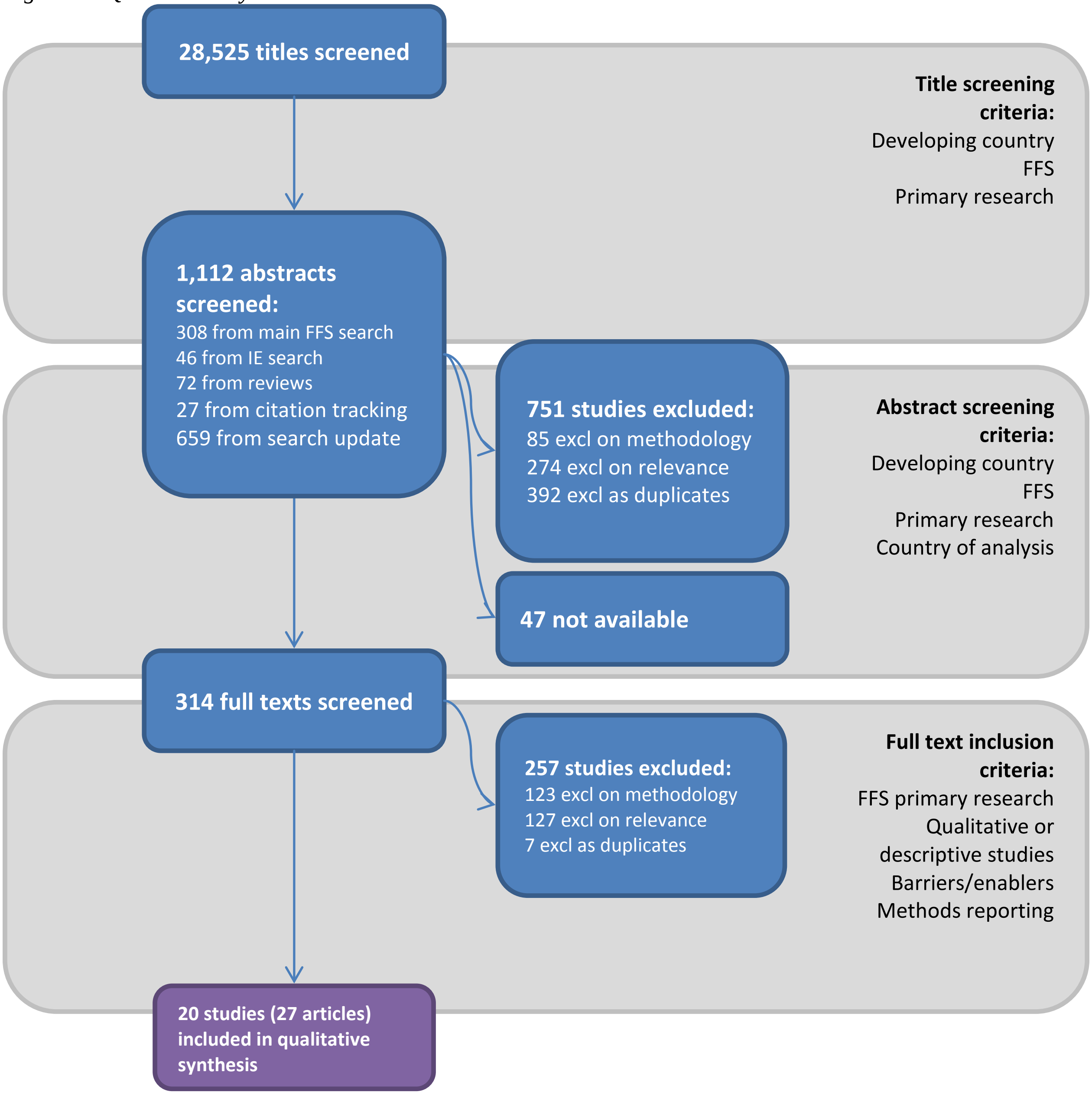
5 Results of Qualitative Synthesis

5.1 SEARCH RESULTS

In this section we report the results of the synthesis of qualitative studies addressing review question (2) on the barriers to and enablers of FFS effectiveness. The included studies do not necessarily report on the same interventions as the included effectiveness studies.

Figure 27 provides a detailed outline of the search strategy and review process for the studies included to address our second review question. The search for qualitative studies was implemented in parallel with the search for evidence on effectiveness. Over a thousand (1,112) abstracts were systematically screened to assess whether full texts of the papers should be obtained for the qualitative synthesis component of the review according to the separate inclusion criteria for studies answering review question (2); 314 papers were retrieved for full text analysis. Two independent researchers systematically reviewed the texts and assessed whether the papers should be included for qualitative synthesis. Disagreements were resolved by discussion. Most (252) of these studies were excluded on relevance (they did not report on FFS nor provide evidence on barriers to and enablers of FFS effectiveness), or methodology (they were not primary research or failed to meet the methodology criteria as set out in the study selection criteria). Twenty studies (corresponding to 27 articles) were included in the analysis.

Figure 27 Qualitative synthesis search results



5.2 STUDY CHARACTERISTICS

Table 20 displays the basic characteristics of the included studies. Eleven of the studies were conducted in Africa (Cameroon, Kenya, Liberia, Uganda, Tanzania and Zimbabwe), seven of the studies were conducted in Asia (Bangladesh, Cambodia, Indonesia, the Philippines and India) and two in Latin America (Honduras, and Trinidad and Tobago). All the studies were addressing issues pertaining to FFS, including process and implementation, knowledge formation and farmers' experiences of FFS participation.

Where multiple studies reported evidence from the same country, the data were collected from different FFS in different districts. For example, two studies reported on evidence from

Indonesia. However, one study reported evidence from Central Java province (Van de Fliert, 1993), while the other reported evidence from the West Java province (Winarto, 2004). Similarly, there were five studies that reported evidence from Kenya. Of these, three of the studies collected data from different districts (Friis-Hansen et al., 2012; Machacha, 2008; Najjar, 2009), and two studies collected data from different FFS programmes (Hiller et al., 2009; Karanja-Lumumba et al., 2007). Finally, there were two studies reporting evidence from the Philippines, each reporting on a different FFS programme (Palis, 2002; Rola and Baril, 1997).

The studies differed in the methods they used, the quality of reporting and the implementation of these methods. As is described in more detail in Appendix C, we assessed the quality of the included studies using a predetermined checklist. Full results of the quality appraisal are reported in Appendix F, and Figure 28 provides a summary of the quality assessment for each included study according to each criterion in our quality appraisal checklist.

A large number of the studies suffered from weaknesses in reporting, making quality appraisal more challenging. Of particular concern was the limited reporting on sampling and sample characteristics, clarity of analysis and lack of presentation of data to support findings.

All the papers clearly stated their research aim and provided contextual background. The vast majority also contained a description of appropriate participant selection procedures (sampling) and provided details of sample characteristics such as sample size and location. Most studies also included adequate details of how data were collected, but only around one-third set out how data had been recorded. Furthermore, only 35 per cent of the studies provided a clear and explicit explanation of how data were analysed. Nearly all the studies (85%) situated the research within the relevant literature or set out a clear theoretical framework. The methodology was judged appropriate for the research question with the author(s) offering a clear justification for their approach in 50 per cent of the cases and doing so partially in 45 per cent of the cases; 5 per cent of the studies did not provide clear enough information to make a judgment regarding the appropriateness of the methodology. Criteria for appropriate sampling included providing an explanation of why the selected participants were suitable to provide the knowledge sought by the study and whether there were any issues around recruitment such as some potential participants choosing not to take part. Eight of the twenty studies addressed all these issues, ten did so partially and two others did not provide clear enough information for the criterion to be properly assessed.

The "appropriate methods of data collection" criterion required studies to use appropriate and justified methods, including that data be collected in a way that addressed the research issue at hand and for the researcher to discuss saturation of data. Sixty per cent of the studies partially satisfied these requirements and the remaining 40 per cent fully satisfied them. The "appropriate analysis" criterion required studies to provide the data that supported reported findings, and required that the relationship between researcher and participants had been considered, and judged the extent to which contradictory data were taken into account. Fifteen per cent of the studies fulfilled these requirements, 55 per cent did so partially, 20 per cent did not satisfy the criteria at all and 10 per cent were not sufficiently clear to make a judgment. Two of the most common weaknesses were the failure to consider the relationship between researcher and participant and the effect this might have on the data collected, and the absence of any real consideration of the significance of contrary evidence or explanations. Another common shortcoming of the included studies was incomplete reporting of data supporting the findings.

All the included studies provided at least some evidence of having triangulated their results, with 15 per cent of studies satisfying one of the following requirements and the remaining 85 per cent satisfying two or more of them: the verification of findings using two or more data sources; the application of multiple methods; employment of multiple investigators; investigation of multiple theories. However, none of the studies employed theoretical triangulation approaches. To satisfy the “clarity of analysis and conclusions” criterion, researchers needed to have done all of the following: discussed the credibility of their findings; discussed evidence both for and against their own arguments; made their findings explicit and discussed them in relation to the original research question. Twenty-five per cent of studies satisfied all these requirements, 65 per cent did so partially while 10 per cent failed to address them adequately. Finally, only small proportions of the papers clearly set out any ethical considerations (25%) or addressed potential conflicts of interest (15%) in terms of author relationships with funder or implementer.

Table 20 Summary characteristics of included studies

Study	Study objectives	Country	FFS programme	Methods of data collection	Methods of analysis	Summary of quality assessment
DANIDA (2011) FFS	The aim of the study was "to analyse and document – in a gender perspective – the results and the lessons learned from using the FFS approach in the ASPS II in Bangladesh" "According to the ToR the Evaluation should, in particular, provide information about whether and to which extent the FFS approach is contributing to increased income and food security at household level, as well as to women's involvement in development processes in Bangladesh."	Bangladesh	The Bangladesh Agricultural Extension Component (AEC), part of the Agricultural Sector Program Support (ASPS) II	Focus group discussions (FGDs) and/or individual interviews with extension workers, farmer organisation members, NGOs, private service providers and traders, key stakeholders at village level (FFS facilitators/trainers, FFS (former) participants and control groups), direct observation of FFS sessions, FFS technologies/activities implemented by FFS graduates and training-of-trainer learning sessions. An evaluation matrix with key evaluation questions and indicators was used to prepare standardised checklists for the FGDs with different stakeholder groups (FFS farmers, control farmers, facilitators/trainers, community-based organisation/ Farmer Club leaders etc.) to ensure that similar type of data and information would be collected across the components and geographic areas.	The study describes the methods of analysis used for the quantitative component (ex post PSM or DID PSM but with recall data) but does not describe in detail the methods used to synthesise findings from the qualitative component. Context analysis and programme theory based evaluation thinking were parts of the overall analytical framework. Not much detail of how this was operationalised though.	This is a mixed methods study, with a propensity score matching component and a qualitative section. The major limitations of the study are the lack of reporting of some of the data in support of the findings presented; failure to consider the relationship between participants and researchers and lack of discussion on contradictory findings/arguments.
David, 2007	"The aim of the paper is to examine what knowledge and skills farmers acquire in FFS, what they transmit to non-participants and the social impacts of this training approach."	Cameroon	Sustainable Tree Tops Programme, hosted by the International Institute of Tropical Agriculture	Non-structured interviews with selected FFS graduates, formal survey of FFS participants and non-participants, interviews with FFS graduates, farmers from non-FFS villages and knowledge recipients. Interviews conducted in French in most cases, sometimes in the local language if necessary. The survey instrument for FFS and non-FFS farmers covered questions about uptake of practices/knowledge learned in FFS, diffusion of knowledge acquired from FFS to household and non-household members, method of diffusion,	The authors do not explicitly report how the data were analysed, but it is obvious from the study that they used descriptive statistics and t-tests.	Overall the study suffers from limitations in reporting, analysis and transparency. It is mainly focused on assessing impact on knowledge and diffusion, for which the methodology is not appropriate. In addition, there might be potential for conflict of interest: The author seems to be an employee of the International Institute of Tropical Agriculture which hosted the intervention. Information on barriers and enablers is somewhat limited.

Study	Study objectives	Country	FFS programme	Methods of data collection	Methods of analysis	Summary of quality assessment
				social impacts of FFS and a test to assess knowledge related to four broad areas covered in FFS: cocoa physiology, disease and pest management, rational pesticide use and post-harvest operations.		
Dolly, 2009 (incorporates Dolly, 2005, 2008, 2009)	The study set out the following objective: "to assess ... 14 FFS in Trinidad and Tobago from the perspective of the Simpson and Owens (2002) key elements facing extension programs and FFS. These are: relevancy and responsiveness of FFS to local concerns, systems learning and the generation of new knowledge, information flow and farmer-to-farmer communication, institutionalisation and local organisational development, changes in relationships, and the integration of the FFS into existing programs." (Dolly, 2009)	Trinidad and Tobago	Initiatives by the Commonwealth Agricultural Bureau International and Trinidad and Tobago's Ministry of Agriculture Lands and Marine Resources	Interviews of the whole sample conducted by the researcher, focused interviews with six volunteer participants. Observation of field days, committee meetings (of the committee of the Extension, Training and Information Services of the MALMR (including study and recording of minutes of 12 monthly meetings)), and observations of activities of the implementing agency (Caura Valley Farmers Association, CVFA). Document analysis - the researcher studied the minutes of 12 monthly meetings.	No information provided	Overall the study suffers from limitations in reporting, analysis and transparency. Major shortcomings of the study include incomplete reporting on sample characteristics, lack of reporting on methods of analysis and limited analysis. The authors do not present data to support their findings, do not discuss the relationship between the researcher and participants, do not present / discuss contradictory evidence and do not discuss the credibility of their findings. The lack of information about the analysis and no presentation of data make it difficult to assess the reliability of the findings. Information on barriers and enablers is somewhat limited.
Friis-Hansen, 2008 (incorporates Friis-Hansen 2005 and Friis-Hansen et al., 2004)	"This study is inspired by the development-research approach to impact assessment and aims to (1) place the agricultural technology development among poor farmers in Soroti district, Uganda in a socioeconomic and institutional context, and (2) differentiate between different well-being categories when assessing the impact of access to improved technologies, farmer empowerment, and access to privatised demand-driven advisory services."	Uganda	Global Integrated Pest Management Facility Project under the auspices of the FAO	"The study is based on two sets of field work in 2001 and 2004." (Friis Hansen et al., 2004, p. 251) Two quantitative surveys (2001, 2004); interviews; strengths, weaknesses, opportunities and threats; participatory rural appraisal; qualitative in-depth life history interviews. For the 2004 survey wellbeing indicators were developed based on consultation with farmers, and poverty index was developed based on this exercise. Not clear how information on changing opportunity structures, responsiveness of advisory services	Method of analysis for quantitative survey is reported. They used SPSS statistics software for the analysis, computing correlation and chi squared tests between group membership and poverty indicators. It is not clear how the in-depth interviews were analysed. Not clear how information on changing opportunity structures, responsiveness of advisory services was analysed.	The study does not clearly report on methods of sample selection and methods analysis. The main shortcoming is the lack of clarity and depth of analysis. Another major limitation is that not all findings are supported by a presentation of evidence and the authors arrive at contradictory findings between publications.

Study	Study objectives	Country	FFS programme	Methods of data collection	Methods of analysis	Summary of quality assessment
				and other institutional context were collected.		
Friis-Hansen, 2011, 2012	The study objectives were: "(1) to explore how FFS impacts on the daily lives of participants, their family relationships and their relations with other members of the group and the wider community; (2) to examine the relationship between collective processes and gender relations; (3) to explore transformative learning as a possible explanation for the learning and changes that individuals experience from participating in FFS."	Kenya	IFAD-FAO Programme in East Africa	Individual and group interviews. Observations and key informant interviews. The in-depth interviews followed an interview guide developed to ensure that certain questions were covered.	Constant comparative approach. "The data were separated from the original transcript using NVIVO-QSR (version 8) in order to identify their essential elements. Codings of responses (Miles & Huberman, 1994) were made in an inductive manner, where themes were developed based on emerging similarities of expression. As a result, common themes were identified and grouped into main and sub-themes (Lincoln & Guba, 1985)."	The main shortcomings are a lack of clarity on sampling procedures (especially for the key informant interviews) and some lack of transparency and clarity in the analysis. The study does not present data on contradictory evidence so it is not clear to what extent it has been taken into account.
Gottret & Córdoba, 2004	The paper aimed to tackle the following questions: the role of social actors on innovation processes; the ways in which institutions influence actors' access to knowledge, technology, information and the complementary resources necessary for innovation; the influence of external intervention, particularly that of the state, on innovation processes; the impact of innovation on strategies to generate livelihoods and their sustainability; ways in which the state can facilitate and promote innovation processes with small-scale producers more effectively.	Honduras	The Central American Integrated Pest Management Programme or Programa de Manejo Integrado de Plagas en América Central (PROMIPAC)	Document review, in-depth interviews with government stakeholders, participation in PROMIPAC workshops, in-depth interviews with FFS facilitators, an FFS farmer and a non-participant farmer.	Limited description of analysis, although detailed description of the analytical framework which was used for the analysis. The paper states: "The information collected through the review of documents and in-depth interviews was analysed using the logical framework presented in Figure 1." .	The study is relatively clear, but there is a lack of detail on the methods of analysis and only limited presentation of data. The authors do not discuss the relationship between researchers and participants and the credibility of their findings.
Hiller et al., 2009	The objectives of the study were to: "compare the sustainability score of FFS farmers at the start and after graduation; to assess the impact of the FFS on knowledge, implementation of good agricultural practices, and livelihood aspects before and after FFS participation and between FFS and non FFS participants; to assess the perception of farmers of the FFS approach."	Kenya	The Kenya Tea Development Agency (KTDA)/Lipton Sustainable Agriculture Project	Semi-structured individual questionnaire for FFS members; semi-structured individual questionnaire for non FFS members. Data collected by student enumerators originating from the area.	No information provided	The study has detailed reporting on data collection and a clear analysis and conclusion, clearly stating the limitations of drawing causal inferences from the findings. The main shortcomings of the study include lack of reporting on methods of analysis and lack of engagement with the relevant literature. Although not entirely clear, the authors

Study	Study objectives	Country	FFS programme	Methods of data collection	Methods of analysis	Summary of quality assessment
						conducting the evaluation (follow-up survey) appear to be independent of the implementing and funding agencies.
Hofisi, 2003	The aim of the study was to: "a) examine the relevance of a FFS learning approach to the resource poor farmers of the Zambezi Valley. b) To examine the impact of active experimentation and Indigenous Knowledge on the farmers' learning process. c) To find out problems which are being experienced in the FFS and their possible solutions. d) To see whether the approach may have a wider application."	Zimbabwe	Zambezi Valley Organic Cotton Project	Mapping (groups); semi-structured interviews (groups and individuals); matrix scoring, score ranking and historical trend analysis conducted. Paper provides brief descriptions of how these methods were implemented (p. 23).	Very little detail is provided on how the collected data were integrated and analysed. The author notes that the participants were involved in the analysis of the findings.	This is a well-conducted study with some shortcomings, including incomplete reporting on sampling and methods of analysis. In addition, the author notes that the researcher has been involved in training and the overall implementation of the project, but does not consider the potential conflict of interest arising from this.
Isubikalu, 2007	To "describe and analyze this FFS-based process of agro-technological adaptation, in order to arrive at some overall judgment about how well the FFS-based 'innovation system' is working."	Uganda	a. Integrated Production and Pest Management project/scheme (IPPM) implemented by FAO b. Integrated Pest Management (IPM) project implemented by Makerere University (MAK) c. Integrated Soil Productivity Improvement (ISPI) under Africa 2000 network (A2N) d. Integrated Production and Post-harvest Handling Management (IPPHM) implemented by International Potato Centre (CIP). Safe Pesticide Use and Handling (SPUH) implemented by MAK	Participant observation and direct observation, prolonged stay in the field, including working with the farmers, key informants, interviews, photography, focus groups, group discussions, attendance at formal meetings. Participant ranking used to identify local priorities.	Transcribed data from the field were reduced and sorted into emerging themes and patterns to describe and explain processes and activities in FFS, using the context-mechanism outcomes framework of interactions in FFS. To convey a flavour of the feelings of the different respondents, some excerpts based on their own wording have been built into the analysis as direct quotes.	Overall, this is a well-designed study with clear reporting on data collection and analysis. Main shortcomings include the failure to present and consider alternative/contradictory evidence. The study could also have presented more data as it is difficult to judge how representative the information provided is.
Karanja-Lumumba et al., 2007	The main purpose of the study was "to establish the role of emerging second order associations in sustaining and providing continuity to community based groups by: (1) Understanding the key elements in the design of the second order associations; (2) Identifying services provided by second order organizations to community-based organizations and farmers; (3) Understanding the role of second-order associations in strengthening and sustaining a two-way flow of information between the farmers and collaborators and (4) Identifying the financing mechanisms	Kenya	The FFS networks arose independently from the East African Sub-Regional Pilot Project for Farmers Field Schools, funded by IFAD and implemented by the FAO.	"Pre-tested checklists were used to guide the Focus Group Discussions and the in-depth interviews." (p. 1346) No further detail provided.	No explicit mention of how data were analysed. It is not clear from the text what analyses were conducted and how information was extracted and combined.	The study has several major limitations. The study does not clearly report on the sampling characteristics and data collection. The major shortcoming of this paper is that there are no data presented and no explicit description of how the analysis was conducted. It is unclear how the information from in-depth interviews and focus groups was combined and how the authors arrived at the findings presented. It is not clear whether the methodology was appropriate to

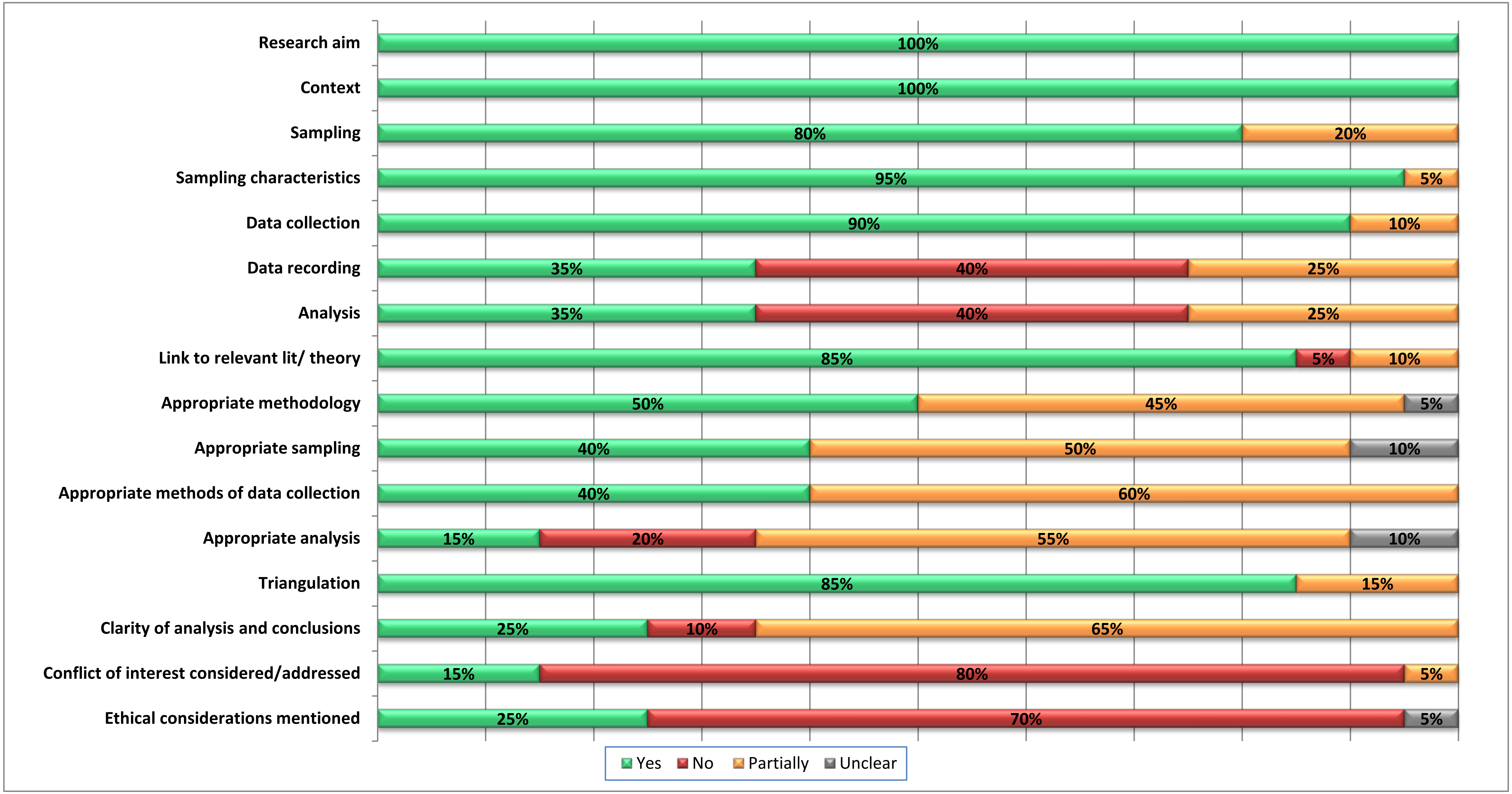
Study	Study objectives	Country	FFS programme	Methods of data collection	Methods of analysis	Summary of quality assessment
	the Second Order Associations use to ensure they are self-sustaining."					answer the research questions presented.
Machacha, 2008	The first objective is to learn more about Farmer Field Schools as organized in this region today; the second objective is to compare some elements among the FFS in order to identify the characteristics and processes that are associated with outcomes that provide members the greatest benefits in terms of learning and sustainable livelihoods.	Kenya	Ongoing programmes, initially set up by the FAO and then by the Kenyan Ministry of Agriculture Extension department and the Kenya Agricultural Research Institute	Interviews and direct observation of farmers' fields. Focus groups. The researcher explained the purposes of the study once to the entire group through reading the prepared Information Letter and responding to any questions that arose. The purposes of the study were explained again to any person selected for an individual interview through reading the prepared Information Letter and responding to any questions they had.	The only explicit description of method of analysis is that data were analysed qualitatively. The data are then presented thematically in the findings section, prefaced with a sentence saying so.	Overall, this is a well-designed study with clear reporting and analysis. It adopts a case study design and various methods of data collection appropriate for the research questions. Minor shortcomings of this study are incomplete reporting on data analysis methods, lack of reporting on data recording methods and failure to discuss the relationship between the researcher and participants and other limitations of the study.
Mancini et al., 2007	"The aim of the study was to test the SL [sustainable livelihoods] framework to document the emic perception of change in people's livelihoods since they attended IPMFFS (or over the same time period without IPMFFS for the control groups)."	India	EU-FAO Cotton IPM, and Indian Government	Questionnaire. Spider diagramming, respondents were first elicited to define the different types of capital during an interview with a trained facilitator, an outline diagram was drawn and participants were asked to rate the state of these capitals at present and 2 years ago.	Sustainable livelihoods framework and statistical analysis. The initial process of generating and interpreting findings was participatory.	The study has clear reporting on data collection and analysis. A major shortcoming is that the majority of the relevant findings (on barriers and enablers) are not supported by the presentation of data. Another limitation is that the conclusions seem at times to overstate/misrepresent the presented findings. In addition, there is a potential conflict of interest as the study has been funded by the implementing agency. The funding source is acknowledged, but the conflict of interest is not disclosed.
Najjar, 2009	"This research explores transformative learning occurring in FFS in Kenya following five specific objectives: (1) to understand the characteristics of the local agricultural production systems; (2) to consider gender specific interests with implications for the FFS program; (3) to assess the conditions of learning; (4) to understand the individual learning outcomes of farmers involved in the FFS; (5) to determine whether the extension activities promote broader community	Kenya	Ministry of Agriculture	Unstructured and semi-structured interviews, focus group discussions, gender and social analysis, Rapid Rural Appraisal (RRA), Participatory Rural Appraisal (PRA), Resource Flow Maps (RFM), Farm Transects (FT), transect walks, local NGO workshops on gender sensitisation and a document review of farmers' notes, NGO and government FFS forms and relevant minutes of meetings. Participant observation	Gender and social analysis using an adaptation of the Moser framework. QSR NVivo, a qualitative data-analysis software, was used to code and explore data in search of themes and regularities. Excel and Arc Map were used for representing the gender specific adoption rates of FFS technologies in the Mwora FFS and the case study area location, respectively. Data were coded into 100 nodes derived from	Overall, this is a well-designed case study with very good reporting and analysis. The biggest limitation of the study is a lack of information on the sample characteristics at the individual level.

Study	Study objectives	Country	FFS programme	Methods of data collection	Methods of analysis	Summary of quality assessment
	thinking about sustainable agriculture."			(which included participating in farm work, attending FFS sessions and farm visits). (p. 6)	the interview questions. These nodes were then grouped into five data sets, description of agriculture system, gender issues, how learning occurred, what was learned and social action and change, representing the five research objectives.	
Palis 2002 (incorporates thesis and 2006, as well as several co-authored: Palis et al., 2002, 2005)	The study aimed to: "a) Understand the process of IPM adoption among FFS farmers; b) Identify the effective sources of social capital that facilitates farmer sharing, learning and practice of IPM; c) Assess the building up of social capital and its impact on the promotion of IPM by understanding the process of farmer sharing and learning, and the spread of IPM practice; d) Assess the impact of IPM, mediated by social capital, both at the individual and village level; and e) Utilize the identified effective sources of social capital in coming up with a strategy in upscaling IPM in a swift, efficient, and spontaneous manner."	Philippines	The Barangay (village) Integrated Pest Management (BIPM) project	A range of different methods of data collection used; household survey using semi-structured questionnaire; observations (regular periodic collection of the input–output data was done every season, from 1993 until 1995 and 1999). Semi-structured questionnaire; focus group discussion; participatory mapping; and key informant interviews; social network survey; household map; genealogy.	Household map, farm map, genealogy, and case presentations in supporting qualitative inferences. For quantitative inferences, used graphical analysis and basic statistical tests like t-test, F-test, frequency distributions, chi-square test, Fisher's exact test, and logistic regression.	The study has clear reporting and analysis of rich data. Minor shortcomings include failure to consider the researcher–participant relationship in the analysis and the potential for conflict of interest as the author notes: "I was involved with this project throughout the study period" (Palis, 2006) and then returned to conduct dissertation research.
Pedersen et al., 2008	"To assess institutional capacity, identify implementation successes and bottlenecks, quality, and sustainability ... The objective was to make a status, survey, review, analyse, discuss, and conclude on district implemented FFS in Mbeya region targeting all those who were *DADS*/supported."	Tanzania	District Agricultural Development Support (DADS), supported by local training institute. Further, support was allocated to rural district farmers by IFAD and the Ministry of Agriculture. FAO and WWF supported Mbarali district. Extensive support also provided by DANIDA in seven districts.	Semi-structured interviews, field visits to the FFS groups and physical field visits/registrations.	A mixture of descriptive statistics, correlations and content analysis.	The study has several major limitations. It does not clearly report on the data collection methods and does not report on the methods of analysis. Moreover, it does not link to existing literature, nor present all the data in support for its findings and conclusions. It is therefore difficult to assess how reliable the findings of this study are.
Rola and Baril, 1997	This is a case study of "the economic, social and educational impact of FFS. Analysis included a) measuring knowledge gains of FFS farmers, b) monitoring changes in practices, c) investigating the economics of these changed practices, d) estimating cost savings due to higher efficiencies of FFS graduates."	Philippines	Philippine National IPM Programme	Recall benchmark survey, plot-size measurement, weekly monitoring of crop level data, in-house FFS documentation, weekly AESA data, postproduction household data, soil samples, FFS evaluation, knowledge tests, information network survey, and decision-	No information provided	The study has several major limitations, with limited information on barriers and enablers. The major shortcomings of this study include incomplete reporting on sampling, context, lack of reporting on data recording and methods of analysis, failure to present data for the

Study	Study objectives	Country	FFS programme	Methods of data collection	Methods of analysis	Summary of quality assessment
				making variables.		implementation (only relevant section) aspect of the study, failure to present and consider evidence against the authors' arguments and failure to consider the researcher–participant relationship. In addition, there is a potential conflict of interest as the research has been funded by an FFS-implementing agency.
Simpson, 1997	The study set out to answer the following research question: "Has the IPM-FFS extension mode succeeded in empowering farmers to promote the long term sustainability of agriculture in Svay Teap. The thesis focuses on analysing IPM extension experiences from a village level perspective ... The goal is to shed some light on the project's success and illuminate areas which may need to be improved."	Cambodia	National IPM Programme of MAFF (Ministry of Agriculture, Forests and Fisheries)	Key informant interviews (mostly with international NGOs, academics, government workers and members of the Cambodian national IPM team, sessions often very informal, conducted in French or English, used for getting information, bouncing ideas and triangulating information, also conducted with village leaders); semi-structured interviews (informed by the key informant interviews, open ended, avoiding leading questions, while planned to be with individuals often joined by the rest of the family, lasted 1-3 hours) and focus group discussions (with FFS and non-FFS participants, and also with more vulnerable groups, mainly facilitated by the translator); participant observations/ daily life (participation by the researcher in the daily village life).	Apart from saying this is a case study analysis, no information provided.	The study has clear reporting and analysis with rich information on barriers and enablers. The major shortcomings include incomplete reporting on sampling and methods of analysis, incomplete presentation of data on which the findings are based and failure to present / discuss evidence contradictory to the author's arguments.
Van de Fliert, 1993	"To describe and analyse the processes and effects taking place at the village level as a result of IPM training and dissemination, and to provide useful management information to the programme for further implementation" including "information with respect to characteristics and diversity of intended and actual programme beneficiaries and to actual achievements considering behaviour of farmers and farm level effects as a result of	Indonesia	The National IPM Programme, implemented as a government programme through the existing extension system (assisted by FAO and expatriate and local experts)	Focus groups, individual interviews, qualitative observations, quantitative surveys, farmers' record keeping, field observations.	Case study design: multi-case design evaluating IPM training at village level.	Overall a strong study with rich data and analysis. The study could have been clearer in reporting of the analysis methods. The main shortcoming is that little of the data from which the findings and conclusions are drawn is presented in the study.

Study	Study objectives	Country	FFS programme	Methods of data collection	Methods of analysis	Summary of quality assessment
	IPM training and dissemination"					
Van Der Wiele, 2004	The study set out to examine the following: "Whether and how external assistance, within the field of community and ecological design specifically, can be used more effectively to enable smallholder households to secure their basic needs, promote self-reliance, and adopt sustainable resource management practices as a means of breaking the unending cycle of environmental degradation and persistent poverty."	Liberia	United Methodist Church Committee on Relief's Sustainable Agriculture and Rural Development Initiative	In-depth interviews, semi-structured interviews, field observations, conversations with key informants and reviews of official documents, photographic documentation of field observations. Detailed description of how interviews were conducted provided, including interview questions.	Grounded theory analysis approach. Analysis conducted using an iterative process – the constant comparative method. Involves creating a data matrix for each respondent, comparison of emerging patterns within and between respondents, using content analysis.	Overall this is a strong study with only minor limitations. It adopts a case study design and various methods of data collection appropriate for the research questions. The reporting on methods is extensive and transparent. Data are presented and the analysis and conclusions are clearly presented. The main shortcoming is incomplete reporting on sampling procedures.
Winarto, 2004	"The main objectives of this book are not only to examine the interaction between those with differing modes of knowledge acquisition, but to investigate the subsequent processes in which knowledge is continuously formed and changed, and the extent to which action plays a part in the continuous knowledge formation ... The study will examine the following issues: ... how the learning process took place; how the new knowledge was disseminated and adopted by other farmers; to what extent those ideas were diversely or uniformly adopted and which elements of previous knowledge persisted."	Indonesia	The National IPM Programme, implemented as a government programme through the existing extension system (assisted by FAO and expatriate and local experts)	Direct observation, semi-structured/ informal interviews and questionnaires.	Not reported. The author used a comparative case study design, though presents findings from only one of the locations.	The study contains rich material, but there is some lack of clarity on methods used, including a lack of clarity in reporting on sampling, data collection and failure to report on methods of analysis.

Figure 28 Summary of critical appraisal across all included studies



5.3 SYNTHESIS RESULTS

This section reports the results of the synthesis of findings from the qualitative studies, presented using the hypothesised programme theory as an overall framework for structuring the synthesis. Based on the findings from the synthesis we also present an updated programme theory (Figure 29). The figure includes revised assumptions as well as statements about the barriers and enablers related to each step in the causal chain, based on the evidence in the included studies.

As can be seen from the critical appraisal (Figure 28), there are considerable weaknesses in the underlying evidence base. The findings should therefore be interpreted with caution and the findings presented below should be considered suggestive rather than definitive. There were likely biases in terms of what is studied. For instance, a lot of the qualitative evidence related to barriers, rather than enablers.

Programme components

General inputs

As with any programme FFS require a range of different inputs at the outset in order to establish the programme and start delivering services to participants. There was a lack of systematic reporting of the resources devoted to individual FFS interventions and assessment of the quality of the services delivered to farmers in the included studies. However, some studies reported a lack of (timely) funding and inadequate provision of resources, including inputs and finances, as potential reasons for implementation failures (Pedersen et al., 2008; Najjar, 2009; Winarto, 2004). These included insufficient and incidental provision of inputs, discrepancies between budgeted and received payments, payment delays and difficulties with logistics and dissemination. In addition, selection of inappropriate FFS sites and a lack of adequate follow-up and support during pest outbreaks were noted as constraints.

Facilitators

The facilitator is an important input in FFS programmes, and according to the programme theory adequate training of facilitators is a key assumption for the FFS training to lead to improved knowledge and skills among participating farmers. If facilitators are not adequately trained the quality of the training received by farmers may be lower, affecting knowledge formation, adoption and final outcomes.

Six of the seven studies that reported on training of facilitators suggested that there were issues related to a lack of appropriate training, resources and ongoing support of facilitators (DANIDA, 2011; Gottret & Córdoba, 2004; Hofisi, 2003; Pedersen et al., 2008; Rola & Baril, 1997; Simpson, 1997). Examples of deficiencies included gaps in the curriculum covered in the training of facilitators and lack of focus on participatory techniques and facilitation skills. The studies also highlighted issues related to a lack of ongoing support or backstopping, and lack of inputs to support facilitators in their roles.

One theme which was not included in the original programme theory relates to the selection and characteristics of FFS facilitators. Four studies suggested appropriate criteria for selecting facilitators were important for identifying candidates suitable to be facilitators (DANIDA, 2011; Hofisi, 2003; Machacha, 2008; Winarto, 2004). These studies found that rather than high levels of education, characteristics such as personal attitude, maturity, literacy, leadership skills and experience with farming might be more important for facilitators to perform their role successfully. Facilitators not having the right characteristics from the outset appeared to have influenced their ability to successfully perform the role of FFS facilitator.

Moreover, a large difference between farmers and facilitators in terms of socioeconomic characteristics may prevent farmers from fully participating and making suggestions or raising concerns (Simpson, 1997). Finally, the gender of the facilitator might be important, in particular in more conservative contexts. Some studies found that women preferred female facilitators (Hofisi, 2003; Van Der Wiele, 2004), suggesting that FFS programmes aiming to target women farmers should take account of this when selecting facilitators.

The characteristics of the facilitators and the training they receive in turn effect another theme which was highlighted by several of the included studies: the relationship between facilitators and participants. Three of the studies suggested an imbalance in the farmer–facilitator relationship as a potential barrier to farmers' learning and adoption (Isubikalu, 2007; Najjar, 2009; Simpson, 1997), with farmers not feeling comfortable enough to admit when they did not understand something, or to voice concerns or make suggestions.

Targeting criteria and procedures

While not included in the original programme theory our synthesis suggests a key assumption in the FFS programme theory may be that the right farmers are targeted and reached by the FFS. The targeted farmers must be willing and able to participate in FFS training throughout the full season, and be able to implement FFS practices in their fields. Those studies that provided information on targeting, selection procedures and group composition, have been linked to FFS effectiveness analysis above, and are covered in a separate piece on FFS targeting (Phillips et al., 2014).

Available evidence suggests that structural factors such as socioeconomic status, gender and cultural norms influence both who is targeted and who is able to participate in FFS. In some cases targeting procedures privileged the elite and more affluent (DANIDA, 2011; Simpson, 1997; Van de Fliert, 1993), or excluded women and the poor (DANIDA, 2011; Najjar, 2009; Simpson, 1997). In other cases poverty and ill health prevented farmers from participating (Gottret & Córdoba, 2004;

Najjar, 2009). In yet another case, an absence of targeting criteria was suggested as a barrier to effectiveness (Pedersen et al., 2008).

While several studies found that women were able to participate in FFS (Hofisi, 2003; Machacha, 2008; Najjar, 2009; Rola & Baril, 1997), other studies found that women were often not allowed to participate by their husbands or could not participate due to time constraints and lack of access to resources and land (DANIDA, 2011; Hofisi, 2003; Najjar, 2009; Van de Fliert, 1993, Van Der Wiele, 2004).

Farmers' education levels and motivation to participate was another key determining factor highlighted by existing evidence (Gottret & Córdoba, 2004, Hofisi, 2003). The most commonly cited reason to join a field school was to improve knowledge, skills and livelihoods (DANIDA, 2011; Friis-Hansen, 2008; Hofisi, 2003, Najjar, 2009). Several studies found high levels of drop-out (Friis-Hansen, 2008; Gottret & Córdoba, 2004; Machacha, 2008; Najjar, 2009; Rola & Baril, 1997; Winarto, 2004). Unmet expectations of hand-outs or loans were the most commonly cited explanation in the literature (Friis-Hansen, 2008; Hofisi, 2003; Machacha, 2008; Najjar, 2009). Additional reasons for drop-outs included lack of interest, access and time (Gottet & Córdoba, 2004; Machacha, 2008; Najjar, 2009).

Overall, the review identified several key barriers related to targeting, such as inappropriate selection criteria and targeting procedures, and structural barriers to participation such as gender, poverty and cultural norms. If there is not a considered approach to targeting, this may result in farmers participating for the wrong reasons and ultimately dropping out. Alternatively, beneficiaries may not have the right characteristics, such as education levels, or access to land and resources, to be able to fully benefit from the FFS training. FFS should target farmers with appropriate education levels, motivation and access to land, and those who do not live too far away to attend the weekly FFS sessions.

Approach to learning

A key characteristic of FFS design is that programmes should follow a participatory approach, based on theories of adult education and discovery-based learning (Pontius et al., 2002). A participatory, bottom-up approach to the training is considered important in communicating complex concepts, strengthening problem-solving capabilities and ultimately convincing farmers to adopt the practices promoted in FFS.

Over half of the included studies included themes pertaining to the way in which FFS were delivered in the field (DANIDA, 2011; Dolly, 2009; Friis-Hansen, 2008; Gottret & Córdoba, 2004; Hofisi, 2003; Isubikalu, 2007; Machacha, 2008; Najjar, 2009; Pedersen et al., 2008; Rola & Baril, 1997; Van de Fliert, 1993, Winarto, 2004). Some of the studies represented cases where FFS were delivered in a top-down manner, using a transfer of technologies approach rather than according to the original approach characterising FFS (Isubikalu, 2007; Pedersen et al., 2008; Najjar, 2009; Simpson, 1997). The top-down approach seemed to have occurred at different levels – a bias towards talk, rather than practice, experiments being managed by the facilitators rather than farmers, or the delivery of the FFS in terms of the overall approach, budgeting, monitoring and inputs provided.

Nevertheless, a greater proportion of the included studies represented cases where FFS were delivered in a participatory manner (DANIDA, 2011; Dolly, 2009; Friis-Hansen, 2008; Gottret & Córdoba, 2004; Hofisi, 2003; Machacha, 2008; Rola & Baril, 1997; Van de Fliert, 1993; Winarto, 2004),[40] with farmers taking part in field trials and development of the curriculum. According to the participating farmers of one FFS, their active experimentation and information-sharing enhanced their learning and increased knowledge and ownership of the resulting farming systems.

Related to this, there is consistent evidence that due to the complexity of the curriculum, observability is important for farmers to trust the messages promoted in FFS and to develop analytical skills (Dolly, 2009; Hofisi, 2oo3; Machacha, 2008; Palis, 2002; Simpson, 1997; Van Der Wiele, 2004; Winarto, 2004). The observability of IPM practices and their relative advantage compared with conventional methods was found to be important in enhancing farmers' confidence and trust in IPM messages. Similarly, in a few cases facilitators were unable to demonstrate observable benefits from FFS practices and this acted as a barrier to adoption.

The extent to which the FFS in the included studies were delivered according to the original principles upon which the intervention was designed varied, ranging from approaches to learning similar to traditional extension, to "true FFS". Where implementation in practice was characterised by a more top-down, transfer of technology approach farmers were not able to see and practice IPM, and this appeared to have been a barrier to farmers developing their knowledge and analytical skills.

The evidence highlighted the importance of empirical study, successful demonstration plots, and visibility of benefits in other farmers' plots in convincing farmers to adopt new practices. The apparent importance of observability and relative advantage of FFS practices in farmers' adoption is consistent with Rogers' theory of diffusion (2003), which suggests peoples' perceptions of these characteristics are among the important attributes determining adoption of innovation.

[40] The description and analysis of actual implementation of FFS is limited in both Friis-Hansen (2008) and Friis-Hansen et al. (2012). They provide what is a rather generic description of an "ideal type" FFS, backed up with very limited description and no data on implementation.

FFS content and coverage

The FFS curriculum is another major component of the intervention. For farmers to learn and adopt the practices promoted in FFS, an assumption is that the content of the curriculum is relevant to the needs of farmers, appropriate for the local context in terms of the crops it covers and feasible for farmers to implement in their fields. Most of the included studies reported themes relating to the FFS curriculum (DANIDA, 2011; David, 2007; Dolly, 2009; Gottret & Córdoba, 2004; Hiller et al., 2009; Hofisi, 2003; Isubikalu, 2007; Mancini et al., 2007; Najjar, 2009; Palis, 2002; Simpson, 1997; Van de Fliert, 1993; Van Der Wiele, 2004).

From the studies it appears that in most cases the FFS curriculum was relevant and appropriate to the local context (DANIDA, 2011; Dolly, 2009; Gottret & Córdoba, 2004; Hiller et al., 2009; Hofisi, 2003; Mancini et al., 2007; Van de Fliert, 1993), for instance by responding to local concerns over economic and environmental costs of pesticides (Dolly, 2009; Mancini et al., 2007).

However, in some cases FFS curricula appeared to lack relevance to the local context (Isubikalu, 2007; Najjar, 2009; Simpson, 1997), and the major barrier in these cases seemed to be that the curriculum was not sufficiently tailored to the needs and resources of the farmers it was targeting. For instance, in some cases the practices were seen to be too labour- or time-intensive (Isubikalu, 2007) or failed to address the issues that were of highest priority among farmers (Simpson, 1997).

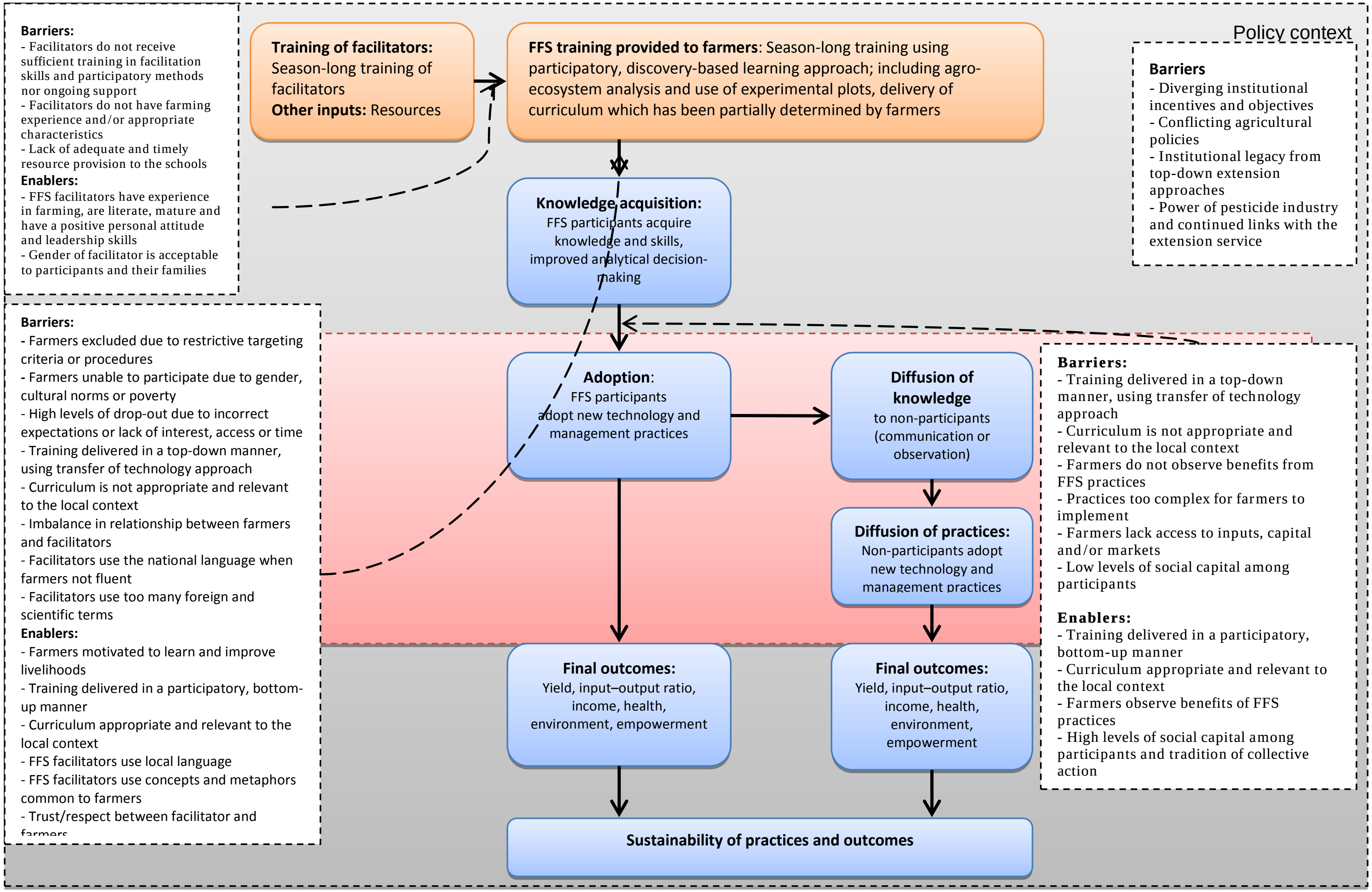
Farmers may have a range of concerns, such as water management, fertilisation, diversification and marketing. A failure to incorporate a broader range of concerns in the curriculum was perceived by farmers to be a weakness in several studies (DANIDA, 2011; Mancini et al., 2007; Najjar, 2009; Van de Fliert, 1993, Winarto, 2004), who expressed that the curriculum was not sufficiently comprehensive in its coverage. Therefore a broader focus might encourage participation in FFS, and could potentially also facilitate greater improvement of agricultural outcomes. Nevertheless, as one case from Kenya demonstrates (Pedersen et al., 2008), trying to cover too many topics or crops in one cycle may put the technical quality of the intervention at risk.

Limited evidence suggests that in some cases the complexity of IPM made it difficult for farmers to implement all the IPM practices on their crops (Gottret & Córdoba, 2004; Van de Fliert, 1993; Winarto, 2004). Some of the analytical tools used were too complex and perceived as impractical in relation to the time, energy and resources they required (Winarto, 2004). For instance, the use of forms to record field sampling with formulae to calculate percentages for damages and prevalence of insects was found to be of little practical use for the farmers, who abandoned this in favour of simply recording what they observed in their fields (Van de Fliert, 1993). On the other hand, some studies found that including indigenous and practical knowledge, rather than theoretical concepts, may enhance farmers' understanding of FFS practices (David, 2007; Hofisi, 2003).

Related to the complexity of the curriculum is the discourse and language used for communication in FFS. An assumption not included in our original programme theory, but which emerged from the synthesis is that the curriculum needs to be communicated in a language farmers understand. Evidence from Indonesia suggested that when facilitators used unfamiliar foreign and scientific terms which were part of their vocabulary, such as "economic threshold level" (ETL) and "ecosystem", these terms were not easily understood by farmers (Van de Fliert, 1993; Winarto, 2004). On the other hand, the use of common concepts and metaphors, such as "natural enemy" (musuh alami) or "farmers' friends" (teman petani), were more easily understood and facilitated knowledge formation and adoption (Dolly, 2009; Winarto, 2004).

Moreover, farmers might not be sufficiently fluent in the national language to be able to comprehend the FFS content (DANIDA, 2011; Najjar, 2009), and in one case farmers' understanding was improved when facilitators used the local language (Van de Fliert, 1993).

Figure 29 Barriers to and enablers of knowledge acquisition, adoption and improved final outcomes



External/contextual factors

A range of contextual factors external to the programme can act to promote or hinder FFS effectiveness. Several of the included studies contained findings related to the policy context and institutional set-up, the community context and the infrastructure and physical context within which FFS were implemented.

Policy context and institutional set-up

FFS are implemented within the context of existing and emerging policies, institutional structures and industry activities. A range of actors are involved in agricultural extension, including international donors, national, regional and local governments, research institutions, NGOs and various industry actors. Several studies noted that diverging institutional incentives and objectives of these various actors influence how FFS are implemented in practice, with a tendency for some of the participatory elements to be eroded (Isubikalu, 2007; Pedersen et al., 2008; Simpson, 1997).

There is some evidence suggesting that the existence of conflicting agricultural policies can act as a barrier to adoption of FFS practices. In some cases, the involvement of a multitude of institutions each promoting their own mandate resulted in each impacting on the design, content and implementation of FFS, crowding out the beneficiary needs and interests (Isubikalu 2007, Simpson, 1997). In other cases, the institutional legacy of existing extension systems influenced the implementation of FFS (Isubikalu 2007; Mancini et al., 2007; Van de Fliert, 1993; Winarto, 2004). Institutional structures associated with earlier top-down agricultural extension systems, such as subsidised input schemes, trickle-down messages and off-the-shelf technology promotion, remained and contradicted the bottom-up, participatory approach of FFS.

Other evidence suggested that the power of the pesticide industry and their continued links with the extension system can act as a barrier to adoption and diffusion of FFS practices. In at least two cases, studies found that the pesticide industry maintained close links with the extension system at the local level (Mancini et al., 2007; Van de Fliert, 1993), paying commission to extension workers and local cooperatives to promote pesticides, hampering farmers' efforts to practice IPM.

Community context and social capital

Several of the included studies highlighted the role of the community in influencing farmers' practices (Dolly, 2009; Machacha, 2008; Najjar, 2009; Palis, 2002; Simpson, 1997; Van Der Wiele, 2004; Winarto, 2004). One of the hypothesised assumptions in the programme theory was that for sustained adoption of FFS practices it was important "farmers are convinced others will do the same". There was limited evidence to support this assumption, which was based on the suggestion by Feder et al. (2004a) that lack of adoption of IPM practices by neighbouring farmers might curtail the effectiveness of the intervention, as pests from their fields may re-infest the fields of adopters, eventually leading to disadoption of IPM by FFS participants. In one case farmers in Indonesia found it difficult to practise new strategies when the rest of the community continued applying old practices (Winarto, 2004). However, the reason for this seems to be that they faced discouragement and disbelief from their untrained peers, rather than a fear of re-infestation.

In our original programme theory we suggested that a “high degree of social cohesion” might be an assumption that needs to hold for knowledge to diffuse to neighbouring farmers not participating in FFS, but we did not include it as a factor that might affect adoption among FFS participants. Several of the included studies suggested that existing social capital and reach of social networks may also influence adoption among FFS participants (Dolly, 2009; Gottret & Córdoba, 2004; Palis, 2002; Simpson, 1997). In some cases high levels of social cohesion and a tradition of collective action from existing farmer groups may have encouraged a willingness to learn and succeed with the training, facilitating adoption (Dolly, 2009; Gottret & Córdoba, 2004; Palis, 2002). On the other hand, in one case low levels of social capital and little sense of community in the FFS villages may have been a barrier to FFS effectiveness.

Access to inputs

One of the assumptions included in the programme theory was that farmers have access to any complementary inputs necessary to adopt FFS practices. Five studies highlighted issues related to availability of inputs, labour and markets (DANIDA, 2011; Machacha, 2008; Mancini et al., 2007; Najjar, 2009; Van Der Wiele, 2004). In all cases the lack of access to inputs, capital and/or markets were suggested as factors influencing uptake of FFS practices or final outcomes of the FFS training. These issues are common challenges for farmers, and are not particular to FFS programmes, but in some cases they appear to have remained a barrier for FFS farmers to adopt FFS practices and fully benefit from adoption.

Other themes

Sustainability

FFS aim to provide farmers with skills which enable them to solve problems for themselves. An implicit assumption behind this is that the FFS training will enable farmers to continue with FFS practices and deal with any new challenges after they graduate. The sustainability of these skills and practices, along with their successful diffusion to broader farmer communities are an important outcome for cost-effectiveness of FFS interventions. Eleven out of 20 studies discussed factors affecting sustainability of FFS (DANIDA, 2011; David, 2007; Dolly, 2009; Friis-Hansen, 2008; Gottret & Córdoba, 2004; Karanja-Lumumba et al., 2007;

Machacha, 2008; Simpson, 1997; Van de Fliert, 1993; Van Der Wiele, 2004; Winarto, 2004).

Based on the descriptive themes, all studies highlighted that ongoing support and follow-up are important for sustainability of FFS practices and the establishment and sustainability of FFS-related activities (DANIDA, 2011; David, 2007; Dolly, 2009; Gottret & Córdoba, 2004; Karanja-Lumumba et al., 2007; Machacha, 2008; Simpson, 1997; Van Der Wiele, 2004; Winarto, 2004). In particular, included studies identified a lack of technical assistance and backstopping from researchers and extensionists to support farmers in continuing development of local practices (Dolly, 2009; Gottret & Córdoba, 2004; Simpson, 1997; Winarto, 2004). The studies that reported on follow-up group activities taking place suggested that active follow-up and continued support by the implementing agency, encouragement to establish farmer clubs and additional sessions on club formations may facilitate the establishment of sustainable and effective groups and practices.

In addition, four studies also suggested that particular group characteristics may affect sustainability of farmer groups and FFS-related practices (DANIDA, 2011; David, 2007; Machacha, 2008; Van Der Wiele, 2004). Studies reporting successful follow-up farmer activities suggested consistent membership, good leadership, collective goals and a supportive group environment might be important in maintaining FFS groups and providing impetus for further farmer-led initiatives.

Overall, the studies suggested that lack of ongoing support and follow-up is an important barrier to the sustainability of the FFS approach. In the absence of formal follow-up, the implicit assumption is that the FFS training is sufficient to enable farmers to continue with FFS practices and deal with any new challenges. However, the evidence suggested that this might not hold in most cases, as farmers expressed the need for additional follow-up support and technical backstopping to be able to continue the development of local practice. A lack of formal follow-up activities therefore appears to be a barrier to sustainability of FFS practices.

An assumption missing from the original theory of change is that the group characteristics may play a crucial role in enabling sustainability of FFS practices and related activities. Based on the available evidence, it appears that choosing groups with common goals, good leadership and high attendance rates might be important enablers of sustainability of FFS-related practices.

Perceived outcomes: gender and empowerment

Proponents of FFS suggest empowerment is a key outcome of FFS. While few impact evaluation studies looked at these outcomes, empowerment and improved gender relations were frequently highlighted in the qualitative literature (DANIDA, 2011; Dolly, 2009; Friis-Hansen, 2008; Friis-Hansen et al., 2012; Hofisi, 2003; Machacha, 2008; Mancini et al., 2007; Najjar, 2009; Simpson, 1997, Van Der Wiele, 2004; Winarto, 2004). Evidence based on participants' perceptions suggests FFS may influence empowerment positively. Some studies also suggest participation in FFS may lead to women's empowerment and improve gender relations.

IPM diffusion to neighbour farmers

The evidence from quantitative impact evaluations overwhelmingly supports the notion that there is little, if any, diffusion of IPM knowledge and adoption to neighbouring farmers who do not participate in FFS. Over half of the studies included in the qualitative synthesis covered themes relevant to the diffusion of FFS knowledge and practices to non-participants (David, 2007; Gottret & Córdoba, 2004; Hiller et al., 2009; Karanja-Lumumba et al., 2007; Machacha, 2008; Mancini et al., 2007; Palis, 2002; Rola & Baril, 1997; Simpson, 1997; Van de Fliert, 1993; Winarto, 2004). Overall they suggested both characteristics of FFS and contextual factors influenced diffusion, summarised in the updated programme theory (Figure 30).

Several characteristics of FFS may explain why practices promoted in IPM-FFS do not appear to diffuse spontaneously to farmers who have not participated in training. Four studies highlighted the complexity and the experiential nature of FFS learning as a barrier to diffusion (David, 2007; Mancini et al., 2007; Van de Fliert, 1993; Winarto, 2004). They noted that, despite high awareness of IPM by non-participants (Van de Fliert, 1993; Winarto, 2004), the skills and practices are complex and their experiential nature makes them difficult to convey via verbal communication (Mancini et al., 2007; Van de Fliert, 1993; Winarto, 2004). In two studies where some diffusion was observed, the findings suggested concrete practices were more likely to diffuse than theoretical concepts and principles (David, 2007; Hiller et al., 2009), with relatively simple practices, such as pruning and weeding techniques, being more easily disseminated.

Just as observability of IPM practices and their relative advantage compared with conventional methods was found to be important in encouraging FFS farmers to adopt new practices, the evidence suggested observability is important for convincing non-FFS farmers to adopt IPM practices (David, 2007; Gottret & Córdoba, 2004; Palis, 2002; Machacha, 2008; Simpson, 1997; Winarto, 2004; Van de Fliert, 1993). In theory this should be done on the plot so that non-participant farmers can see what is done and trained farmers may not have the time or skills to do so. In two cases non-FFS farmers perceived FFS practices as having relative advantage compared with existing practices, facilitating interest in IPM (Gottret & Córdoba, 2004; Hiller et al., 2009).

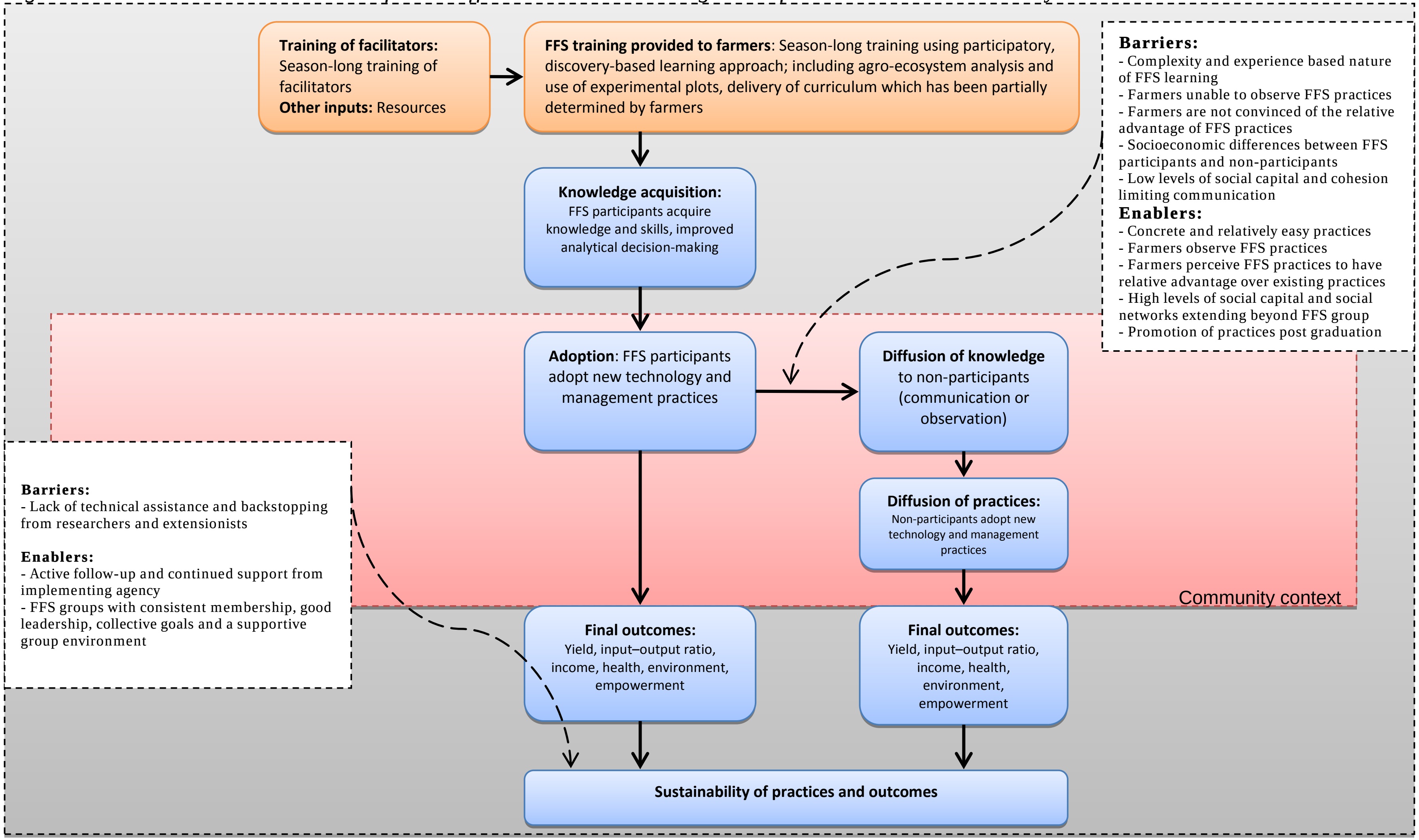
For many observers the lack of diffusion of IPM practices may not be surprising. FFS differ from agricultural extensions that focus on disseminating knowledge of more simple practices, such as application of fertiliser and pesticides, or adoption of new, improved seeds. Instead of heavy reliance on external inputs, the practices promoted in FFS typically rely on analysis and use of what is available in farmers' fields and local ecosystems. Given the skills-based nature of the practices promoted in FFS, the rate and nature of diffusion will differ from the diffusion of more simple technological innovations.

One of the assumptions included in our initial programme theory was that a “high degree of social cohesion” would be important for diffusion. Evidence from five studies suggests existing levels of social capital may influence diffusion of IPM knowledge and practices (David, 2007; Gottret & Córdoba, 2004; Palis, 2002; Rola & Baril, 1997; Simpson, 1997). In some cases low levels of social capital and cohesion limited communication within the community and presented a barrier to diffusion of FFS messages (David, 2007; Simpson, 1997). On the other hand, in the Philippines, high levels of social capital, in particular among farmers with kinship ties, facilitated sharing of IPM concepts with farmers who did not participate in FFS training. Awareness of the main sources of social capital in a particular context, as well as analysis of social networks, might provide an opportunity to facilitate greater diffusion.

In our original programme theory one of the assumptions for IPM knowledge and practices to diffuse was that formal community-building activities and training of FFS alumni to train other farmers were implemented. Overall the themes emerging from the synthesis of issues related to diffusion seemed to confirm this, and supported the assumption that, in the absence of formal mechanisms promoting diffusion, targeting “appropriate” farmers for FFS participation is particularly important.

This issue was highlighted in a study from Indonesia, which found that socioeconomic differences between FFS participants and non-participants impeded diffusion (Van de Fliert, 1993). The non-representative composition of the FFS groups impeded interaction between participants and non-participants. FFS participants communicated to a “selective audience in the villages” and made no deliberate efforts to train other members of the community in IPM principles. However, another study from Indonesia found that a few inquisitive farmers played a prominent role in the ongoing process of knowledge formulation and transmission. These farmers progressively established their position within the community as “experts”, “farmer professors” and “consultants” (Winarto, 2004, p. 351), suggesting some spontaneous diffusion may be possible, but that careful targeting of farmers with the appropriate characteristics may be necessary.

Figure 30 Barriers to and enablers of IPM diffusion to non-FFS neighbour farmers and sustainability



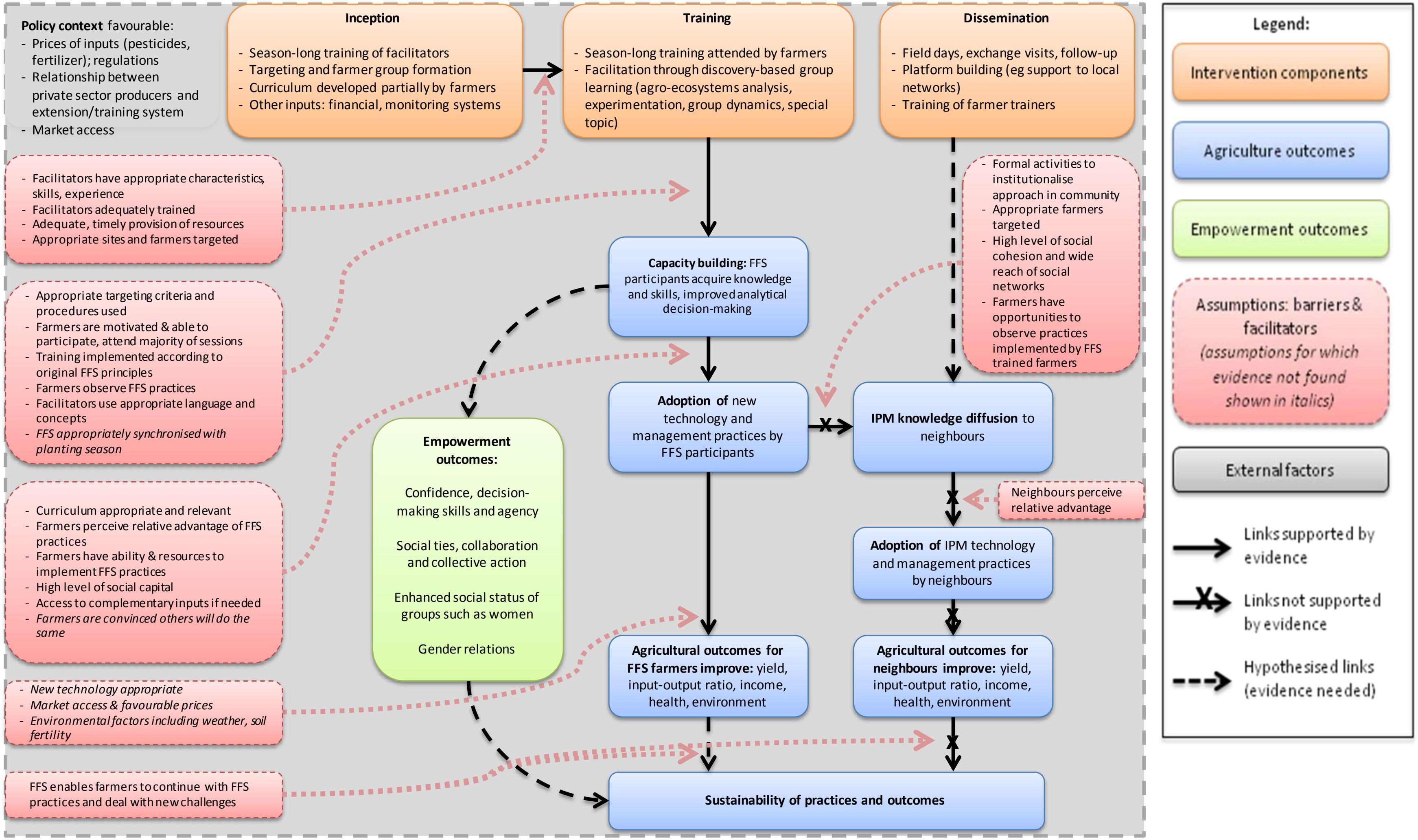
6 Integrated Synthesis

What are the effects of farmer field schools on farmers' wellbeing in terms of intermediate and final outcomes? What explains differences in effects across different contexts? Are these effects sustainable? This chapter integrates the two syntheses with the aim of answering these questions.

The findings and conclusions regarding the effect of FFS on intermediate and final outcomes are based on the meta-analysis of quantitative impact evaluations addressing review question (1): What are the effects of farmer field schools on intermediate and final outcomes for FFS participants and non-participating neighbours? The findings and conclusions regarding the possible reasons for differences in FFS effectiveness are based on the qualitative synthesis addressing review question (2): What are the enablers of and barriers to FFS effectiveness, diffusion and sustainability?

We updated the theory of change based on the findings from the syntheses, and also attempted to explain heterogeneity in findings using causal chain analysis (White, 2009). Figure 31 shows the updated programme theory, indicating where the causal chain breaks down, together with assumptions based on the identified barriers and enablers.

Figure 31 Farmer field schools theory of change: integrated synthesis of evidence



6.1 INTERMEDIATE OUTCOMES

Knowledge

No studies with a low risk of bias were identified and only three quasi-experimental studies were assessed as of being of medium risk of bias in measuring knowledge outcomes. The meta-analysis findings indicated that field school participants improved their knowledge of farming technology, both on average across evaluations as well as in all sufficiently powered individual studies. The improvements in scores were measured across a range of knowledge tests and also appeared to be both for simpler and more complex types of knowledge among the few studies, which differentiated these. However, the policy-relevant findings of effects are based on only three studies and owing to the range of methods used hence the heterogeneity in effects was particularly high for these outcomes. Knowledge outcomes improved across all FFS curricula, although they were greatest for IPM-FFS graduates. The finding across three medium-risk-of-bias studies suggested consistent increases in knowledge for FFS farmers of 0.21 standard deviations in test scores over comparison farmers (SMD=0.21, 95% CI=0.07, 0.35; Q=5, Tau-sq=0.008, I-sq=55%; evidence from 3 studies) (Figure 14). The quantitative studies did not, however, attempt to assess other aspects of capacity such as farmers' problem-solving capabilities, which is also an important weakness of the evidence on empowerment.

While the evidence indicated knowledge acquisition among participants, it also suggested participant targeting and participation, facilitator training and the programme implementation as important barriers and enablers which might influence it.

Farmer targeting and participation

A key assumption in the FFS programme is that the "right" farmers are targeted and reached by the FFS. The targeted farmers must be willing and able to participate in FFS training throughout the full season, and be able to implement FFS practices in their fields.

Overall, the review identified several key barriers related to targeting, such as inappropriate selection criteria and targeting procedures, and structural barriers to participation such as gender, poverty and cultural norms. If there is not a considered approach to targeting, this may result in farmers participating for the wrong reasons and ultimately dropping out. Alternatively, beneficiaries may not have the right characteristics, such as education levels, or access to land and resources, to be able to benefit fully from the FFS training. We were able to assess whether there were differences in knowledge gains among field schools which targeted farmers based on education levels and land size, but due to limited data provided in most included studies the results, though suggestive of benefits for higher socioeconomic status, were not conclusive.

General inputs

FFS require a range of different inputs at the outset in order to establish the programme and start delivering services to participants. Some studies reported a lack of (timely) funding and inadequate provision of resources, including inputs and finances, as potential reasons for implementation failures (Pedersen et al., 2008; Najjar, 2009; Winarto, 2004). These included insufficient and incidental provision of inputs, discrepancies between budgeted and received payments, payment delays and difficulties with logistics and dissemination. In addition, selection of inappropriate FFS sites and a lack of adequate follow-up and support during pest outbreaks were noted as constraints for IPM field schools.

Facilitator training, performance and support

The facilitator is an important input in FFS programmes, and adequate training of facilitators is a key assumption in the theory of change for the FFS training to lead to improved knowledge and skills among participating farmers. Six of the seven studies that reported on training of facilitators suggested that there were issues related to a lack of appropriate training, resources and ongoing support of facilitators (DANIDA, 2011; Gottret & Córdoba, 2004; Hofisi, 2003; Pedersen et al., 2008; Rola & Baril, 1997; Simpson, 1997). Examples of deficiencies included gaps in the curriculum covered in the training of facilitators and lack of focus on participatory techniques and facilitation skills. The studies also highlighted issues related to a lack of ongoing support or backstopping, and a general lack of inputs to support facilitators in their roles.

One issue relates to the selection and characteristics of FFS facilitators. Studies in Bangladesh, Indonesia, Kenya and Zimbabwe suggested appropriate criteria for selecting facilitators were important for identifying candidates suitable to be facilitators (DANIDA, 2011; Hofisi, 2003; Machacha, 2008; Winarto, 2004). These studies found that rather than high levels of education, characteristics such as personal attitude, maturity, literacy, leadership skills and experience with farming may be more important for facilitators to perform their role successfully. Facilitators not having the right characteristics from the outset appear to have been less successful in performing their role as a FFS facilitator.

A big difference between farmers and facilitators in terms of socioeconomic characteristics might prevent farmers from fully participating and making suggestions or raising concerns (Simpson, 1997). Some studies also suggested that the gender of the facilitator is important, in particular in more conservative contexts (Hofisi, 2003; Van Der Wiele, 2004).

The characteristics of the facilitators and the training they receive in turn effect another theme which was highlighted by several of the included studies: the relationship between facilitators and participants. Three of the studies suggested an imbalance in the farmer–facilitator relationship as a potential barrier to farmers learning and adoption (Isubikalu, 2007; Najjar, 2009; Simpson, 1997), with farmers not feeling comfortable enough to admit when they did not understand something, or to voice concerns or make suggestions.

Adoption of practices

No studies with a low risk of bias were identified and only 11 quasi-experimental studies were assessed as being of medium risk of bias in measuring pesticide use and adoption of practices. The majority of quantitative impact studies measured adoption of new agricultural practices. The more traditional farmer field schools delivering IPM or IPPM training usually measured adoption in terms of reduced amounts of pesticide application, and the meta-analysis found evidence for adoption among these FFS beneficiaries on average across medium-risk-of-bias studies, in terms of reduction in pesticide use by 23 per cent on average (RR=0.77, 95% CI=0.61, 0.97; Q=40, Tau-sq=0.07, I-sq=83%; 8 studies) ().

Other practices, whether promoted by IPM/IPPM field schools or those utilising other technology, were also adopted according to the evidence, leading to average improvements of 0.22 standard deviations in adoption indices (SMD=0.22, 95% CI=0.06, 0.38; Q=10, Tau-sq=0.02, I-sq=80%, 3 observations) (Figure 18).

However, there was substantial heterogeneity in findings, the most consistent effect sizes from the best-quality studies being for adoption of cotton crops in Asia. Furthermore, several prominent studies of longer-term, scaled-up projects estimated null or negative impacts; that is, no significant change or lower rates of adoption among FFS participants than non-participants. The qualitative synthesis suggested several key factors may influence adoption.

Approach to learning

A key characteristic of the design of FFS is that they follow a participatory approach, based on theories of adult education and discovery-based learning (Pontius et al., 2002).

Over half of the qualitative studies included themes pertaining to the way in which FFS were delivered in the field (DANIDA, 2011; Dolly, 2009; Friis-Hansen, 2008; Gottret & Córdoba, 2004; Hofisi, 2003; Isubikalu, 2007; Machacha, 2008; Najjar, 2009; Pedersen et al., 2008; Rola & Baril, 1997; Van de Fliert, 1993; Winarto, 2004). The extent to which the FFS were delivered according to the original principles upon which the intervention was designed varied, ranging from approaches to learning similar to traditional extension, to bottom-up FFS. Where implementation in practice was characterised by a more top-down, transfer of technology approach, the qualitative evidence suggests that farmers were not able to see and practice IPM, which appears to have been a barrier to farmers developing their knowledge and analytical skills. However, we were not able to test whether this made a difference to FFS effectiveness in quantitative analysis due to inadequate reporting of intervention delivery in those (and linked) studies.

Related to this, the qualitative evidence suggests that due to the complexity of the curriculum, observability is important for farmers to trust the messages promoted in FFS and to develop analytical skills (Dolly, 2009; Hofisi, 2oo3; Machacha, 2008; Palis, 2002; Simpson, 1997; Van Der Wiele, 2004; Winarto, 2004). The observability of IPM practices and their relative advantage compared with conventional methods was found to be important in enhancing farmers' confidence and trust in IPM messages. Similarly, in a few cases facilitators were unable to demonstrate observable benefits from FFS practices which may have acted as a barrier to adoption.

FFS content and coverage

For farmers to learn and adopt the practices promoted in FFS, the content of the curriculum should in theory be relevant to the needs of farmers, appropriate for the local context in terms of the crops it covers and feasible for farmers to implement in their fields. Most of the qualitative studies reported themes relating to the FFS curriculum (DANIDA, 2011; David, 2007; Dolly, 2009; Gottret & Córdoba, 2004; Hiller et al., 2009; Hofisi, 2003; Isubikalu, 2007; Mancini et al., 2007; Najjar, 2009; Palis, 2002; Simpson, 1997; Van de Fliert, 1993; Van Der Wiele, 2004). It appears that in most cases the FFS curriculum was indeed relevant and appropriate to the local context (DANIDA, 2011; Dolly, 2009; Gottret & Córdoba, 2004; Hiller et al., 2009; Hofisi, 2003; Mancini et al., 2007; Van de Fliert, 1993), for instance by responding to local concerns over economic and environmental costs of pesticides (Dolly, 2009; Mancini et al., 2007).

However, in some cases the FFS curriculum appears to have lacked local relevance (Isubikalu, 2007; Najjar, 2009; Simpson, 1997), and the major barrier in these cases seemed to be that the curriculum was not sufficiently tailored to the needs and resources of the farmers it was targeting. A failure to incorporate a broader range of concerns in the curriculum was perceived by farmers to be a weakness in several studies (DANIDA, 2011; Mancini et al., 2007; Najjar, 2009; Van de Fliert, 1993; Winarto, 2004).

In some cases the complexity of IPM made it difficult for farmers to implement all the IPM practices on their crops (Gottret & Córdoba, 2004; Van de Fliert, 1993; Winarto, 2004). Some of the analytical tools used were too complex and perceived as impractical in relation to the time, energy and resources they required (Winarto, 2004).

Related to the complexity of the curriculum is the discourse and language used for communication in FFS, which needs to be in a language farmers understand (DANIDA, 2011; Dolly, 2009; Najjar, 2009; Van de Fliert, 1993; Winarto, 2004).

Policy context

Field schools are inevitably embedded within a policy and community context which can act to promote or hinder FFS effectiveness. Some evidence suggested that the existence of conflicting agricultural policies can act as a barrier to adoption of FFS practices. In some cases, the involvement of a multitude of institutions each promoting their own mandate resulted in each impacting on the design, content and implementation of FFS, crowding out the beneficiary needs and interests (Isubikalu 2007; Simpson, 1997).

In other cases, the institutional legacy of existing extension systems influenced the implementation of FFS (Isubikalu 2007; Mancini et al., 2007; Van de Fliert, 1993; Winarto, 2004). Institutional structures associated with earlier top-down agricultural extension systems, such as subsidised input schemes, trickle-down messages and off-the-shelf technology promotion, remained and contradicted the bottom-up, participatory approach of FFS.

There was also some evidence suggesting the power of the pesticide industry and continued links with the extension system acted as a barrier to adoption and diffusion of FFS practices. At least two studies found that the pesticide industry maintained close links with the extension system at the local level (Mancini et al., 2007; Van de Fliert, 1993), paying commission to extension workers and local cooperatives to promote pesticides, hampering farmers' efforts to practise IPM.

Several studies suggested that policy context was key for FFS effectiveness and sustainability, although no studies provided any systematic analysis (Praneetvatakul & Waibel, 2006; Pananurak, 2010; Wu, 2010). In particular, high levels of subsidies for inputs, including pesticides, might have provided strong incentives against IPM (Pananurak, 2010). Incentives to use pesticides, such as subsidies, and different market-based as well as institutional disincentives to the adoption of IPM, may have reduced adoption rates (Praneetvatakul & Waibel, 2006; Pananurak, 2010). This was the case in Thailand where, after a period of high-level support for FFS in the Department for Agricultural Extension, a change of leadership in the department reversed priorities towards pesticide-based crop protection and the FFS programme declined (Praneetvatakul & Waibel, 2006). In China, plant protection stations at township and county levels were found to be involved in pesticide sales due to shortages of operation funds, resulting in a diversion of human resources or even outright subversion of extension agents' attitudes towards pesticide use (Wu, 2010).

Community and social capital

Another emerging theme was the potential role of existing social capital in influencing FFS effectiveness. Several of the qualitative studies highlighted the role of the community in influencing farmers' practices (Dolly, 2009; Machacha, 2008; Najjar, 2009; Palis, 2002; Simpson, 1997; Van Der Wiele, 2004; Winarto, 2004).

There was limited evidence to support the assumption that sustained adoption of FFS practices requires community-wide uptake (Feder et al., 2004a). In one study, farmers in Indonesia found it difficult to practise new strategies when the rest of the community continued applying the existing practices (Winarto, 2004). However, the reason for this seems to be that they faced discouragement and disbelief from their untrained peers, rather than a fear of re-infestation.

Several of the qualitative studies suggested existing social capital and reach of social networks may also influence adoption among FFS participants (Dolly, 2009; Gottret & Córdoba, 2004; Palis, 2002; Simpson, 1997). In some cases high levels of social capital and a tradition of collective action from existing farmer groups may have encouraged a willingness to learn and succeed with the training, and facilitated adoption (Dolly, 2009; Gottret & Córdoba, 2004; Palis, 2002). On the other hand, in one case low levels of social capital and little sense of community in the FFS villages may have been a barrier.

Access to inputs

Five studies highlighted issues related to availability of inputs, labour and markets (DANIDA, 2011; Machacha, 2008; Mancini et al., 2007; Najjar, 2009, Van Der Wiele, 2004). In all cases the lack of access to inputs, capital and/or markets were suggested as factors influencing uptake of FFS practices or final outcomes of the FFS training. These issues are common challenges for farmers, and are not particular to FFS programmes, but they appear to have remained a barrier for FFS farmers to adopt FFS practices and benefit fully from adoption. Indeed, the analysis suggested field schools involving farmers who were of higher socioeconomic status (measured by education and landholdings) tended to have greater impacts in terms of adoption as well as agricultural outcomes.

6.2 FINAL OUTCOMES

Agriculture and other outcomes

No studies with a low risk of bias were identified and 11 quasi-experimental studies were assessed as being of medium risk of bias in measuring agricultural outcomes. The meta-analysis found evidence that FFS improved agricultural outcomes among participants, as measured by a 13 per cent increase in yields on average across medium-risk-of-bias studies (RR=1.13, 95% CI=1.04, 1.22; Q=53, Tau-sq=0.008, I-sq=81%; 11 observations) (Figure 20) and 19 per cent increase in profits or net revenues (RR=1.19, 95% CI=1.11, 1.27; Q=1, Tau-sq=0, I-sq=0%; 2 observations) (Figure 22). However, the analysis also found evidence for publication bias for yields outcomes, suggesting effects may be smaller or non-significant.

The estimated impact on net revenues was proportionately greater than yields, a likely consequence of the combination of both improved agricultural output and reduced costs in terms of pesticide use. The effects were similar both for IPM/IPPM field schools and field schools promoting other curricula, although the extent of evidence for FFS promoting these other curricula was relatively weak. However, impacts of FFS do not appear to be significantly positive for longer follow-up periods (greater than two years) and scaled-up programmes implemented at national level.

There was no evidence that longer-term programmes implemented at national scale are effective, although only two such programmes in Asia have been evaluated.

Authors have suggested that FFS are likely to result in substantial benefits only in areas where farmers overuse pesticides, practise intensive methods of farming or have so far ignored economic considerations in their decisions to apply pesticides (Praneetvatakul et al., 2007). Furthermore, barriers in going to scale may arise due to problems in recruiting and training sufficient numbers of facilitators, as noted above.

The qualitative evidence suggested ongoing support and/or follow-up are important for sustainability of the FFS approach, including sufficient technical support and backstopping from researchers and extensionists to allow farmers to continue the development of local practices (DANIDA, 2011; David, 2007; Dolly, 2009; Gottret & Córdoba, 2004; Karanja-Lumumba et al., 2007; Machacha, 2008; Simpson, 1997; Van Der Wiele, 2004; Winarto, 2004).

The studies which reported on follow-up group activities taking place suggested that active follow-up and continued support by the implementing agency, encouragement to establish farmer clubs and additional sessions on club formations may facilitate the establishment of sustainable and effective groups and practices. Existence of support and follow-up was also found to contribute to the establishment and sustainability of FFS-related activities.

Several factors were highlighted as important for the sustainability of FFS groups following graduation. These include consistent membership participation, leadership, collective goals and activities, and group support and validation important in building up confidence in FFS practices of FFS graduates. There was also a suggestion that reimbursing participants for FFS attendance may have undermined sustainability of the FFS groups.

The evidence on outcomes relating to health and the environment was very limited. No studies of sufficient internal validity measured health outcomes. A number of studies measured the environmental impact quotient score, which is an indirect measure based solely on estimates of pesticide use, finding improvements for FFS farmers only (RR=0.61, 95% CI=0.48, 0.78; Q=3, Tau-sq=0.01, I-sq=33%; 3 observations) (Figure 24).

Empowerment and gender relations

Proponents of FFS suggest empowerment is a key outcome of FFS. Few quantitative studies were able to report on aspects of empowerment such as self-esteem. One medium-risk-of-bias study in Peru (Van Rijn et al., 2010) estimated increases in the probability of feeling capable of solving problems in the field, feeling comfortable in giving an opinion, and participating in the community (RR=2.13, 95% CI=1.46, 3.12) (Figure 26).

While few impact evaluation studies looked at these outcomes, empowerment and perceived improvements in gender relations were frequently highlighted in the qualitative literature (DANIDA, 2011; Dolly, 2009; Friis-Hansen, 2008; Friis-Hansen et al., 2012; Hofisi, 2003; Machacha, 2008; Mancini et al., 2007; Najjar, 2009; Simpson, 1997; Van Der Wiele, 2004; Winarto, 2004). Evidence from these studies based on participants' perceptions suggests FFS may influence feelings of empowerment and gender relations positively. However, there is a lack of causal evidence to support these findings.

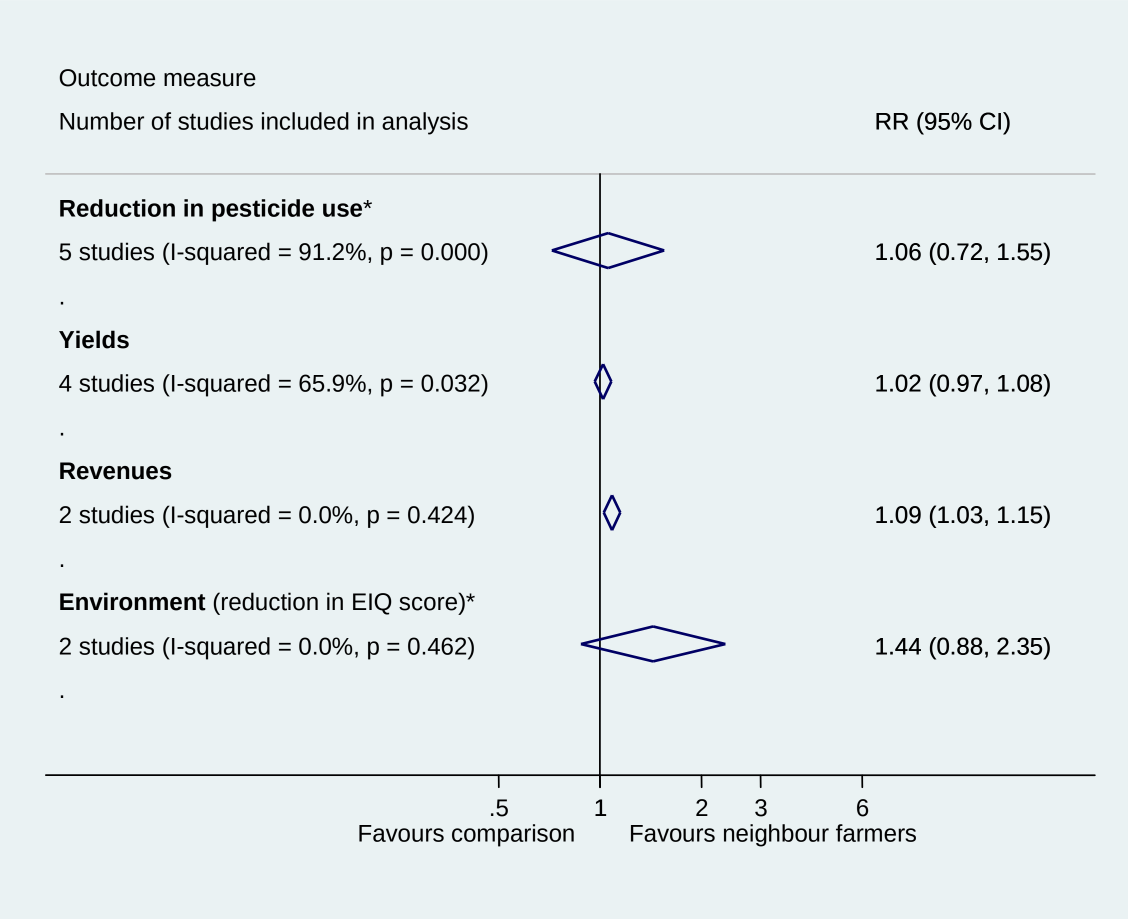
6.3 DIFFUSION TO NON-PARTICIPATING NEIGHBOUR FARMERS

The quantitative impact evidence overwhelmingly supported the notion that there was little, if any, diffusion of integrated pest management (IPM) to non-participating neighbour farmers through their interactions with FFS participants or other outreach activities. The impact evaluations did not provide any evidence for diffusion of knowledge to neighbouring farmers. Only four high-risk-of-bias studies estimated impacts which were insignificantly different from zero, individually and pooled. Consequently, there was no evidence for adoption among neighbours in terms of pesticide use (RR=0.95, 95% CI=0.64, 1.39; Q=45, Tau-sq=0.14, I-sq=91%; 5 observations) on average across studies (no studies measured adoption of other practices for neighbours), nor any significant changes in outcomes for neighbour farmers in terms of yields (RR=1.02, 95% CI=0.97, 1.08; Q=9, Tau-sq=0.002, I-sq=66%; 4 observations) (Figure 32).

Some evidence suggested that there may have been diffusion of simple messages in the short term, where FFS participants were relatively well educated, but not in the long term and no studies collected data for more complex practices.

Over half of the studies included in the qualitative synthesis covered themes relevant to the diffusion of FFS knowledge and practices to non-participants (David, 2007; Gotret & Córdoba, 2004; Hiller et al., 2009; Karanja-Lumumba et al., 2007; Machacha, 2008; Mancini et al., 2007; Palis, 2002; Rola & Baril, 1997; Simpson, 1997; Van de Fliert, 1993; Winarto, 2004). Overall they suggested both characteristics of FFS and contextual factors act as barriers to diffusion.

Figure 32 Summary meta-analysis findings for IPM-FFS neighbours



Notes: Response ratio (RR) measures ratio of outcomes among FFS neighbours to comparison group. * Variable inverted.

Characteristics of FFS: Complexity, observability and relative advantage

Several characteristics of FFS may explain why practices promoted in FFS did not spontaneously diffuse in the community. Studies in Cameroon, India and Indonesia highlighted the complexity and the experiential nature of FFS learning as a barrier to diffusion (David, 2007; Mancini et al., 2007; Van de Fliert, 1993, Winarto, 2004). They noted that, despite high awareness of IPM by non-participants (Van de Fliert, 1993; Winarto, 2004), the skills and practices are complex and their experiential nature makes them difficult to convey via verbal communication (Mancini et al., 2007; Van de Fliert, 1993; Winarto, 2004). In two studies in Cameroon and Kenya where some diffusion was observed, the findings suggested concrete practices were more likely to diffuse than theoretical concepts and principles (David, 2007; Hiller et al., 2009). The studies also found that relatively simple practices, such as pruning and weeding techniques, were more easily disseminated than more complex practices, as also found in one quantitative study in Bangladesh (Ricker-Gilbert et al., 2008).

Just as observability of IPM practices and their relative advantage compared with conventional methods were found to be important in encouraging FFS farmers to adopt new practices, the evidence suggested observability of FFS practices were important for convincing non-FFS farmers to adopt FFS practices (David, 2007; Gottret & Córdoba, 2004; Palis, 2002; Machacha, 2008; Simpson, 1997; Van de Fliert, 1993; Winarto, 2004).

Contextual factors

Five qualitative studies suggested existing levels of social capital influenced diffusion (David, 2007; Gottret & Córdoba, 2004; Palis, 2002; Rola & Baril, 1997; Simpson, 1997).

In some cases low levels of social capital and cohesion limited communication within the community and presented a barrier to diffusion of FFS messages (David, 2007; Simpson, 1997). On the other hand, in the Philippines, high levels of social capital, in particular among farmers with kinship ties, facilitated sharing of IPM concepts with farmers who did not participate in FFS training. Awareness of the main sources of social capital in a particular context, as well as analysis of social networks, might provide an opportunity to facilitate greater diffusion.

Targeting FFS farmers

Meta-analysis suggested that, while IPM messages did not spill over to neighbour farmers on average, there may have been diffusion in terms of reduced pesticide use and improved yields among cotton growers in the short term (less than two years after FFS training), where field schools targeted participants who were more highly educated. The findings should be interpreted with caution due to the limited sample size. However, those studies that examined sustainability found that any initial adoption among neighbouring farmers, in terms of knowledge gains, pesticide use and yields, fell considerably over time.

6.4 AUTHORS' CONCLUSIONS

In this review we have synthesised evidence on the effectiveness of farmer field schools in improving intermediate outcomes (farmers' knowledge, adoption), and final outcomes (yields, revenue, health, empowerment, environmental outcomes). Farmer field schools are complex interventions implemented using different methods of delivery in a range of different contexts. For the review to be more useful for decision-makers, we also synthesised qualitative evidence on barriers to and enablers of the effectiveness of FFS programmes.

The results of meta-analysis provide evidence that FFS are effective in improving intermediate and final outcomes among farmers participating in the training. Although no single study reported on all outcomes, this finding is consistent across the theory of change – farmers appear to learn as a result of training, they adopt simple practices such as reduced pesticide use in the case of IPM, and they experience improvements in outcomes such as yields and revenues. The finding also appears to hold for different types of FFS curricula including the more standard IPM as well as IPPM and farming approaches based on other curricula.

The vast majority of evaluations were assessed as being of high risk of bias due to the approach to counterfactual generation. No studies randomly assigned farmer groups or villages to the programme, an approach which is very feasible for FFS, and most did not use rigorous quasi-experimental designs and methodologies. Due to the nature of the evidence, it is not possible to say at this point whether the benefits were sustained, as few studies have collected follow-up data for more than two years. And the evidence suggests that the few FFS programmes which have been implemented on a national scale have not been effective in improving farmer outcomes. Data from more rigorous evaluations with longer follow-ups are urgently needed.

Evidence suggests that there are no significant effects of diffusion of IPM to neighbouring farmers who did not participate in the FFS training. For many observers the lack of evidence for sustained diffusion of FFS practices in the case of IPM may not be surprising. FFS differ from other interventions such as those that focus on disseminating knowledge of more simple practices, for instance application of fertiliser and pesticides, or adoption of new, improved seeds. The qualitative evidence suggests that both characteristics of FFS and contextual factors are the primary barriers to diffusion. In particular, the complexity of FFS practices, the need for experiential training, and the importance of observing FFS practices to recognise their relative advantage over conventional farmer practices, appear to act as barriers to spontaneous diffusion. Existing levels of social capital and the reach of social networks are also potentially important.

7 Implications

7.1 IMPLICATIONS FOR POLICY

The systematic review provides evidence that farmer field schools can be effective in the short term in improving farmer knowledge and adoption of better practices, and improving yields, revenues and environmental outcomes among field school beneficiaries. These beneficial impacts have been recorded across different types of field school, including those incorporating IPM, IPPM and other techniques.

The impacts on agricultural outcomes are potentially of substantive importance to farmers, in the region of a 13 per cent increase in yields and a 20 per cent increase in profits (net revenues). The effects on revenues appear to be particularly large when FFS are implemented alongside complementary upstream or downstream interventions (access to seeds and other inputs, assistance in marketing produce).

For IPM field schools there is no convincing evidence for diffusion to neighbour farmers who live in the same communities as field school graduates. If diffusion is important for sustained adoption, this is a potentially important weakness of the approach as it has been implemented thus far.

There is also no evidence that the impacts on trained farmers are sustained over time or scalable. Studies of scaled-up programmes measuring outcomes over the longer term (more than two years post-training) do not find any evidence of effects.

As a method of rural adult education, the farmer field school appears suited for gradual scale-up with a clear focus on ensuring local institutionalisation (i.e. favouring depth of coverage in each community over geographical breadth). On the other hand, FFS seem unsuited to solve the problems of large-scale extension from the past. The highly intensive nature of the training programme, the relative successes in targeting more educated farmers as compared with disadvantaged groups, and failures in promoting diffusion of IPM practices, suggest that the approach is not cost-effective compared with agricultural extension in many contexts, except where existing farming practices are particularly damaging.

Stronger policies and regulatory measures may be necessary to counteract the activities of the pesticide industry, including the promotion and sale of pesticides by extension workers. New policies facilitating participatory agricultural extension approaches, replacing earlier extension policies aimed at promoting off-the-shelf technologies and input packages, may also be necessary.

7.2 IMPLICATIONS FOR PROGRAMME IMPLEMENTATION

The review also highlighted factors which are relevant to implementation of farmer field school projects and programmes.

Training of facilitators: In terms of intervention delivery, the training and performance of FFS facilitators is important for the success of FFS and this does require considerable initial investment. This is likely to be particularly problematic for programmes implemented at scale. Recruitment of facilitators should take into account personal attitude, maturity, literacy, leadership skills, knowledge in local language and experience with farming. In many contexts the gender of the facilitator should be carefully considered. Training of facilitators should provide sufficient substantive expertise in IPM or other relevant practices as appropriate to the local context. The training should also focus on participatory techniques and facilitation skills and emphasise the need to use language and concepts with which farmers are familiar. Facilitators should have access to ongoing support and backstopping from supervisors and technical experts connected to local research centres.

Field school design and approach: Our underlying theory of change suggests FFS should be delivered according to a participatory and discovery-based approach to learning, including opportunities for farmers to experiment and observe new practices, where the main objectives are skills development and other forms of empowerment. Regular monitoring of facilitators may help to ensure this happens in practice, and to identify schools where additional support is required.

Consultation and needs assessments are important to ensure the appropriateness of the curriculum to the local context, as well as its relevance to farmers' needs. The curriculum and crops covered in FFS should also be adapted according to the local agricultural system and the needs of the farmers targeted by the programme. Curricula need to deal with the major challenges facing farmers. In most cases these challenges will be multifaceted and there is a need to balance comprehensiveness with the ability to cover all issues in sufficient depth. A cumulative approach over several seasons might be preferable.

Complementary interventions, such as access to finance and inputs such as improved seeds, as well as assistance with marketing, may improve profits (net revenues).

Efficient monitoring and evaluation systems should be put in place alongside FFS implementation to ensure adequate and timely delivery of resources, and to ensure that sites selected for FFS are appropriate.

Dissemination of information to farmers about the resources allocated to FFS might enhance accountability and improve the likelihood of resources reaching FFS.

Targeting: Proponents of FFS have recommended targeting younger farmers, those with greater land endowments, and women, favouring those with relatively low opportunity costs of labour and/or farmers with relatively high pesticide costs. Indeed, Davis et al. (2012) suggest that the FFS approach could serve as a key strategy to provide agricultural extension services to female farmers in Africa, whose access to agricultural extension is generally poor. Women are frequently targeted by FFS, but field schools will be less effective if women are from households where they are not in a decision-making position (as was found in several of the studies included in this review). There were also some problems highlighted with targeting youth that cannot dedicate their time to the FFS plot or their fields.

Analysis suggests field schools involving relatively better-educated farmers tend to produce larger effects on adoption and agricultural outcomes. Nevertheless, FFS may be more effective if they adopt a considered approach to targeting based on who the intended beneficiaries are and in-depth analysis of the local context, including agricultural practices, cultural norms and gender relations. Strategies which include sensitisation around an interest to learn new skills might be successful at recruiting relevant participants.

If the aim is to include women and disadvantaged members of the community, the implementing agency may need to tailor the intervention to enable their participation in the programme. The curriculum needs to be relevant and consistent with the needs and opportunities of women and the poor. For example, in contexts where women are primarily responsible for growing subsistence crops, a curriculum that covers only commercial crops is unlikely to attract women participants.

Sensitisation exercises in the community might facilitate participation of disadvantaged groups, for example where men do not allow their wives to participate in the training because they do not see the benefits or are uneasy about the prospect of their wives working with other men.

Institutional actors involved in FFS should consider beneficiary needs and interests in the design and implementation of the FFS programme.

Sustainability: Formal support and encouragement of FFS alumni, including technical assistance and backstopping may be important for the sustainability of FFS practices and related activities. Working with FFS groups to support common goals, good leadership and high attendance rates might facilitate sustainability of FFS activities after the end of the training. Particular contexts may be more relevant for sustainability such as areas with clear overuse of pesticides and therefore clearer benefits from IPM adoption.

Adoption of IPM by neighbouring farmers: Awareness of the main sources of social capital in a particular context and analysis of social networks to inform targeting may enhance the efficiency of farmer-to-farmer diffusion of FFS practices. Complementary interventions such as mass media campaigns are likely to improve diffusion for simple messages (such as "no early spray") only. However, given the skills-based nature of the practices promoted in FFS, formal community-building activities, support and attempts to institutionalise the approach, to encourage FFS graduates to train other farmers, are likely to be needed for any diffusion to neighbours. However, the evidence does not suggest that such approaches have been effective so far.

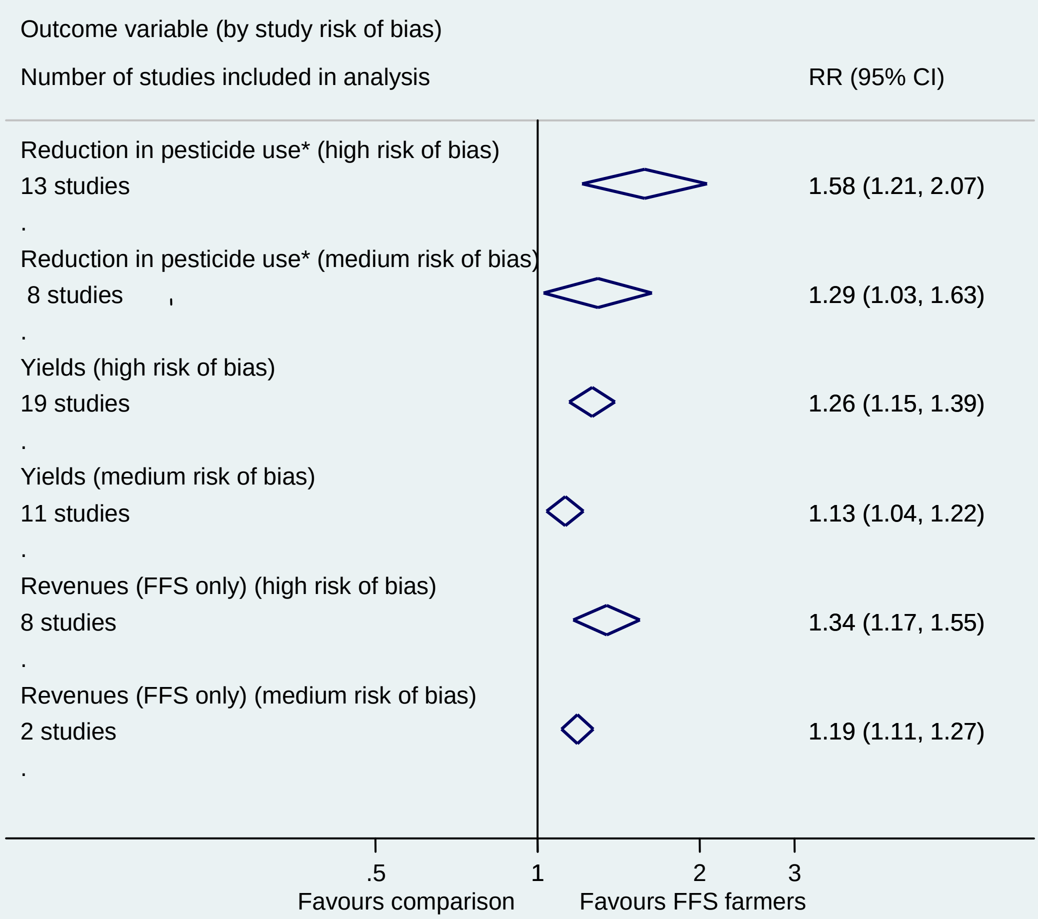
7.3 IMPLICATIONS FOR RESEARCH

A large number of impact evaluations aim to demonstrate the effects of farmer field schools, mainly on agriculture outcomes. A smaller number examine other outcomes such as health, empowerment and environmental impacts. However, the majority of available studies are not sufficiently rigorous to inform policy.

Most quantitative impact evaluations were classified as having a high risk of bias. In many studies, no serious attempts were made to control for confounding through statistical matching or in other statistical analysis, and in many cases statistical significance tests were not reported. Many studies stated that they matched communities although this matching does not appear to be statistically rigorous. The consequence was the systematic overestimation of impacts, as demonstrated in the analysis for nearly all outcomes (Figure 33). We were not able to identify any high-quality impact evaluations which we could classify as of low risk of bias in causal attribution. No studies used randomised assignment, although cluster randomised trials are feasible for studying FFS impacts on participating communities. More studies using rigorous counterfactuals, especially those based on prospective assignment (randomised or otherwise), allocated at cluster level to measure spillovers, together with long-term follow-ups to determine sustainability, are needed.

Impact evaluations should routinely report information needed to calculate effect sizes in particular means and standard deviations of outcome variables and sample sizes including numbers of clusters and cluster sample sizes per treatment arm.

Figure 33 High-risk-of-bias studies produce systematically larger effects



Note: * variable inverted

A body of high-quality, theory-based impact evaluations that report and analyse a hypothesised causal chain is needed to improve policy relevance and usefulness of findings. Evaluations should collect and report data on intermediate and endpoint outcomes, and incorporate qualitative assessment of implementation processes where possible. Studies should also assess whether FFS have heterogeneous effects across sub-groups of farmers.

Studies need to measure a broader range of policy-relevant outcomes. More studies are needed to assess the effects of attending FFS on empowerment outcomes. In addition to measuring empowerment quantitatively, such studies should also attempt to assess the mechanisms underlying any empowerment effects. In addition to empowerment, some FFS also aim to improve health and environmental outcomes, but few existing studies included in our review have measured these. Future studies should collect data on these outcomes using high-quality research methods, drawing on the programme theory and consulting with stakeholders to identify all relevant important outcomes.

The analysis presented here suggests that causal chain analysis can be useful. However, studies need to measure consistently the full range of intermediate and final outcomes along the causal chain in order to enhance understanding of where the theory of change breaks down in particular programmes. Better access by donors and implementers to project documents and evaluation reports would also enable more rigorous analysis of programme design and implementation. In addition, as shown by the large number of studies that were excluded due to a lack of detail on methods, qualitative evaluations need to report aspects of the research process in greater detail to allow users to assess their credibility and trustworthiness. In particular, clear reporting on objectives, on methods of sampling, data collection and analysis are needed. Use of structured abstracts and more structured reporting of the full text of primary studies will also enhance our ability to assess the credibility of qualitative research and to use that research in evidence syntheses.

Few studies reported on the subjective views and experiences of FFS facilitators. This is a weakness of the existing evidence base and future studies should include perspectives of FFS facilitators and, where relevant, agricultural extension workers.

7.4 LIMITATIONS OF THE REVIEW

Due to the large number of quantitative impact studies included in this review, we did not undertake double-coding for studies assessed to be of high risk of bias, nor did we contact authors to obtain additional information not reported in these high-risk-of-bias studies. The data from these studies are particularly unreliable, hence we have not drawn any conclusions for policy based on those findings. The review reports information on the extent of agreement between coders, although tests for inter-rater reliability based on Cohen's *kappa* were not calculated.

A second important limitation is that the meta-analysis has involved the synthesis of quantitative studies that come from different study designs, estimating both bivariate and multivariate relationships, and multivariate models with different study covariates. While all medium-risk-of-bias studies, which were used to make implications for policy, did report results from multivariate analyses, these effect sizes are not truly comparable due to the different covariates included in each model (see Appendix D).

There are limitations to the qualitative synthesis both due to the quality of the included studies, as well as the way in which we conducted the review of those included studies. As highlighted by the quality appraisal, there are clear limitations to the evidence base, and therefore the findings of the synthesis should be interpreted with caution.

There remains some disconnect between the effectiveness synthesis and the qualitative synthesis, as there is not a clear link between the interventions studied in the quantitative and qualitative studies. We attempted to link the studies by FFS programme name, but information on implementation was insufficiently reported in either the included impact and qualitative studies or the project documentation we were able to identify. We are not able to conclude strongly about heterogeneity in effects with respect to the moderating factors identified in the qualitative synthesis, particularly FFS design and implementation, and therefore we are not able to provide strong policy guidance on how to amend programme design or implementation to maximise impacts. There are no cases where we have information about intervention effects based on rigorous counterfactual analysis and detailed information about implementation and other barriers and enablers that may moderate intervention effectiveness.

7.5 DEVIATIONS FROM PROTOCOL

The protocol suggested we would include all qualitative and quantitative studies relevant to assessing the barriers to and enablers of FFS effectiveness to answer review question (2). However, during the review process we realised that synthesising such a broad range of studies presented challenges for data extraction, quality appraisal and synthesis. Hence we revised the inclusion criteria for barriers and enablers synthesis to exclude correlation, regression and simulation or modelling studies. However, we collected additional data on farmer characteristics and programme targeting from all effectiveness studies (including linked papers) to supplement the quantitative analysis for review question (1), conducting moderator analyses across all studies where these data were available. Some of the moderator variables, such as on intervention components, were identified a posteriori after the qualitative synthesis had been completed. For mixed methods studies that included an impact evaluation component, we assessed, coded and synthesised only those sections relevant for the qualitative synthesis (i.e. those sections that presented evidence about the barriers to and enablers of FFS effectiveness). The impact evaluation evidence in these studies was separately assessed for inclusion for the quantitative review component.

8 Support and Authorship

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The views in this report are not attributable to MCC, 3ie or 3ie's member organisations. All errors are the responsibility of the authors.

DECLARATIONS OF INTEREST

We are not aware of any conflicts of interest arising from either researcher interest or financial sources.

REVIEW TEAM

Lead reviewers:

The lead authors developed and coordinated the review team, discussed and assigned roles for individual members of the review team, liaised with the editorial base and will take responsibility for the ongoing updates of the review.

Name:	**Hugh Waddington**

Title:	Senior Evaluation Specialist
Affiliation:	International Initiative for Impact Evaluation
Address:	London International Development Centre
City, State, Province or County:	36 Gordon Square, London
Postal Code:	WC1H 0PD
Country:	UK
Phone:	+44 207 958 8352
Email:	hwaddington@3ieimpact.org
Name:	**Birte Snilstveit**
Title:	Evaluation Specialist
Affiliation:	International Initiative for Impact Evaluation
Address:	London International Development Centre
City, State, Province or County:	36 Gordon Square, London
Postal Code:	WC1H 0PD
Country:	UK
Phone:	+44 207 958 8352
Email:	bsnilstveit@3ieimpact.org

Co-authors:

Name:	**Jorge Garcia Hombrados**
Title:	Research Officer
Affiliation:	International Initiative for Impact Evaluation
Address:	London International Development Centre
City, State, Province or County:	36 Gordon Square, London
Postal Code:	WC1H 0PD
Country:	UK
Name:	**Martina Vojtkova**
Title:	Research Officer
Affiliation:	International Initiative for Impact Evaluation
Address:	London International Development Centre
City, State, Province or County:	36 Gordon Square, London
Postal Code:	WC1H 0PD
Country:	UK
Name:	**Daniel Phillips**
Title:	Research Officer
Affiliation:	International Initiative for Impact Evaluation

Address:	London International Development Centre
City, State, Province or County:	36 Gordon Square, London
Postal Code:	WC1H 0PD
Country:	UK
Name:	**Philip Davies**
Title:	Deputy Director
Affiliation:	International Initiative for Impact Evaluation
Address:	London International Development Centre
City, State, Province or County:	36 Gordon Square, London
Postal Code:	WC1H 0PD
Country:	UK
Name:	**Howard White**
Title:	Executive Director
Affiliation:	International Initiative for Impact Evaluation
Address:	New Delhi
Country:	India

ROLES AND RESPONSIBILITIES

The study was undertaken by Jorge Hombrados (JH), Daniel Phillips (DP), Birte Snilstveit (BS), Martina Vojtkova (MV), and Hugh Waddington (HJW). HJW and BS developed the study protocol. HJW led the quantitative effectiveness synthesis and compiled the overall systematic review report. BS led the qualitative synthesis of barriers and enablers.

JH, BS, MV and HJW conducted the search, using EndNote reference management software. Decisions on inclusion for impact evaluation studies were made by JH and HJW, with conflicts resolved through discussion and consensus. Decisions on inclusion for qualitative impact evaluation studies were made by BS and MV, with Philip Davies (PD) acting as an arbiter. Qualitative study coding was carried out by BS, MV, JH and DP, while critical appraisal and effect sizes estimation was undertaken by JH and HJW. HW and PD provided technical support. DP also undertook the portfolio systematic review reported in Appendix A, with support from Gracia Pacillo (IFAD) and HW.

PLANS FOR UPDATING THE REVIEW

We will update the review once sufficiently rigorous studies and resources become available.

9 References

The references are organised into included effectiveness studies, included qualitative studies, studies excluded from synthesis, and additional references. Reasons for exclusion of marginal studies are given in Appendix B.

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Appendix A

GLOBAL PROJECT PORTFOLIO REVIEW

The global status of farmer field schools

The following analysis is intended to provide an overview of the way in which the FFS approach has been developed, the manner in which it has been implemented, the objectives that FFS projects have pursued, and the types and groups of people that have participated in them. The portfolio review is based upon a systematic search for relevant published and unpublished literature, the use of predetermined inclusion criteria for admissable data, and a systematic coding and data extraction process (for full details of the research methodology, see Appendix A1). Although the portfolio's research methodology aimed to cast as wide a net as possible, not all FFS project documentation was freely available and therefore the portfolio does not represent a comprehensive review of all global FFS projects to have been carried out to date.[41]

The search process employed in this portfolio review of projects is shown in Figure A1. As far as possible, where projects were clearly identified, any data relating to a project was consolidated in a single portfolio entry. Hence, there should be no multiple entries for the same projects. Careful checks were made to avoid double-counting (by comparing project names, locations and other reported details).

By combining the information available in the portfolio from our searches[42] with that from Braun et al.'s (2006) dataset,[43] we estimate that, historically, somewhere in the range of 400,000 to 475,000 farmer field schools[44] have been undertaken across all low- and middle-income countries (LMICs), producing 10–12 million graduating farmers.[45] The latter figure is comparable with Braun and Duveskog's (2008) estimate that by 2008 between 10 million and 20 million farmers had graduated from farmer field schools globally. The figures above should be

[41] In particular, the FAO were unfortunately unable to release internal documentation on FAO-funded FFS projects. The information provided by different source documents is also of a varying standard and completeness.

[42] See Appendix A1, Data extraction and analysis (1).

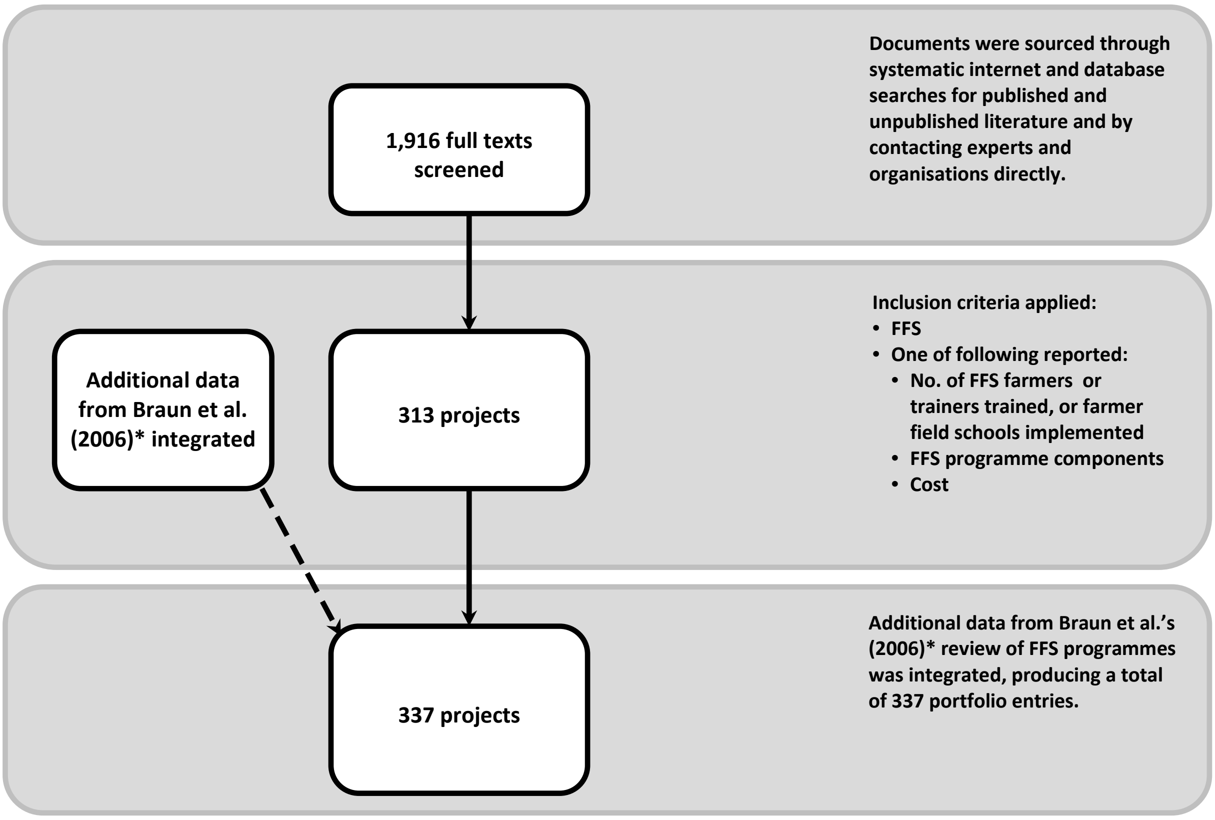
[43] The authors would like to thank Arnaud Braun for sharing this data with us.

[44] A school is typically a single cohort receiving FFS training for a determined time. Typically this would be in one (or occasionally) multiple specified locations (though not wide geographic areas). The total figures are approximate given problems in identifying the unit of analysis, and acknowledged as such in the text. A school was defined in one of two ways: some projects reported that they included a given number of schools; others reported a number of participants only and this figure was divided by 25 to produce a proxy number of schools.

[45] See Appendix A1, Data extraction and analysis (2).

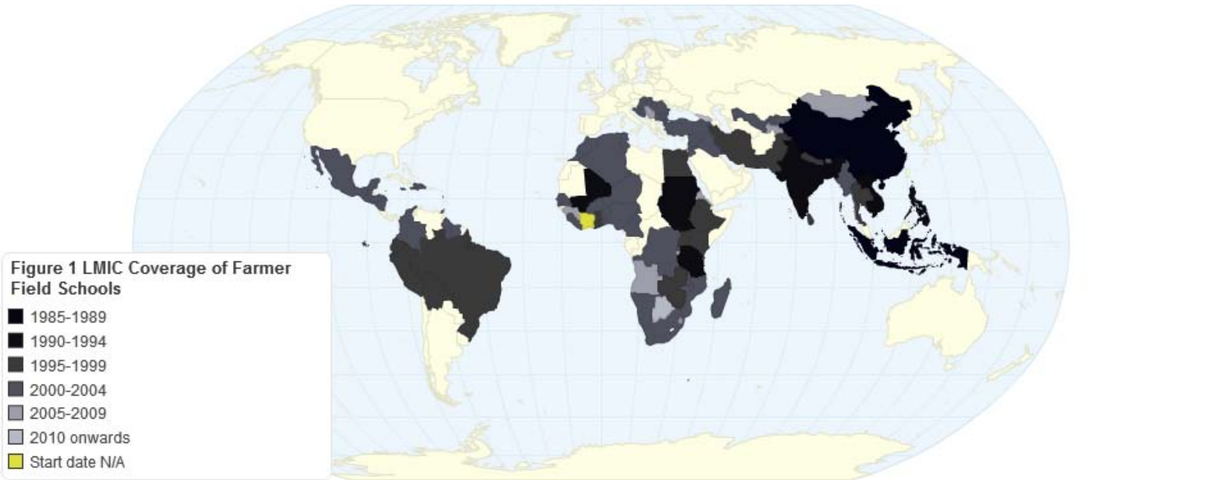
interpreted as lower bound estimates, given that the portfolio and the Braun et al. (2006) dataset still only capture a proportion of all historic FFS initiatives.

Figure A1 FFS global portfolio research overview



Combining analysis from the portfolio with data again taken from the Braun et al. (2006) FFS review indicates that farmer field schools have been introduced to at least 90 LMICs worldwide, as illustrated in Figure A2.

Figure A2 Coverage of farmer field schools in LMICs[46]

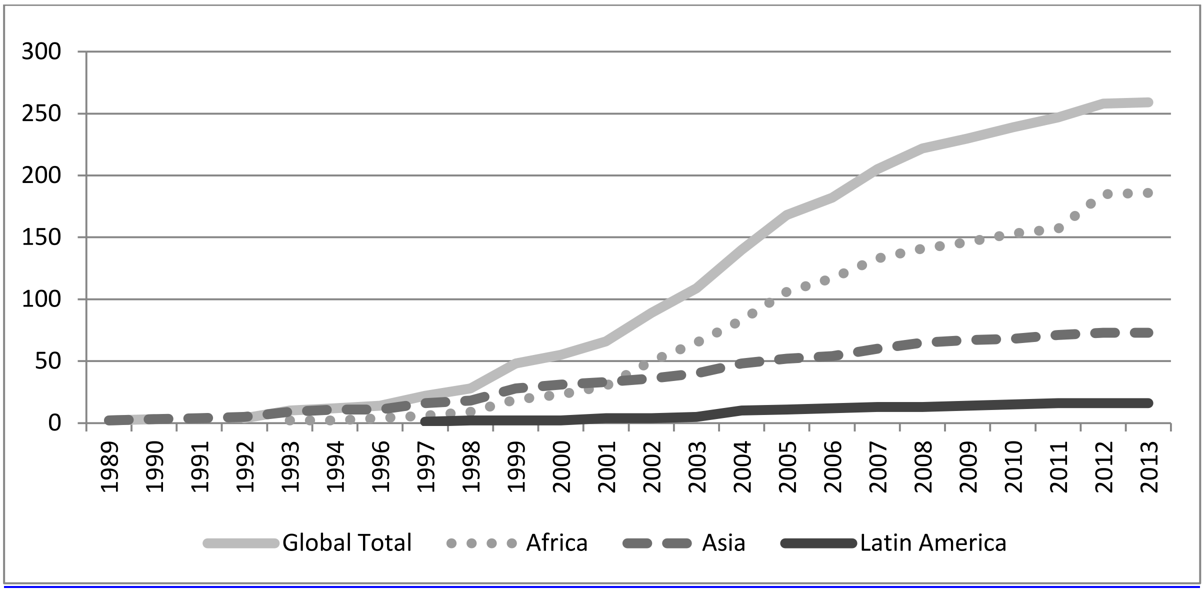


[46] The map in Figure A2 was created using using the chartsbin website: www.chartsbin.com

Farmer field schools were first introduced in Indonesia in 1989. With the support of the FAO, they were then implemented in various other South-East Asian countries. The popularity of the FFS approach subsequently led to its adoption and adaptation in countries around the world, especially in Africa. Over half of all FFS projects in the portfolio were based in Africa, although the majority of beneficiaries (around 60%) were Asian. This illustrates both the extent to which the FFS approach has been implemented in Africa and the comparatively larger scale of Asian-based FFS programmes. Figure A3 illustrates the growth in implementation of the FFS approach since the early 1990s, with a marked growth in the number of projects in Asia and especially in Africa during the 2000s and beyond.

The average duration[47] of the projects in the portfolio was around four and a half years, although the most common project duration was three years. The actual FFS duration for most of the benefiting farmers was most commonly a single season, although there were a significant number of projects for which training lasted a year or longer. Thus, a typical project from the portfolio would last three years and would contain several FFS, each lasting a single season.

Figure A3 Cumulative number of farmer field school projects implemented



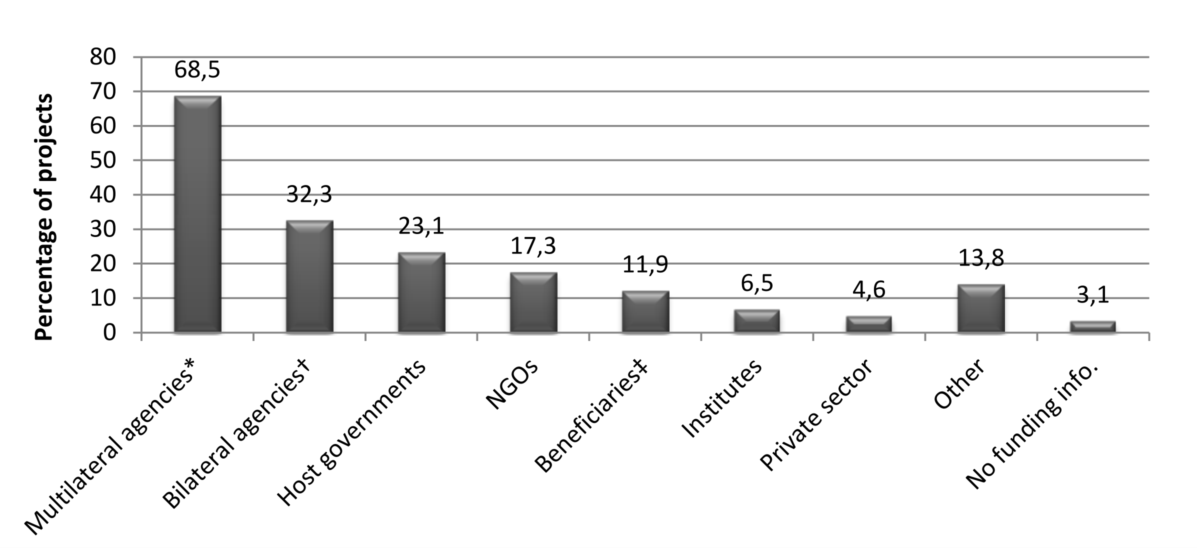
Note: The trend calculated here is based on project start dates and includes data for the 99% of portfolio projects for which a start date could be established.

Funding, implementation and costs

Agricultural extension activities provide an opportunity to reach some of the poorest in the world and provide them with the knowledge and tools to increase productivity and improve livelihoods. Organisations with a special interest such as the FAO or IFAD have led the way, but host governments and other multilaterals, bilaterals and NGOs have also enthusiastically provided funding for a range of FFS projects around the world (Figure A4).

[47] A distinction is made here between *project duration*, or the number of months or years that an FFS project lasts for, and the *FFS duration*, or the length of time for which a given cohort of benefiting farmers receive training.

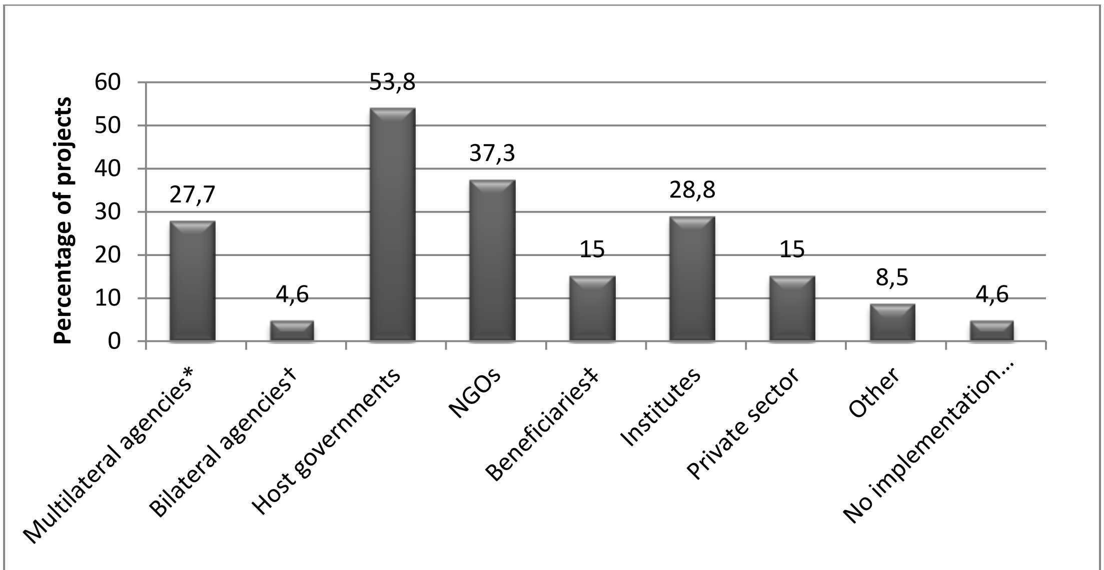
Figure A4 Funding organisations



Notes: * Such as UN bodies and multilateral banks. † Including agencies such as DFID or AusAID or direct funding from foreign governments. ‡ Including producer groups, farmer collectives and associations. Projects may receive funding from multiple organisations, hence total percentage sums to greater than 100 per cent.

Figure A5 provides a breakdown of the proportion of projects in which different types of organisation have helped to coordinate or implement projects on the ground. Host governments have been involved in the implementation of over half the projects in the portfolio, while NGOs and multilateral agencies have also played a big part. Research institutes with a specific interest in FFS have also played a significant role in the implementation and/or coordination of projects. For example, the International Potato Center (CIP) played a key role in the implementation of a number of FFS projects in Peru which have specialised in potato farming (Zuger, 2004).

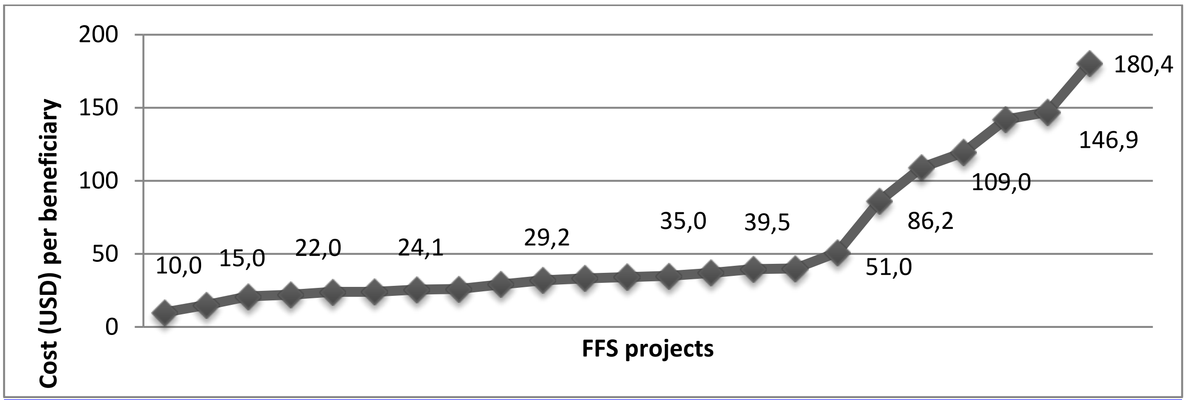
Figure A5 Coordinating and implementing organisations



Notes: *Such as UN bodies and multilateral banks. † Including agencies such as DFID or AusAID or direct funding from foreign governments. ‡ Including producer groups, farmer collectives and associations. Projects can be implemented by multiple organisations, hence total percentage sums to greater than 100 per cent.

Van den Berg and Jiggins (2007) report costs of FFS projects per graduating farmer ranging from less than a dollar to over USD60, attributing this wide variation in part to the lack of any standardised system of reporting. In Figure A6, we provide a basic calculation of cost per beneficiary for a subset of around 10 per cent of the projects in our portfolio.[48] We find that the average cost per beneficiary is around USD56, with the majority of values clustered around the USD20–40 mark.[49] Some of the higher figures included here are likely to include start-up costs or costs of inputs such as seeds or tools, as well as variable costs, and so provide upper bound estimates on the costs of implementing and maintaining field schools.

Figure A6 Cost per FFS beneficiary



Note: Current costs not adjusted for inflation.

Crops, livestock and curricula[50]

While the first FFS targeted rice farmers, they have increasingly been adapted for a wide variety of crops and livestock to reflect the diversity of farming practices around the world (Davis et al., 2010). Some FFS have supported the production of a number of different crops or types of livestock husbandry while others have focused more narrowly (see Figures A7 and A8). The large majority (92%) of portfolio projects developed FFS which targeted some form of crop, in particular cereal crops, root crops, vegetables, cash crops such as tea or coffee and fruit. Over a third of the projects collected in our portfolio supported some form of livestock farming, mainly poultry, cattle, and sheep and/or goats.

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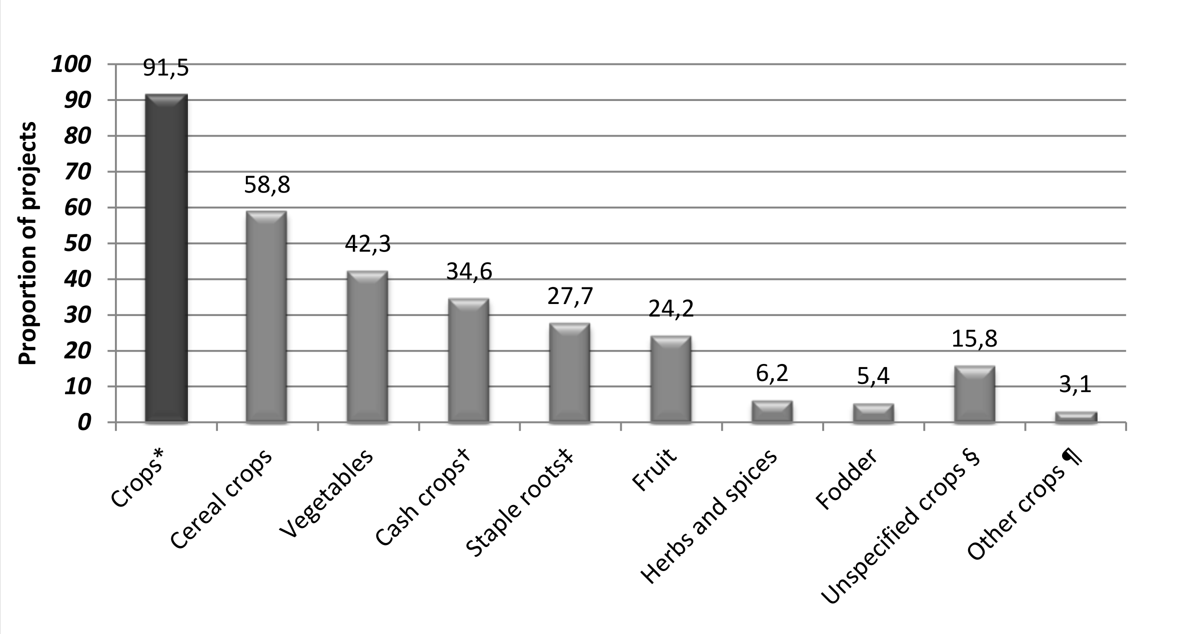
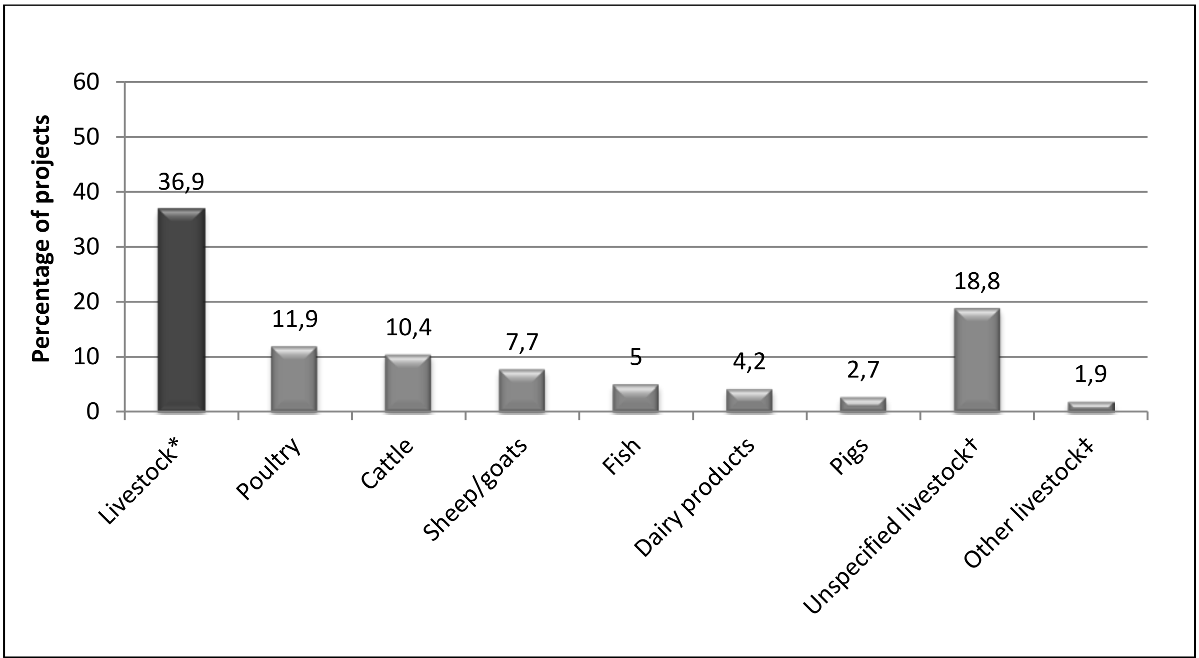
[48] See Appendix A1, Data extraction and analysis (3).
[49] See Appendix A1, Data extraction and analysis (4).
[50] See Appendix A1, Data extraction and analysis (5), for a note on how totals were calculated.

Figure A7 Percentage of projects addressing crop topics



Notes: * Incorporates all crop types. †Including tea, coffee, cocoa, cotton, sugarcane etc. ‡ Such as potato, manioc, cassava etc. § Where a data source has indicated crops without specifying type. ¶ Including floriculture, honey etc. Projects can cover multiple crops, hence total percentage sums to greater than 100 per cent.

Figure A8 Percentage of projects addressing livestock

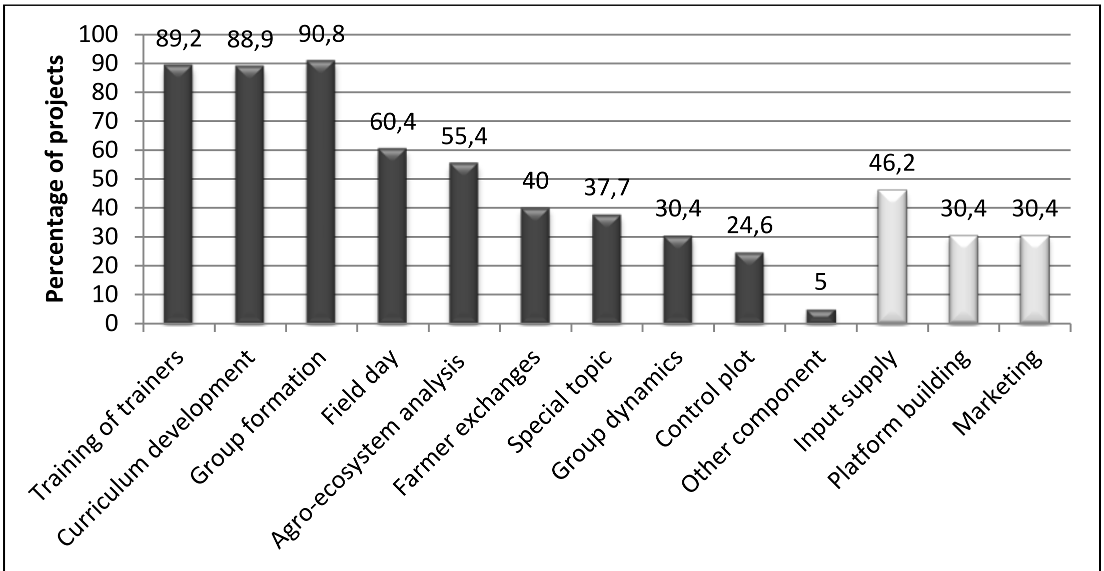


Notes: * Incorporates all livestock types. † Where a data source has indicated "livestock" without specifying type. ‡ Such as boar, rabbits and other small animals. Projects can cover multiple livestock, hence total percentage may sum to greater than 100 per cent.

The foundation of the FFS approach involves participatory learning in the field with farmer observations as the basis for analysis and learning (Gallagher, 2003). FFS sessions themseves are usually built around a flexible set of curriculum components which follow the subject topics of interest. Figure A9 provides a breakdown of the different curriculum and complementary components that are common elements of projects in the portfolio. Also depicted are the estimated share of projects which included complementary upstream and downstream components such as input support, platform building and marketing support. A brief summary of each component is provided in Figure A10.

Analysis of the portfolio shows that a high proportion of the projects included training of trainers, curriculum development and group formation (each around 90%), all of which would be expected to be core elements of an FFS.[51] Over half of the projects also incorporated field days and agro-ecosystem analysis, while many also included farmer exchanges, special topics and group dynamics components. However, only one-quarter of the projects reported that they had incorporated "business as usual" control plots. Pontius et al. (2002) state that control plots should be a part of every FFS for comparison purposes. Even allowing for the fact that some projects may have included control plots, but not documented this, our analysis suggests that this key aspect of the approach is not always implemented. It was also common for projects to incorporate complementary components, with around half providing additional inputs such as seeds or tools, a third setting up farmer organisations and networks, and a further third providing marketing training.

Figure A9 FFS curriculum and complementary components



Note: Projects cover multiple curriculum components, therefore total percentage sums to greater than 100 per cent.

Figure A10 FFS curriculum and complementary components

Curriculum components:

- *Training of trainers:* This entails providing theoretical and practical training to all FFS trainers. Training is usually season-long and typically includes facilitation and teaching skills, farming techniques and management skills.
- *Curriculum development:* This involves planning a farmer field school's workplan, setting out the different modules to be studied, usually with some inbuilt flexibility.
- *Group formation:* This involves setting up an organised group with specified goals such

[51] In interpreting these results it is important to bear in mind that not all the available documentation for the portfolio projects comprehensively reported on curricula. The growth in the number of farmer field school interventions has also made it possible for some projects to recruit trained staff and borrow or adapt existing curricula. In addition, some FFS have actively targeted pre-existing farmer groups.

as a shared workplan, and which has an organisational structure such as a representative committee.

- *Field day:* Field days are designed to promote the work going on in an FFS by inviting local farmers and people of influence to see what has been learned and the benefits that can be produced.
- *Agro-ecosystem analysis (AESA)*: This involves undertaking regular observations of crops to understand the interrelationship between soil, the natural elements and biological pests or weeds.
- *Farmer exchanges:* This involves visits by FFS members to other schools with a view to observing their activities and exchanging ideas.
- *Special topic:* This curriculum component involves the selection of a topic which is usually either suggested by the farmers themselves or is chosen as a response to field observations (e.g. the discovery of a pest in a field).
- *Group dynamics:*This activity is designed to develop leadership, problem-solving, discussion and communication skills. The emphasis is also on collaboration and the promotion of collective action.
- *Control plot:* This involves the setting aside of control plots which either receive no treatment at all or continue to be farmed as before. These plots serve as a baseline comparison for those where new techniques or technologies are implemented.

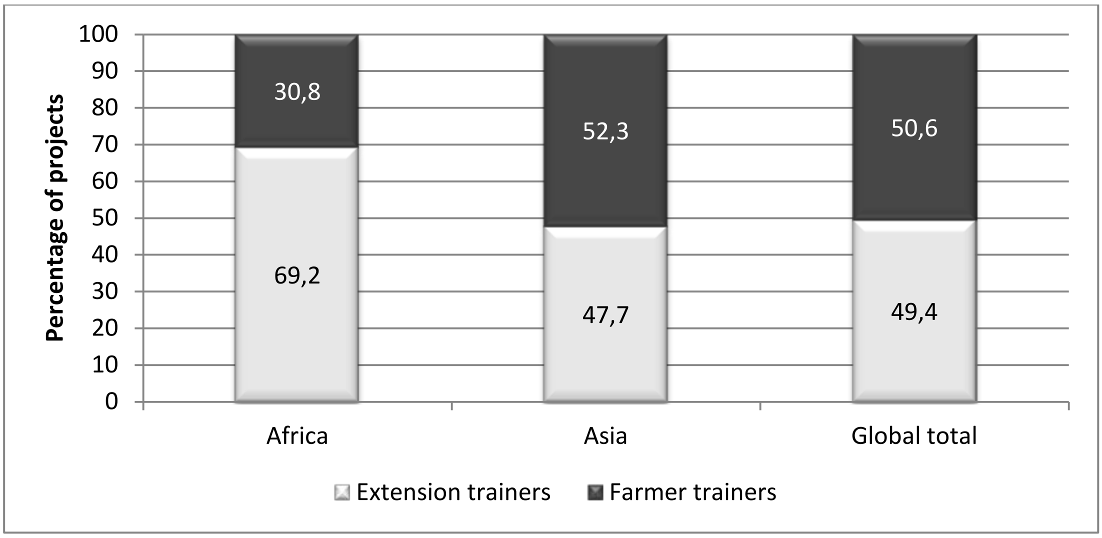
Other component: This category includes components specifically built for a particular group, such as hill farmers or ethnic minorities. Other additional components include community education and animal husbandry.

Complementary components:

- *Platform building:* This includes efforts to ensure that the benefits of FFS are sustained in the long term. Examples of such activities include organising farmers' clubs or building local networks which can ensure continued collective action.
- *Input supply:* This entails the provision of farmers with seeds, tools or other equipment.
- *Marketing*: This component involves providing farmers with training and help in setting up networks, transport and information-sharing geared towards marketing their products.

One of the core elements of the vast majority of the projects examined in the portfolio was to provide training of trainers to produce a cadre of staff able to facilitate the FFS. FFS trainers do not instruct or provide lectures, but instead facilitate the learning process (Khisa, 2004). Trainers may simply be local agricultural experts who have participated in a training course (extension trainers), but increasingly farmers who have themselves graduated from farmer field schools have also been encouraged to undertake training and take the lead role in facilitation (farmer trainers) (Figure A11).

Figure A11 Training of trainers



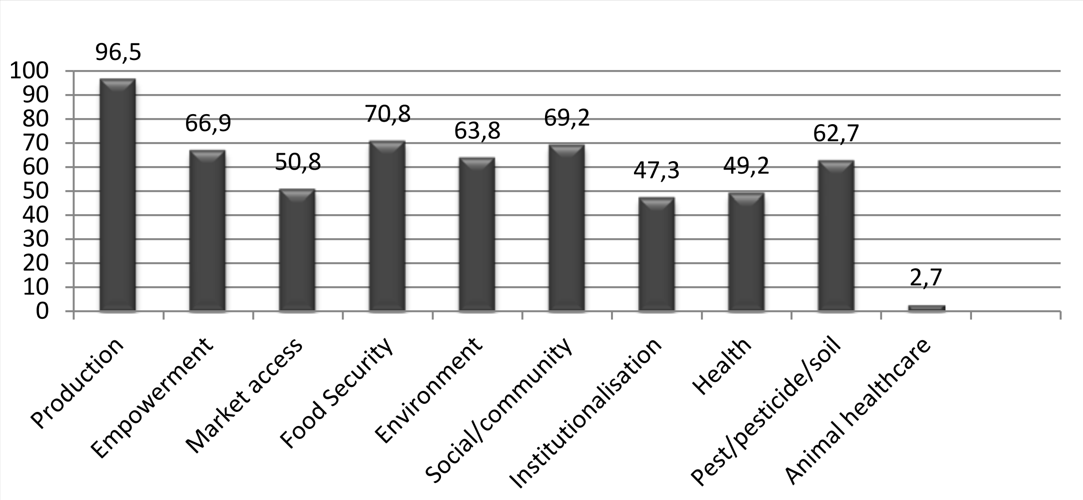
Documentation for around 20 per cent of the portfolio projects recorded this distinction between extension and farmer trainers. Data analysis of this sample showed that around 50 per cent of global FFS trainers have been farmer trainers. This trend was reflected in Asia, though was less true in Africa. Often, as in the case of the Indonesian National IPM Programme (Van den Berg et al., 2004), an initial cohort of extension trainers has helped to train later groups of farmer trainers. This is especially true of larger-scale projects with a longer duration. It may be that for African FFS a lower proportion of all trainers were farmer trainers because, on average, African FFS projects have been on a smaller scale than Asian ones. It is also worth noting that the distinction between types of trainer is more likely to have been documented for projects which encouraged the training of farmer trainers, with the consequence that this analysis may exaggerate their relative numbers. Analysis of the portfolio also indicates that FFS trainers were more than twice as likely to be male than female, regardless of region.

Field school objectives[52]

The proliferation of variations in goals and focus of farmer field schools is reflected by the emergence of a variety of different types of FFS. These include those geared towards specific groups such as Junior Farmer Field and Life Schools, which target orphans and youths between 12 and 18 years old who come from communities where HIV/AIDS has impacted on food security. Other variants, such as business or marketing FFS, are intended to develop additional skills which can improve farmer livelihoods, or to adapt the original approach for an alternative type of farming, as with Farmer Livestock Schools. More generally, FFS have been designed to realise a number of more general goals. The categories in Figure A12 cover some of the most common objectives for FFS projects, as reported in project documentation. Figure A13 provides some definitions for each objective type.

[52] See Appendix A1, Data extraction and analysis (5), for a note on how totals were calculated.

Figure A12 Project objectives



Note: Projects may have multiple objectives, therefore total percentage sums to greater than 100 per cent.

Figure A13 Project objectives definitions

- *Production:* This includes objectives such as increased production, increased quality of production and improved production techniques.
- *Empowerment:*This objective refers to the desire to improve beneficiaries' self-regard, social skills and control over assets, as well as interactions with other local farmers, local government and service providers.
- *Market access:* This involves providing training and help in setting up networks, transport and information-sharing geared towards marketing produce.
- *Food security:* This involves improving access to sufficient, safe and nutritious food.
- *Environment*: This category includes education on the environment and climate change, sustainable land and water use, the reduction of negative environmental impacts from farming and the protection of the local environment and existing natural assets through dyke construction or forestation/reforestation, for example.
- *Social and community objectives:* This includes objectives such as reducing gender inequality, targeting minority groups, community development or strengthening producer groups.
- *Institutionalisation:* This includes the construction of infrastructure, or the setting up of networks or groups with the intention of ensuring ongoing FFS benefits.
- *Health:* This includes targeting improved health outcomes for local populations through education or the reduction of harmful chemicals used in agriculture.
- *Pest, pesticide and soil management:*This includes the introduction of pest control methods, reduced use of chemical pesticides and the implementation of crop or soil management techniques.
- *Animal healthcare:* This category includes objectives such as improving animal health, husbandry and the provision of veterinary support.

Improved production was a central goal for almost all the portfolio projects,[53] with the majority also aiming to boost food security, strengthen communities and

[53] A project was only coded as targeting production where it was clearly stated as a goal or this was clear from context in the documentation available. In reality, improved production is such a universal goal for FFS that the figure here may well underestimate the proportion of projects targeting it.

empower individuals. Protecting the environment or promoting sustainable farming techniques was also a very common objective as was some form of pest/pesticide/soil management (see Figure A14 for a more detailed analysis of FFS and pest management). Around half of the projects targeted health improvements, market access and institutionalisation of FFS, while only a small minority were designed to support animal healthcare.

The first farmer field schools in Asia were designed to introduce integrated pest management (IPM) to tackle the problems resulting from an over-reliance on chemical pesticides (Van den Berg & Jiggins, 2007). Since then, farmer field schools have evolved so that many focus on different soil management or production techniques rather than on pests. Around 60 per cent of the portfolio projects explicitly stated that some form or combination of pest, pesticide or soil management was an objective (although this type of component is such a common element of the FFS approach that it is likely that some projects included such components, but details were not documented). A large proportion of the projects that did report this type of component stated that IPM had been a part of the FFS. A significant number of projects have also pursued variant forms of IPM, developed to suit specific geographical locations or objectives. Figure A14 sets out the incidence of the different management techniques as reported.

The majority of projects that reported on this type of management technique stated that IPM was incorporated as part of the FFS intervention. Variant integrated techniques such as IPPM, ICM and ICPM were also recorded, while others simply reported some form of pesticide management or soil management (see Figure A15 for definitions). In many cases, the type of pest, pesticide or soil management utilised is reported only briefly. Where more detail is available, there is considerable overlap between the usage of the different concepts. While some of the categorisations below are fairly clearly defined in FFS literature, others are more general terms whose meaning has been inferred from their usage.

Figure A14 Pest, pesticide and soil management (percentage of projects)

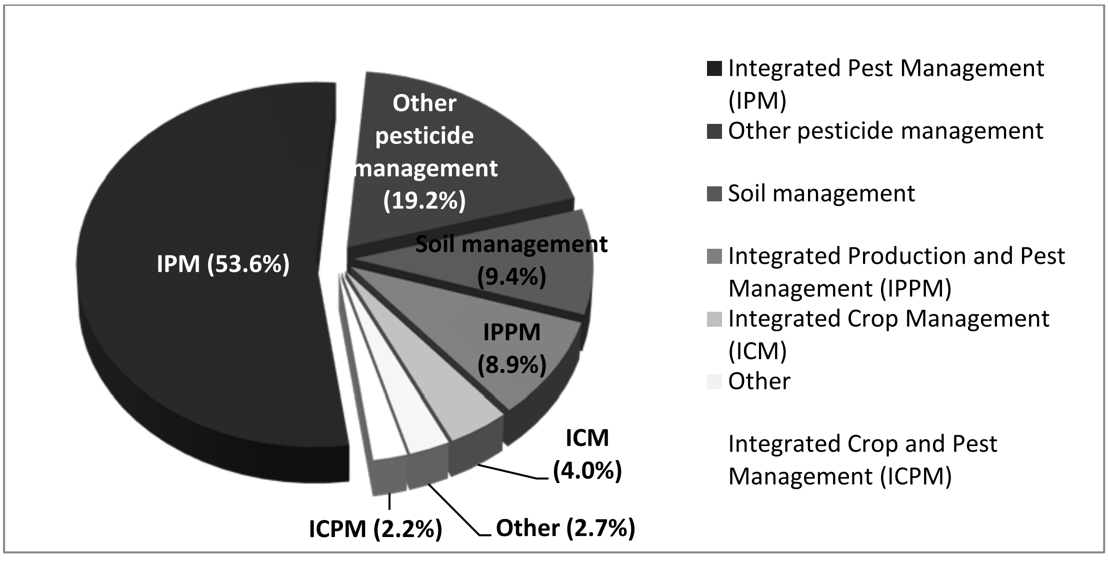


Figure A15 Pest, pesticide and soil management definitions

- *Integrated pest management (IPM):* IPM draws on an understanding of the life cycles of pests and their interaction with the environment to manage populations of pests economically while minimising risks to the environment or human health.
- *Other pesticide management:* This category includes non-specific references to chemical or pesticide management techniques.
- *Soil management:* This category includes non-specific references to soil or crop management techniques.
- *Integrated production and pest management (IPPM):* IPPM is a variant of IPM which has eveolved in Africa and which emphasises both the management of natural pests and the production of a healthy crop.
- *Integrated crop management (ICM)*: ICM draws on an understanding of interactions between soil, the natural environment and biological pests or weeds to promote sustainable crop production. Example components include site selection, crop-specific production strategies, nutrient management and cover cropping.
- *Other:* This category includes other variants of IPM (examples include integrated pest and vector management [IPVM] or integrated pest biosystem management [IPBM]), or other general references to management techniques.
- *Integrated crop and pest management (ICPM):* ICPM combines chemical, biological and cultural pest control methods with crop management strategies.

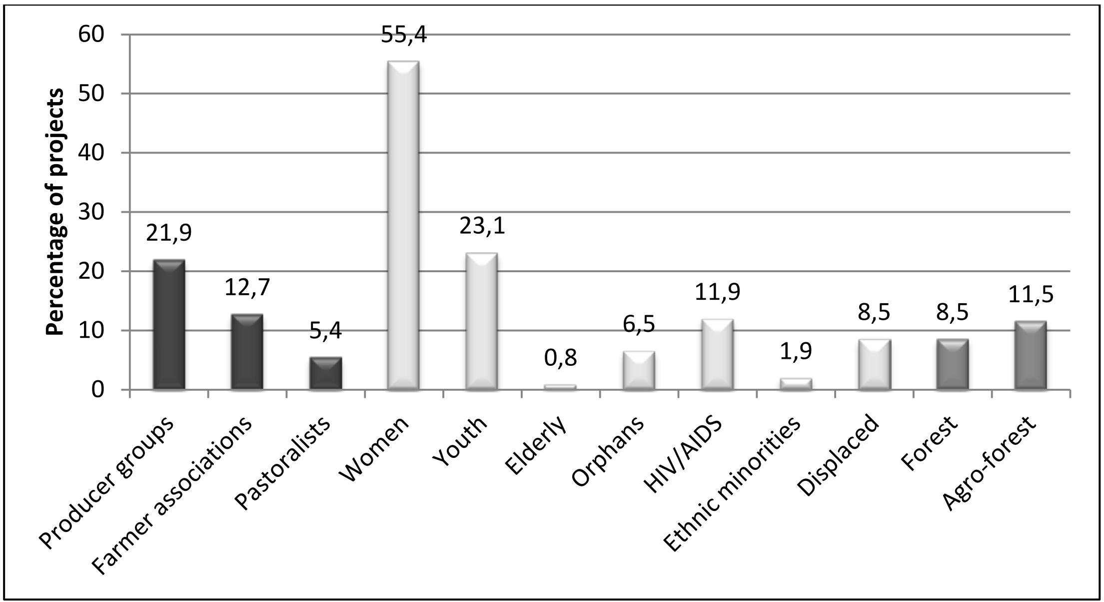
Participant groups[54]

Figure A16 sets out some of the different participant groups and themes that FFS commonly address. Around a quarter of the projects supported producer groups with smaller proportions including pre-existing farmer associations and pastoralists. A significant minority of the projects promoted positive outcomes for forestry or agro-forestry. One aspect of the farmer field schools approach that is often put forward as an important strength is its ability to reach out to marginalised or minority groups who might otherwise not have access to the training, knowledge, employment or inputs. Over half of all projects included women, while just under a quarter targeted youths and around 12 per cent targeted HIV/AIDS sufferers. Smaller numbers included displaced people, orphans, ethnic minorities and the elderly.

Despite the fact that women comprise, on average, 43 per cent of the agricultural labour force in developing countries, they have far less access than men to productive resources and opportunities (FAO, 2011). Agricultural extension programmes such as farmer field schools have been put forward as a potential way to support female farmers, with some projects specifically targeted at women and others designed to be inclusive.

[54] See Appendix A1, Data extraction and analysis (5), for a note on how totals were calculated.

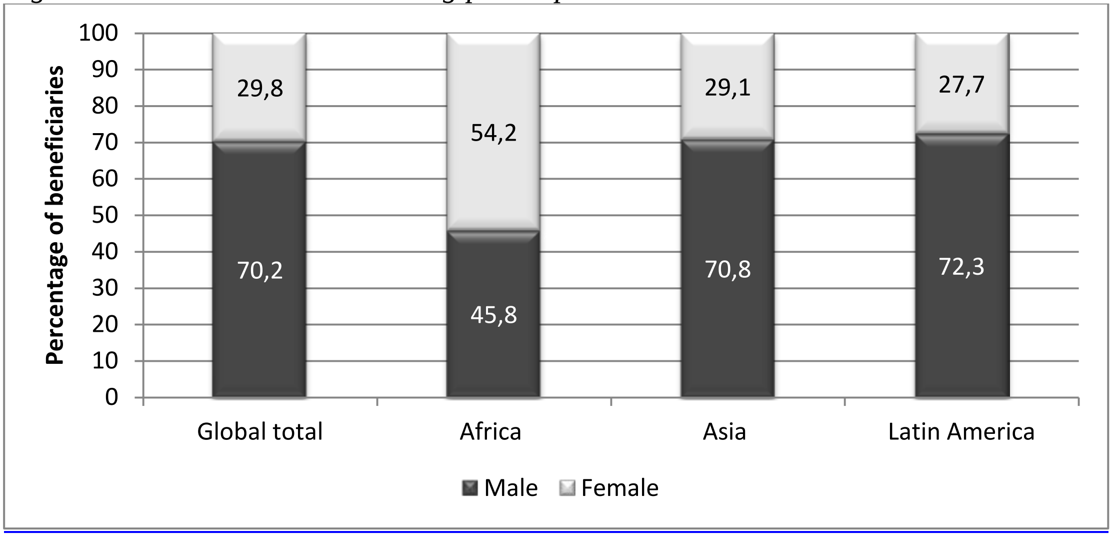
Figure A16 Participant groups and themes



Note: Projects may target multiple groups and themes, therefore total percentage sums to greater than 100 per cent.

Although over half of the projects in the portfolio reported that they had either included, or explicitly set out to target, female farmers (see Figure A16), there is some evidence to show that gender equity elements in FFS projects have been more successful, or at least more heavily implemented, in Africa. Indeed, while global totals based on the portfolio show that FFS-benefiting farmers were more likely to be male (70%) than female (30%), women made up the majority of FFS beneficiaries in Africa. This emphasis may be, in part, a result of FFS being seen as a way to overcome the traditional problems of extension in reaching and empowering female farmers in Africa (see, for example, Saito & Weidemann, 1990; World Bank & IBRD, 2009). It may also reflect the predominant role that African women play in agriculture (Udry et al., 1995). Only a small proportion (around a third) of the projects in the portfolio actually report numbers of benefiting farmers subdivided by gender. It may be that those projects reporting figures for women do so precisely because of their emphasis on female empowerment, with the result that the figures set out in Figure A17 actually overestimate female inclusion.

Figure A17 Gender balance among participants



APPENDIX A1 PORTFOLIO REVIEW RESEARCH METHODOLOGY

Search methodology

Relevant documentation was identified through an internet search, a review of studies already included in the effectiveness review of this report, documentation provided directly by IFAD and documentation provided directly by expert contacts.

The internet search was based on ex-ante identification of appropriate websites and search terms. Searches were carried out in the following electronic databases: EconLit (EBSCO); IDEAS/RePEc repository; Science Direct; International Bibliography of the Social Sciences – IBSS (EBSCO); JSTOR; JOLIS; Zetoc (British Library); BLDS and ELDIS (portals); Mendeley.

In addition to these databases, the following agriculture- and FFS-related sources were also searched: Global FFS-Net / FFS Foundation; LEI (Agricultural Economics Research Institute); DAC (Development Assistance Committee) evaluation database; ODI (Overseas Development Institute); NRI (Natural Resources Institute); CABI (Centre for Agricultural Bioscience International); ILEIA Newsletter (Centre for Learning on Sustainable Agriculture); FAO, especially documents contained in the FAO Document Repository,[55] the FAO IPM Near East website[56] and the FAO IPM vegetable programme in Asia;[57] IFAD, especially documents held on the IFAD projects by country page[58] and the IFAD intranet "xdesk".

Combinations of the following set of search terms were used:

"Farmer field school"+

[55] http://www.fao.org/documents/
[56] http://www.ipm-neareast.com
[57] http://www.vegetableipmasia.org/Concepts.html
[58] http://www.ifad.org/operations/projects/regions/country.htm

a) Geographical coverage

- "**....**" – name of country (all countries were searched for)
- "**....**"– name of continent (all continents were searched for)

b) Funders

- "FAO", "IFAD", "EU", "World Bank", "UNDP", "Asian Development Bank", "African Development Bank", "IFPRI", "..." – name of main foreign government's department for international development

c) Type of document

- Appraisal report, Final report, Activities report, Annual report, Quarterly report, Progress report, Terminal report, Completion report, Evaluation report

All possible combinations of the different terms were searched for in order to ensure that content was captured as comprehensively as possible from the different databases. Follow-up searches on citations found in studies retrieved from the initial round of searches were also carried out. In all, the search strategy returned a total of 1,916 documents, including evaluations, project documents, project descriptions, academic articles, grey literature and personal communications. A list of all included texts is provided in Appendix A2.

Inclusion criteria

Only documentation that described projects involving farmer field schools was included in the portfolio analysis. Projects that only involved other agricultural extension activities were excluded. Additionally, projects were only included in the portfolio if they met one or more of the following criteria:

1. Documentation provided data on one or more of the following: the number of farmer field schools implemented by a project, the number of benefiting farmers, the number of FFS trainers.
2. Documentation provided information on intervention components (such as training of trainers, curriculum development etc.).
3. Documentation provided data on the total cost of the project or the cost of implementing FFS-specific components.

Data extraction and analysis

Two independent reviewers assessed the papers against the inclusion criteria, with any discrepancies resolved through discussion. Each author extracted data from a subset of the included studies, with data coded in Excel.

Entries were made by FFS projects, with data from all relevant documentation for a particular programme included as a single entry. Analysis of coded data for the 337 programmes captured by the portfolio review was then carried out in Excel and Stata.

(1) Figures for both the number of FFS implemented and the number of benefiting farmers were available for just over 60 per cent of the 260 projects in the portfolio. This subset of portfolio projects was examined to discover how many beneficiaries, on average, graduated from each FFS. Both the average and the modal value for the beneficiaries from an FFS equalled 25, a figure

also common in the FFS literature. By assuming that one FFS produces 25 graduating farmers for those projects for which only partial information was available (either number of benefiting farmers or number of FFS), we were able to estimate the numbers of FFS and graduating farmers for 97 per cent of the portfolio projects.

(2) In order to combine the figures from our portfolio with those from the Braun et al. (2006) dataset, the two datasets were first compared to ensure that, where possible, figures were not double-counted. The following steps were then undertaken to calculate lower and upper estimates:

- Lower estimates were calculated by adding figures from the Braun et al. (2006) dataset only where they were higher than those already included in the portfolio for a particular country. Where Braun et al. (2006) had data on a particular country and the portfolio did not, or vice versa, these figures were included in the total.
- Upper estimates were calculated by adding all figures from the Braun et al. (2006) dataset to those from the portfolio.

(3) It was not possible to calculate cost per beneficiary for the majority of the portfolio, either because of insufficient information or because they constituted large agricultural or developmental programmes for which the implementation of FFS methodology is only one element within a far larger whole.

(4) This analysis included only either (a) projects that reported cost per beneficiary or (b) projects for which both the number of beneficiaries and the cost of FFS-related components were available. For the latter category, cost per beneficiary was calculated by dividing total cost by number of farmers trained.

(5) Analysis reported in the portfolio for *Crops, livestock and curricula, Objectives* and *Participant groups* was coded based on a document providing information on either, the intention to include a particular component, objective or participant group, or a report of its actual inclusion in a programme.

APPENDIX A2 PORTFOLIO INCLUDED STUDIES

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Appendix B

EXAMPLE SEARCH STRATEGY

Farmer Field Schools Review Update (August–October 2012): CAB Abstracts (Ovid)

1. (integrated control or integrated pest management or crop management).sh.
2. ((integrated adj (production or management or pest or nutrient)) or crop management).ti,ab.
3. 1 or 2
4. on-farm training.sh.
5. (field school* or farm* school* or farmer* field*).ti,ab.
6. (practical education or extension education or education programmes or community education or agricultural education or inservice training or vocational training or innovation adoption).sh.
7. extension/
8. (participatory extension or agricultural advisory or agricultural extension or rural extension).ti,ab.
9. 6 or 7 or 8
10. exp developing countries/ or exp africa/ or exp asia/ or exp south america/ or exp central america/ or exp latin america/ or exp pacific islands/ or exp middle east/ or mexico/
11. 3 and 9 and 10
12. 5 and 9 and 10
13. 4 or 11 or 12
14. (farmer* adj field* adj school*).ti,ab.
15. 10 and 14
16. 13 or 15

RECORD OF DATABASE SEARCHES

Name of database	Date of search
International Bibliography of Social Sciences (ProQuest)	May 2010; Updated: 9 October 2012
EconLit (EBSCO host)	May 2010; Updated 2 August 2012
Web of Knowledge (Social Sciences Citation Index and Social Science Conference Proceedings)	May 2010; Updated 15 August 2012
AgEcon	May 2010; Updated 2 August 2012
CAB Abstracts	June 2010; Updated 2 August 2012
EBSCO multifile search – Academic Search Research and Development, Africa-Wide Information, Business Source Complete, SocIndex	19 October 2012
United States National Agricultural Library (Agricola)	May 2010
ProQuest: Dissertations and Theses	May 2010
Index to Theses	July 2010
Theses Canada	July 2010
BLDS	May 2010
JOLIS	May 2010
IDEAS	May 2010

RECORD OF INTERNET SEARCHES

Organisation	Website	Search date
African Development Bank (AfDB)	http://www.afdb.org	02-Jul-10
Agricultural program IFAP	http://www.ifap.org *	05-Jan-10
Asian Development Bank	www.adb.org	11-Jun-10
Australian Aid Agency	www.ausaid.gov.au *	11-Jun-10
Canadian international development agency	www.acdi-cida.gc.ca	11-Jun-10
Centre for Environment and Society (Essex University)	http://www.essex.ac.uk/ces/	05-Jan-10
CGIAR research centres (including IFPRI, International Potato Centre, CIMMYT, IRRI, IWMI)	http://www.cgiar.org/publications/library/index.html	12-Jul-10
Christian Aid	www.christianaid.org.uk	30-Jun-10
CIP-UPWARD (International Potato Center/Users' Perspectives with Agricultural Research and Development)	www.cip-upward.org *	11-Jun-10
Cotton IPM Asia	www.cottonipmasia.org (website not working)	06-Jan-10
Danish development agency	www.um.dk	11-Jun-10
Environment for Development (EfD)	www.efdinitiative.org	11-Jun-10
European Commission	http://ec.europa.eu/index_en.htm	12-Jul-10
FAO (Food and Agriculture Organization of the United Nations)	http://www.fao.org/nr/research/informres/research-publications/en/ *	13-Aug-10
FarmAfrica	www.farmafrica.org.uk	09-Jul-10
Future Agricultures	www.future-agricultures.org	30-Jun-10
GIZ (German international development agency)	www.giz.de/en	09-Jul-10
Global FFS Network and Resource Centre (FFS net)	http://www.farmerfieldschool.info/	05-Jan-10
Global Forum for Rural Advisory Services (GFRAS)	http://www.g-fras.org/	09-Jul-10
Global IPM Facility	Unable to locate website	06-Jan-10
Independent Science and Partnership Council (CGIAR)	http://impact.cgiar.org/	06-Jan-10
Inmasp	http://www.lei.dlo.nl/inmasp/results.php3 *	06-Jan-10
Inter-American Development Bank (IDB)	http://www.iadb.org/	11-Jun-10
International Development Research Centre (IDRC)	http://www.idrc.ca/en/ev-1-201-1-DO_TOPIC.html *	05-Jan-10
International Fund for Agricultural Development (IFAD)	http://www.ifad.org	05-Jan-10
Japan International Cooperation Agency and Japan Bank for international Cooperation	www.jica.go.jp/english/ www.jbic.go.jp	12-Jul-10
Leibniz University of Hannover, Pesticide Policy Project	http://www.ifgb.uni-hannover.de/2699.html *	30-Jun-10

ODI Agricultural Research and Extension Network (Agren)	http://www.odi.org.uk/networks/agren/ http://www.odi.org.uk/networks/agren/publist1.html *	05-Jan-10
OECD-DAC	http://www.dac-evaluations-cad.org/abstracts_e.htm	09-Jul-10
Oxfam	http://publications.oxfam.org.uk/index.asp	03-Jul-10
Poverty Action Lab	www.povertyactionlab.org	05-Jan-10
Practical Action	Contacted key informant: operate a participatory extension programme, but no prospective evaluations with comparison group observations have been conducted to-date.	11-Jun-10
SciDevNet	www.scidev.net	09-Jul-10
Swedish International Development Cooperation Agency	www.sida.org	11-Jun-10
Systemwide Programme on IPM	http://www.spipm.cgiar.org/home	06-Jan-10
The World Bank +Office of Evaluation and Development	www.worldbank.org	11-Jun-10
UK Department for International Development	www.dfid.gov.uk	09-Jul-10
US Agency for International Development	www.usaid.gov	12-Jul-10

Note: * website no longer active as of June 2014.

JOURNALS HANDSEARCHED

Journal searched	Volumes
American Economic Journal: Applied Economics	Vol. 1(1), Vol. 3(1)
Agricultural Economics	Vol. 22(1), Vol. 42(2)
American Journal of Agricultural Economics	Vol. 82(1), Vol. 93(1)
Agricultural Economics Review	Vol. 1(1), Vol. 11(2)
Journal of Agricultural Education	Vol. 41(1)–Vol. 51 (4)
Journal of Agricultural Education and Extension	Vol. 7(1)–Vol. 17(1)
Journal of Extension	Vol. 38–Vol. 49 Feb
Journal of International Agricultural and Extension Education (USA)	Vol. 7(1)–Vol. 17(3)
Integrated Pest Management Reviews	Vol. 5(1)–Vol. 7(4)
Journal of Sustainable Agriculture	Vol. 15(4)–Vol. 35(2)
Journal of Extension Systems (India)	Vol. 16–Vol. 25
Journal of Agricultural & Food Information	Vol. 4(1)–Vol. 12(1)
AgBioForum	Vol. 12(3&4), 2009 Special Issue
LEISA	Vol. 19(1), 2003 Special Issue: Learning with FFS
Indian Journal of Extension Education	Vol. 6(3)–Vol. 10(3)
Indian Journal of Agricultural Economics	Jan 2000–Jul 2010
Journal of Environmental Extension	Vol. 1(2000)–Vol. 8 (2009)
Journal of Development Economics	Vol. 61(1)–Vol. 95(1)
Journal of Development Effectiveness	Vol. 1(1)–Vol. 2(2)
Journal of Development Studies	Vol. 36(3)–Vol. 47(2)
Journal of International Development	Vol. 12(4)–Vol. 23(2)
Pest Management Science	Vol. 56(1)–Vol. 67(4)
World Development	Vol. 28(1)–Vol. 39(5)

REASONS FOR EXCLUSION OF MARGINAL STUDIES

Effectiveness synthesis

Study	Reason for exclusion	Comment
Armen et al., 2002	Methodology	No non-FFS comparison group.
Cole et al., 2002	Methodology	No non-FFS comparison group.
Clavijo Ponce et al., 2007	Relevabnce	Not an internvention study, evaluates farmers' knowledge.
Dalton et al., 2005	Relevance	CIAL participatory research, not FFS
Douthwaite et al., 2007	Methodology	No non-FFS comparison group.
Duveskog et al., 2003	Methodology	No non-FFS comparison group, preliminary evaluation findings.
Gamby et al., 2002	Methodology	No non-FFS comparison group.
Iqbal et al., 2012	Methodology	No non-FFS comparison group.
Heong et al., 1998	Methodology	No non-FFS comparison group.
Kassie et al., 2011	Relevance	Not an intervention study; measures the impact of adoption.
Katrak, 2006	Methodology	No non-FFS comparison group.
Mancini et al., 2008	Methodology	No non-FFS comparison group.
Nabirye et al., 2003	Relevance	Participatory efficacy trial assessing IPM techniques.
Ne Dort et al., 2006	Methodology	No non-FFS comparison group.
Owenya et al., 2012	Methodology	No non-FFS comparison group.
Pretty et al., 2011	Relevance	Not an impact study; review of FFS experiences in some countries, methodologies for case studies not reported.
Rwegasira et al., 2004	Relevance	Not a study of effects.
Samiayyan et al., 2010	Relevance	Not an intervention study; measures impact of adoption.
Smale et al.	Relevance	Not FFS.
Tin et al., 2010	Methodology	No non-FFS comparison group.

Tshiebue, 2010	Relevance	French language study; not an impact evaluation.
Vatta et al., 2009	Relevance	Not FFS.
Van den Berg et al., 2004	Methodology	No non-intervention comparison, selected case studies.
Van den Berg et al., 2007	Relevance	Integrated vector management study
Wijeratne et al., 2004	Methodology	No non-FFS comparison group.
Yajima, 2010	Methodology	No non-intervention comparison.

Qualitative synthesis

Study	**Reason for exclusion**	**Comment**
Afreh-Nuamah, 2003	Methodology and relevance	Mainly a review of experience so far, with one case study. The case study is an efficacy trial.
Anandajayasekeram et al., 2007	Methodology	Limited description of methods.
Assefa and Williamson, 2001	Methodology	Limited description of methods, not even clear it is a primary study.
Banu and Bode, 2003	Methodology	No description of methods
Bartlett, 2005	Methodology	Not clear whether primary study. Lack of information on methods of data collection, sampling and sample characteristics.
Barzman and Desilles, 2001	Relevance	No assessment of barriers or enablers.
Beckmann et al., 2006	Methodology and relevance	Not clear whether FFS and no information on methods.
Belder et al., 2006	Methodology and relevance	Not clear whether primary study. Lack of detail on methods.
Bijlmakers and Islam, 2008	Methodology	No description of methods, data collection, sampling or sample characteristics.
Bokor, 2001	Methodology	No information on sampling and sampling characteristics.
Bunch, 2003	Methodology	No details on methods, not clear if primary study.
Bwalya, 2005	Methodology	Lack of information on methods.
Chianu & Tsujii, 2005	Relevance	Not addressing barriers and

		facilitators. The focus is on efficacy of various INM practices.
CORAD, 2008	Relevance	Some information on targeting and participation, but no information on barriers and facilitators.
Din & Morisson, 2003	Methodology	Insufficient information provided on sampling and sample size.
Duveskog et al., 2002	Methodology	No description of data collection, sampling, no clear research question.
Fakih et al., 2003	Methodology	Lack of information about methods and no data presented to support the findings / conclusions.
Fakih, 2003	Methodology	No description of methods, data collection, sampling or sample characteristics.
FAO, 2008	Methodology	No systematic description of methods, sampling and recruitment or sample characteristics.
Gallagher, 2000	Relevance	Paper does not focus on specific case, and not clear there is any primary data collection.
Gallagher, 2003	Methodology	Not primary study.
Gill, 2004	Methodology	Not clear whether primary study, no information on sampling, sampling characteristics, research question.
Goff et al., 2009	Methodology and relevance	Limited information on barriers and facilitators, limited information on sampling.
Jalalzadeh et al., 2009	Methodology	Methods not clear, limited information on barriers and facilitators
Kebebe et al., 2007	Methodology and relevance	Efficacy study. No information provided on methods (sampling, sample, data collection).
Khisa and Heinemann, 2005	Methodology	No information on data collection or sampling.
Khisa, 2003	Methodology	No description of methods.

Kishi, 2002	Methodology	Insufficient information on sampling and no sample characteristics presented.
Lopez Gaytan et al., 2008	Methodology	Insufficient information on sampling.
Makhdum et al., 2003	Methodology	Lack of information on sampling.
Makhdum et al. 2002	Methodology	No description of methods. No information on sampling.
Mallah & Kerejo, 2007	Methodology	Lack of reporting on methods, including sampling and sample characteristics.
Nathaniels., 2005	Methodology	Insufficient information provided on sampling procedures and sample characteristics.
Okoth et al., 2002a	Methodology	Not clear if any primary research, insufficient methods reporting.
Okoth et al., 2002b	Methodology	Not clear if primary data, no details on methods.
Pontius, 2003	Relevance	Looks at the impact of Farmer study groups (Community IPM) and does not assess barriers/facilitators. Insufficient reporting of methods (no info on sampling and sample characteristics).
Price and Gurung, 2006	Methodology and relevance	Comparative study focusing on comparative methods and outcomes. Sample selection criteria not entirely clear and insufficient information on sample characteristics.
Prudent et al., 2007	Methodology	Insufficient information on methods, no information on sample, limited information on data collection.
Rahman, 2012	Methodology	Lack of info on methods: no information on sample characteristics.
Schut and Sherwood, 2007	Methodology	Insufficient information provided on data collection, no information on sampling and sample characteristics.
Settle & Garba, 2011	Methodology and relevance	Not clear whether primary

		study, no reporting on methods. No focus on barriers and facilitators.
Simpson and Owens, 2002	Methodology	Limited description of methods.
Stock, 1995	Methodology	Lack of info on methods: no info on sampling or sample characteristics.
Teng et al., 2005	Methodology	Not clear if primary study and insufficient information of methods.
Van Beek et al., 2004	Methodology	Lack of detail on sampling.
Van den Berg et al., 2006	Methodology	Unclear whether primary study. Not enough information provided on methods including sampling and sample characteristics.
Van den Berg et al., 2007	Relevance	No information on barriers and facilitators. Limited information on methods.
Warnaars and Pradel, 2007	Methodology	No information on sampling and recruitment.
Williamson et al., 2003	Methodology	Limited description of methods, insufficient information on sample characteristics.
Winarto, 2000	Methodology	Not clear if primary research, no information about methods.

DATA COLLECTION CODES

Quantitative impact evaluations (studies addressing review question 1)

Intervention design	Intervention type: IPM, IPPM, IPNM, IWM, other Components of intervention Additional interventions provided, e.g. input support, marketing support Intervention period (from MM/YY to MM/YY)
Context	Country and region: East Asia & Pacific (EAP), Latin America & Caribbean (LAC), Middle_East & North Africa (MENA), South Asia (SA), sub-Saharan Africa (SSA) Crops: cotton, rice, vegetables, other Length of follow-up (months)
Study design	Study type: RCT, quasi-RCT, RDD, natural experiment, DID, IV, ITS, PSM, adjusted (multivariate) single difference regression, unadjusted comparison of means Description of comparison group (and if relevant non-participant neighbour group) intervention Period of outcomes data collection (from MM/YY to MM/YY) Frequency of outcomes data collection Information reported on method of allocating individuals to groups Sample size (treatment, exposed, comparison): number of clusters, number of individuals Sample attrition (treatment, exposed, comparison), if relevant Spillovers: geographical separation of treatment and comparison Contamination: influence of other intervention which differentially affects treatment and comparison groups on relevant outcomes
	Risk of bias assessment (see Appendix 2)
Effect estimation	Treatment effect estimated: intention-to-treat (ITT), average treatment effect on the treated (ATET), average treatment effect (ATE), local average treatment effect (LATE) Adjusted or unadjusted analysis.
Intermediate outcomes	Knowledge: e.g. knowledge of “simple”, “intermediate” and “complex” practices Adoption: e.g. use of pesticide, cost of pesticide, number of “improved” practices
Final outcomes	Yields: weight per unit of land Net revenue: value of production minus costs of production (farm income or profits) per unit land Environment: e.g. environmental impact quotient score Health: e.g. incidence of health complaint (eye irritation, respiratory problems, stomach ache) Empowerment: e.g. reported self-esteem

Qualitative evaluations (studies addressing review question 2)

#	ID	Description	Coding
1	Author	First author	Open answer
2	Country	Country	Open answer
3	Facilitators	Evidence on barriers and enablers related to the farmer field school facilitators, their recruitment, training, characteristics, support, relationship with participants etc.	Open answer
4	Participants, targeting, equity	Evidence on barriers and enablers related to the participants, including targeting and recruitment, group composition (including equity), participant characteristics and attitudes, attendance and drop-out rates etc.	Open answer
5	FFS content and coverage	Evidence on barriers and enablers related to content and coverage of farmer field schools, including appropriateness and relevance of curriculum, breadth and depth of coverage of topics, complexity of learning material etc.	Open answer
6	Complexity	Evidence on barriers and enablers related to complexity of the FFS curriculum / learning approaches	Open answer
7	Observability	Evidence on barriers and enablers related to observability of the techniques promoted in FFS, and their results	Open answer
8	Relative advantage	Evidence on barriers and enablers related to the (perceived) relative advantage of the FFS-promoted methods and approaches	Open answer
9	Diffusion to non-IPM farmers	Evidence on barriers and enablers related to diffusion of FFS practices to non-IPM farmers, such as the role of social capital, complexity and observability of the techniques and learning materials, observability of the benefits of the FFS approach etc.	Open answer
10	Language/discourse	Evidence on barriers and enablers related to the language or discourse used in FFS training	Open answer
11	Delivery (participatory vs. top-down, experimentation)	Evidence on barriers and enablers related to the use, or lack thereof, of the participatory, experimental learning approaches	Open answer
12	Service selivery / implementation	Evidence on barriers and enablers related to the service delivery and implementation of the intervention, such as availability and timeliness of resources, appropriateness and accessibility of FFS location, timing of	Open answer

#	ID	Description	Coding
		trainings, follow-up etc.	
13	Access to inputs, labour, markets	Evidence on barriers and enablers related to farmers' access to inputs, labour, linkages to markets etc.	Open answer
14	Community / context	Evidence on barriers and enablers related to the community context and other (non-policy) contextual factors	Open answer
15	Policy context	Evidence on barriers and enablers related to the policy context where FFSs were implemented	Open answer
16	Institutional set-up	Evidence on barriers and enablers related to the international, national, regional and local institutional arrangements for implementing FFS	Open answer
17	Gender and empowerment	Evidence reported on the perceived effects of FFS on empowerment and gender roles	Open answer
18	Sustainability	Evidence on the barriers to and enablers of sustainability of FFS practices and outcomes	Open answer
19	Other	Evidence on any other relevant barriers and enablers noted in the study	Open answer

Appendix C

CRITICAL APPRAISAL METHODS

Review question (1): Risk of bias assessment for impact evaluations[59]

Studies were critically appraised according to the likely risk of bias based on: 1) quality of attribution methods (addressing confounding and sample selection bias); 2) the extent of spillovers to farmers in comparison groups;[60] 3) outcome and analysis reporting bias; and 4) other sources of bias. "Low-risk-of-bias" studies are those in which clear measurement of and control for confounding was made, including selection bias, where intervention and comparison groups were described adequately (in respect of the nature of the interventions being received) and risks of spillovers or contamination were small, and where reporting biases and other sources of bias were unlikely. Studies are identified as at "medium risk of bias" where there are threats to the validity of the attribution methodology, or likely risks of spillovers or contamination, arising from inadequate description of intervention or comparison groups or possibilities for interaction between groups such as when they are from the same community, or possible reporting biases. "High-risk-of-bias studies" are all the others, including those where comparison groups are not matched or differences in covariates are not accounted for in multivariate analysis, or where there is evidence for spillovers or contamination to comparison groups from the same communities, and reporting biases are evident. Detailed risk of bias evaluation criteria are presented below.

1) Selection bias and confounding

a) For randomised assignment (RCTs)
Score "YES" if:

- a random component in the sequence generation process is described (e.g. referring to a random number table);
- and if the unit of allocation was at group level (geographical/social/ institutional unit) and allocation was performed on all units at the start of the study;
- or if the unit of allocation was by beneficiary or group and there was some form of centralised allocation mechanism such as an on-site computer system;

[59] We drew on 3ie (n.d.) and EPOC (n.d.) in developing this tool.

[60] Note that, in contrast, spillovers to "exposed" farmers are desirable for the intervention, and will be assessed by the measured effects reported on these groups, in separate meta-analysis.

- and if the unit of allocation is based on a sufficiently large sample size to equate groups on average;
- and if baseline characteristics of the study and control/comparisons are reported and overall similar based on t-test or ANOVA for equality of means across groups;
- or covariate differences are controlled using multivariate analysis;
- and the attrition rates (losses to follow-up) are sufficiently low and similar in treatment and control;
- or the study assesses that loss to follow-up units are random draws from the sample (e.g. by examining correlation with determinants of outcomes, in both treatment and comparison groups);
- and problems with cross-overs and drop-outs are dealt with using intention-to-treat analysis or in the case of drop-outs, by assessing whether the drop-outs are random draws from the population;
- and, for cluster assignment, authors control for external cluster-level factors that might confound the impact of the programme (e.g. weather, infrastructure, community fixed effects etc.) through multivariate analysis.

Score "UNCLEAR" if:

- the paper does not provide details on the randomisation process, or uses a quasi-randomisation process for which it is not clear whether it has generated allocations equivalent to true randomisation;
- or insufficient details are provided on covariate differences or methods of adjustment;
- or insufficient details are provided on cluster controls.

Score "NO" if:

- the sample size is not sufficient;
- or any failure in the allocation mechanism or execution of the method could affect the randomisation process.

b) For discontinuity assignment (regression discontinuity design)

Score "YES" if:

- allocation is made based on a predetermined discontinuity on a continuous variable (regression discontinuity design) and blinded to participants;
- or if not blinded, individuals reasonably cannot affect the assignment variable in response to knowledge of the participation decision rule;
- and the sample size immediately at both sides of the cut-off point is sufficiently large to equate groups on average;
- and the interval for selection of treatment and control group is reasonably small;
- or authors have weighted the matches on their distance to the cut-off point;
- and the mean of the covariates of the individuals immediately at both sides of the cut-off point (selected sample of participants and non-participants) are overall not statistically different based on t-test or ANOVA for equality of means;
- or significant differences have been controlled for in multivariate analysis;
- and, for cluster assignment, authors control for external cluster-level factors that might confound the impact of the programme (e.g. weather, infrastructure, community fixed effects etc.) through multivariate analysis.

Score "UNCLEAR" if:

- the assignment variable is either non-blinded or it is unclear whether participants can affect it in response to knowledge of the allocation mechanism;
- or there are covariate differences across individuals at both sides of the discontinuity which have not been controlled for using multivariate analysis;
- or if insufficient details are provided on (cluster) controls.

Score "NO" if:

- the sample size is not sufficient;
- or there is evidence that participants altered the assignment variable prior to assignment.

c) For identification based on an instrumental variable (IV estimation)
Score "YES" if:

- an appropriate instrumental variable is used which is exogenously generated: e.g. due to a "natural" experiment or random allocation.
- the instrumenting equation is significant at the level of $F \geq 10$ (or if an F test is not reported, the authors report and assess whether the R-squared (goodness of fit) of the participation equation is sufficient for appropriate identification);
- the identifying instruments are individually significant ($p \leq 0.01$); for Heckman models, the identifiers are reported and significant ($p \leq 0.05$);
- where at least two instruments are used, the authors report on an over-identifying test ($p \leq 0.05$ is required to reject the null hypothesis);
- and none of the covariate controls can be affected by participation and the study convincingly assesses qualitatively why the instrument only affects the outcome via participation;[61].
- and, for cluster assignment, authors particularly control for external cluster-level factors that might confound the impact of the programme (e.g. weather, infrastructure, community fixed effects etc.) through multivariate analysis.

Score "UNCLEAR" if:

- the exogeneity of the instrument is unclear (both externally as well as why the variable should not enter by itself in the outcome equation).
- relevant confounders are controlled but appropriate statistical tests are not reported or exogeneity[62] of the instrument is not convincing;
- or if insufficient details are provided on cluster controls (see category f) below).

Score "NO" otherwise.

d) For assignment-based non-randomised programme placement and self-selection (studies using a matching strategy or regression analysis (excluding IV), studies which apply other methods)
Score "YES" if:

- participants and non-participants are either matched based on all relevant characteristics explaining participation and outcomes;
- or all relevant characteristics are accounted for.[63]

Score "UNCLEAR" if:

- it is not clear whether all relevant characteristics (only relevant time varying characteristics in the case of panel data regressions) are controlled.

Score "NO" if:

- relevant characteristics are omitted from the analysis.

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[61] If the instrument is the random assignment of the treatment, the reviewer should also assess the quality and success of the randomisation procedure in part a).

[62] An instrument is exogenous when it only affects the outcome of interest through affecting participation in the programme. Although when more than one instrument is available, statistical tests provide guidance on exogeneity (see background document), the assessment of exogeneity should be in any case done qualitatively. Indeed, complete exogeneity of the instrument is only feasible using randomised assignment in the context of an RCT with imperfect compliance, or an instrument identified in the context of a natural experiment.

[63] Accounting for and matching on all relevant characteristics is usually only feasible when the programme allocation rule is known and there are no errors of targeting. It is unlikely that studies not based on randomisation or regression discontinuity can score "YES" on this criterion.

In addition:
d1) For non-randomised trials using panel data (including DID) models
Score "YES" if:

- the authors use a difference-in-differences (or fixed effects) multivariate estimation method;
- and the authors control for a comprehensive set of time-varying characteristics;[64]
- and the attrition rate is sufficiently low and similar in treatment and control, or the study assesses that drop-outs are random draws from the sample (e.g. by examining correlation with determinants of outcomes, in both treatment and comparison groups);
- and, for cluster assignment, authors control for external cluster-level factors that might confound the impact of the programme (e.g. weather, infrastructure, community fixed effects etc.) through multivariate analysis.

Score "UNCLEAR" if:

- insufficient details are provided;
- or if insufficient details are provided on cluster controls.

Score "NO" otherwise, including if the treatment effect is estimated using raw comparison of means in statistically un-matched groups.

d2) For statistical matching studies including propensity scores (PSM) and covariate matching[65]
Score "YES" if:

- matching is either on baseline characteristics or time-invariant characteristics which cannot be affected by participation in the programme;
- and the variables used to match are relevant (e.g. demographic and socioeconomic factors) to explain both participation and the outcome (so that there can be no evident differences across groups in variables that might explain outcomes);
- and for PSM Rosenbaum's test suggests the results are not sensitive to the existence of hidden bias;
- and, with the exception of Kernel matching, the means of the individual covariates are equated for treatment and comparison groups after matching;
- and, for cluster assignment, authors control for external cluster-level factors that might confound the impact of the programme (e.g. weather, infrastructure, community fixed effects etc.) through multivariate or any appropriate analysis.

Score "UNCLEAR" if:

- relevant variables are not included in the matching equation, or if matching is based on characteristics collected at endline;
- or if insufficient details are provided on cluster controls.

Score "NO" otherwise.

d3) For regression-based studies using cross-sectional data (excluding IV)
Score "YES" if:

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[64] Knowing allocation rules for the programme – or even whether the non-participants were individuals that refused to participate in the programme, as opposed to individuals that were not given the opportunity to participate in the programme – can help in the assessment of whether the covariates accounted for in the regression capture all the relevant characteristics that explain differences between treatment and comparison.
[65] Matching strategies are sometimes complemented with difference-in-difference regression estimation methods. This combination approach is usually superior since it only uses in the estimation the common support region of the sample size, reducing the likelihood of existence of time-variant unobservables differences across groups affecting outcome of interest and removing biases arising from time-invariant unobservable characteristics.

- the study controls for relevant confounders that may be correlated with both participation and explain outcomes (e.g. demographic and socioeconomic factors at individual and community level) using multivariate methods with appropriate proxies for unobservable covariates;
- and a Hausman test[66] with an appropriate instrument suggests there is no evidence of endogeneity;
- and none of the covariate controls can be affected by participation;
- and, either only those observations in the region of common support for participants and non-participants in terms of covariates are used, or the distributions of covariates are balanced for the entire sample population across groups;
- and, for cluster assignment, authors control particularly for external cluster-level factors that might confound the impact of the programme (e.g. weather, infrastructure, community fixed effects etc.) through multivariate analysis.

Score “UNCLEAR” if:

- relevant confounders are controlled but appropriate proxy variables or statistical tests are not reported;
- or if insufficient details are provided on cluster controls.

Score “NO” otherwise.

d4) For study designs which do not account for differences between groups using statistical methods, score “NO”.

2) Spillovers: was the study adequately protected against performance bias?

Score “YES” if:

- the intervention is unlikely to spill over to comparisons (e.g. participants and non-participants are geographically and/or socially separated from one another and general equilibrium effects are unlikely).[67]

Score “UNCLEAR” if:

- spillovers are not addressed clearly.

Score “NO” if:

- allocation was at individual or household level and there are likely spillovers within households and communities which are not controlled for in the analysis;
- or if allocation at cluster level and there are likely spillovers to comparison clusters.

3) Selective reporting: was the study free from outcome and analysis reporting biases?

Score “YES” if:

- there is no evidence that outcomes were selectively reported (e.g. all relevant outcomes in the methods section are reported in the results section);
- and authors use “common’ methods”[68] of estimation and the study does not suggest the existence of biased exploratory research methods.[69]

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[66] The Hausman test explores endogeneity in the framework of regression by comparing whether the ordinary least squares (OLS) and the IV approaches yield significantly different estimations. However, it plays a different role in the different methods of analysis. While in the OLS regression framework the Hausman test mainly explores endogeneity and therefore is related to the validity of the method, in IV approaches it explores whether the author has chosen the best available strategy for addressing causal attribution (since in the absence of endogeneity OLS yields more precise estimators) and therefore is more related to analysis reporting bias.

[67] Contamination, that is differential receipt of other interventions affecting outcome of interest in the control or comparison group, is potentially an important threat to the correct interpretation of study results and should be addressed via PICO and study coding.

Score “NO” if:

- some important outcomes are subsequently omitted from the results or the significance and magnitude of important outcomes was not assessed;
- or authors use uncommon or less rigorous estimation methods such as failure to conduct multivariate analysis for outcomes equations where it is has not been established that covariates are balanced.[70]

Score “UNCLEAR” otherwise.

4) Other: was the study free from other sources of bias?

Important additional sources of bias may include: concerns about blinding of outcome assessors or data analysts; concerns about courtesy bias from outcomes collected through self-reporting; concerns about coherence of results, for example between descriptive statistics and outcome questions; data on the baseline collected retrospectively; information is collected using an inappropriate instrument (or a different instrument/at different time/after different follow-up period in the comparison and treatment groups).
Score “YES” if:

- the reported results do not suggest any other sources of bias.

Score “UNCLEAR” if:

- other important threats to validity may be present.

Score “NO” if:

- it is clear that these threats to validity are present and not controlled for.

Review question (2): Quality appraisal of studies examining barriers and enablers

We assessed the quality of included studies using an adapted version of the Critical Appraisal Skills Programme checklist (CASP, 2006), making judgments on the adequacy of reporting, data collection, presentation, analysis and conclusions drawn. The checklist is presented below. In accordance with our inclusion criteria we filtered out studies of particularly low quality (Hannes, 2011) and studies where questions 1–5 were assessed as “No” were excluded at this stage. The remaining studies were classified as of high or low quality. The results of the quality appraisal are reported in the review.

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[68] “Common methods” refers to the use of the most credible method of analysis to address attribution given the data available.

[69] A comprehensive assessment of the existence of “data mining” is not feasible particularly in quasi-experimental designs where most studies do not have protocols and replication seems the only possible mechanism to examine rigorously the existence of data mining.

[70] i) For PSM and covariate matching, score “YES” if: where over 10% of participants fail to be matched, sensitivity analysis is used to re-estimate results using different matching methods (Kernel Matching techniques). For matching with replacement, no single observation in the control group is matched with a large number of observations in the treatment group. Where not reported, score “UNCLEAR”. Otherwise, score “NO”. ii) For IV (including Heckman) models, score “YES” if: the authors test and report the results of a Hausman test for exogeneity ($p \leq 0.05$ is required to reject the null hypothesis of exogeneity), the coefficient of the selectivity correction term (Rho) is significantly different from zero ($P<0.05$) (Heckman approach). Where not reported, score “UNCLEAR”. Otherwise, score “NO”. iii) For studies using multivariate regression analysis, score “YES” if: authors conduct appropriate specification tests (e.g. reporting results of multicollinearity test, testing robustness of results to the inclusion of additional variables etc.). Where not reported or not convincing, score “UNCLEAR”. Otherwise, score “NO”.

Critical appraisal of qualitative studies included to answer review question (2)			
No	**Question**	**Id**	**Code**
1	Is the research aim clearly stated?	Research aim	Yes=1 No=0 Partially=8
2	Description of the context?	Context	Yes=1 No=0 Partially=8
3a	Description of sampling procedures - How have the participants been selected, were they the most appropriate?	Sampling	Yes=1 No=0 Partially=8 Unclear=9
3b	Please describe sampling procedures	Sampling description	Free answer
4	Are sample characteristics sufficiently reported? (sample size, location, and at least one additional characteristic)	Sampling characteristics	Yes=1 No=0 Partially=8 Unclear=9
5a	Is it clear how the data were collected; e.g. for interviews, is there an indication of how interviews were conducted?	Data collection	Yes=1 No=0 Partially=8 Unclear=9
5b	Please describe data collection methods	Data collection description	Free answer
6a	Methods of recording of data reported?	Data recording	Yes=1 No=0 Partially=8 Unclear=9
6b	Please describe methods recording data	Data recording description	Free answer
7a	Methods of analysis explicitly stated?	Analysis	Yes=1 No=0 Partially=8 Unclear=9
7b	Please describe methods of analysis	Analysis description	Free answer
8	Is there a clear link to relevant literature/theoretical framework?	Link to relevant literature/theory	Yes=1 No=0 Partially=8
9a	Is the design appropriate to answer the research question? - Has the researcher justified the research design?	Appropriate methodology	Yes=1 No=0 Partially=8 Unclear=9
9b	If answer to Q9a is no or partially, justify	Methodology comment	Free answer
10a	Was the sampling strategy appropriate to the aims of the research? - Have the researchers explained how the participants were selected? - Have the researchers explained why the participants they selected were the most appropriate to provide access to the type of knowledge sought by the study? - Have the researchers discussed issues around recruitment? (e.g. why some people chose not to take part)	Appropriate sampling	Yes=1 No=0 Partially=8 Unclear=9
10b	If answer to Q10a is no or partially, justify	Sampling comment	Free answer

11a	Were the data collected in a way that addressed the research issue? - Were the methods used appropriate and justified? - Did the researcher discuss saturation of data?	Appropriate methods of data collection	Yes=1 No=0 Partially=8 Unclear=9
11b	If answer to Q11a is no or partially, justify	Data collection comment	Free answer
12a	Was the data analysis sufficiently rigorous? - Is there a detailed description of the analysis process? - Do the data support the findings? - Is the relationship between the researcher and the participants adequately considered? - To what extent are contradictory data taken into account? - If the findings are based on quantitative analysis of survey data, are multivariate techniques used to control for potential confounding variables?	Appropriate analysis	Yes=1 No=0 Partially=8 Unclear=9
12b	If answer to Q12 is no, partially or unclear, justify	Analysis comment	Free answer
13a	Has triangulation been applied? - Data triangulation (location, time and participants) - Investigator triangulation - Theory triangulation (several theories) - Methodological triangulation	Triangulation	Yes=1 No=0 Partially=8
13b	Describe triangulation methods employed	Triangulation description	
14a	Are the analysis and conclusions clearly presented? - Have the researchers discussed the credibility of their findings? (e.g. triangulation, respondent validation, more than one analyst) - Is there adequate discussion of the evidence both for and against the researcher's arguments? - Are the findings explicit? - Are the findings discussed in relation to the original research question?	Clarity of analysis and conclusions	Yes=1 No=0 Partially=8 Unclear=9
14b	If answer to Q14a is no or partially, justify	Conclusions comment	Free answer
15	Was the potential for conflict of interest considered and addressed?	Conflict of interest considered and addressed	Yes=1 No=0 Partially=8 Unclear=9
16	Does the paper discuss ethical considerations related to the research?	Ethical considerations	Yes=1 No=0 Partially=8
17	Comments/justification about overall reporting and methdology	Comments/justification	Free answer

Appendix D

EFFECT SIZE CALCULATIONS

For studies using a parallel group or statistical matching-based strategy, the response ratio (RR) and its standard error (SE_{RR}) were estimated as follows (Borenstein et al., 2009):

$$RR = \frac{\bar{Y}t}{\bar{Y}c} \qquad SE_{RR} = S_p^2 * \left(\frac{1}{n_t * (\bar{Y}_t)^2} + \frac{1}{n_c * (\bar{Y}_c)^2}\right), \quad \text{where} \quad S_p = \sqrt{\frac{(n_c - 1) * S_c^2 + (n_t - 1) * S_t^2}{n_t + n_c - 2}}$$

where $\bar{Y}t$ is the mean outcome in the treatment group, $\bar{Y}c$ is the mean outcome in the comparison group, n_t and n_c are the sample sizes of the treatment and comparison groups respectively, S_p is the pooled standard deviation and S_c and S_t are the standard deviations in treatment and comparison.[71] For regression-based studies, RR and its standard error were estimated as follows (Borenstein et al., 2009):[72]

$$RR = \frac{\bar{Y}c + \beta}{\bar{Y}c} \qquad SE_{RR} = \hat{\sigma} * \left[\frac{1}{n_t * (\bar{Y}_c + \beta)^2} + \frac{1}{n_c * (\bar{Y}_c)^2}\right]$$

where β is the coefficient of the treatment variable in the regression and $\hat{\sigma}$ the pooled standard deviation.[73] Often S_p or $\hat{\sigma}$ were not reported, therefore we calculated SE_{RR} by rescaling RR using information reported on statistical significance such as a t-statistic or p-value associated with the β coefficient: e.g. $ln(SE_{RR}) = ln(RR)/t_{\beta}$.

Borenstein et al. (2009) indicate response ratios should only be used when the outcome is measured on a true ratio scale and has a natural "zero" point. Thus, the RR is not meaningful in some cases of outcomes measured in FFS studies, such as knowledge test scores and indices of adoption not related to pesticide use. In such cases, we have therefore calculated the Hedges g (sample size corrected) standardised mean difference. For studies using parallel group or matching strategies g and its standard error were computed using the previous notation as follows (Borenstein et al., 2009):

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[71] Note that for studies using a matching strategy the outcome level for the treatment group and control group used to estimate the effect size is the outcome level for each group after matching. If kernel matching is used substitute $\bar{Y}_c$ with $\bar{Y}_t$-ATET (average treatment effect on the treated).

[72] For some maximum likelihood regression models such as Logit or Probit (for dichotomous outcomes) and Tobit (for continuous outcomes), it is not possible to use the regression coefficient to estimate the RR. In such a case, β refers to the "impact effect" calculated from the regression coefficient for Logit, Probit or Tobit models. For semi-logarithmic difference-in-differences multivariate regression we calculate the response ratio as $RR = e^{\beta} * 100$.

[73] There are two main approaches to the calculation of the pooled standard deviation from regression-based studies: in Cohens approach $\hat{\sigma}$ is the standard deviation of the dependent variable across all observations; in Hedges approach $\hat{\sigma}$ is the standard deviation of the error term in the regression.

$$g = \frac{\bar{Y}_t - \bar{Y}_c}{S_p} * \left[1 - \frac{3}{4*(n_t+n_c-2)-1}\right] \qquad SE_g = \sqrt{\left[\frac{n_t+n_c}{n_c*n_t} + \frac{g^2}{2*(n_c+n_t)}\right]}.$$

For studies using regression analysis g and its standard error were estimated following Keef and Roberts (2004):[74]

$$g = c(v)\frac{\hat{\beta}}{\hat{\sigma}} \qquad SE_g = \sqrt{\frac{g^2}{v-2} * \left(\frac{v}{t^2} + v * [c(v)]^2 - v + 2\right)}\ , \quad \text{where } \frac{1}{c(v)} = \sqrt{\frac{v}{2}} * \frac{\Gamma\left(\frac{v}{2}-\frac{1}{2}\right)}{\Gamma\left(\frac{v}{2}\right)}$$

where β refers to the coefficient of the treatment variable in the regression, $\hat{\sigma}$ is the standard deviation of the regression residuals, v is n-k degrees of freedom and $\Gamma()$ is the gamma function. We also calculated SE_g by rescaling g_p using information reported on statistical significance of $\hat{\beta}$, such as a t-statistic or p-value: e.g. $SE_g = \frac{g}{t_\beta}$

In all cases where g was calculable, we were able to calculate RR. In cases where we were not able to calculate g but were able to calculate RR, we translated RR into g using the Cox transformation $g_{Cox}=ln(OR)/1.65$ in order to minimise loss of information (Sánchez-Meca et al., 2003). Recognising that this method is applicable to the log-odds ratio, we conducted sensitivity analysis according to whether the magnitude of g is systematically affected by this transformation.

SYNTHETIC EFFECT SIZES

Where multiple dependent effect sizes were presented in a single study for a particular outcome construct, we calculated synthetic effect size point estimate using the sample-weighted average, and applying appropriate formulae to recalculate variances according to Borenstein et al. (2009, chapter 24):

$$var\left(\sum_{i=1}^{m} Y_i\right) = \sum_{i=1}^{m} V_i + \sum_{i \neq j}\left(r_{ij}\sqrt{V_i}\sqrt{V_j}\right)$$

We calculated the correlation between estimates as the sample-weighted mean of the correlation of treatment groups and the correlation of the comparison groups. The correlation between control arms was assumed 1 where the same control group is used as comparator, and 0 otherwise. The correlation between treatment arms was assumed to be 0 when combining results from different treatment groups, and 1 when combining results from the same treatment groups over time. When combining results across different individuals within the same treatment group the correlation was assumed to be 0.5, which estimates variance at the mid-point between the two extreme cases of treating comparisons as independent (with correlation coefficient equal to 0, and likely underestimating the variance), or treating them as perfectly correlated (correlation coefficient of 1, and likely overestimating the variance).

META-ANALYSIS OF BIVARIATE AND PARTIAL EFFECT SIZES

According to Keef and Roberts (2004, p. 103), effect sizes are only strictly comparable in studies employing a common model, meaning that “suitable proxies for the same constructs [i.e. the outcome variable, treatment variable and covariates] are included in all the studies being synthesized”, and the same estimation methods are used to estimate the treatment effect (Becker & Wu, 2007). There are several obvious reasons for such differences. Firstly, the coefficient may be

[74] For studies with large n, $c(v)$ is considered equal to 1.

biased due to model specification errors, for example due to omitted variables bias (confounding) or multicollinearity. Multicollinearity is particularly problematic for g since it inflates the standard error of the regression $\hat{\sigma}$, thus reducing the absolute value of g (Keef & Roberts, 2004). In addition, while multicollinearity does not cause bias in the predicted values of the dependent variable $\hat{y}$, it may cause the correlated coefficient estimates to be biased individually in misspecified models.

However, even where there are no biases arising from specification error, it is important to note that the partial $\hat{\beta}$ coefficient is measuring the treatment effect conditional on the covariates, and is therefore measuring a different quantity to the bivariate relationship, due to collinearity. In the case of the treatment effect regression, this would be represented as significant interaction effects between treatment variable and correlated covariates, thus violating the "homogeneity of slopes" assumption (the slope coefficients for the covariates are not homogeneous between treatment and comparison group) (Keef & Roberts, 2004). Where treatment variable X and covariates Z are uncorrelated, the adjusted value of $\hat{\beta}_a$ is equal to the unadjusted bivariate value $\hat{\beta}_u$ (equal to the sum of the partial correlation between X and outcome variable Y, ρ_{XY}, and ratio of standard deviation of Y to standard deviation of X):

$$\hat{\beta}_a = \hat{\beta}_u = \rho_{YX}\frac{\sigma_Y}{\sigma_X}.$$

However, where X and Z are correlated by ρ_{XZ}, the adjusted value of $\hat{\beta}$ is:

$$\hat{\beta}_a = \left[\frac{\rho_{YX}-\rho_{YZ}\rho_{XZ}}{1-\rho_{XZ}^2}\frac{\sigma_Y}{\sigma_X}\right] = \hat{\beta}_u\left[\frac{1-\frac{\rho_{YZ}\rho_{XZ}}{\rho_{YX}}}{1-\rho_{XZ}^2}\right]$$

which may be smaller or larger than $\hat{\beta}_u$ depending on the relative magnitude of the partial correlations between Y and X, and X and Z.

Determining the extent that multicollinearity is problematic can potentially be operationalised through risk of bias assessment, including through assessment of risk of bias due to specification error (e.g. whether primary authors use theoretically derived "reduced form" models) and multicollinearity (e.g. use of interaction terms and reporting of statistical diagnostic tests).

A review of the literature identified several other solutions to the problem:

1) Becker and Wu (2007) propose a generalised least squares meta-analysis approach which utilises the variance–covariance matrices of the primary study regression models in the meta-analysis weighting.
2) Adopting ad hoc assumptions regarding correlations among covariates, Becker and Wu (2007) state that reviewers could impose a common correlation among slopes (giving an example correlation of 0.2) and estimating generalised least squares meta-analysis.
3) Others propose synthesising bivariate and partial effect sizes separately and coding information on the presence or absence of variables included in the multivariate specifications which generated the partial effect sizes, and exploring whether these factors are systematically correlated with effect size estimates in sensitivity analysis (Aloe & Becker, 2012).
4) Transforming partial effect sizes to approximate the bivariate effect size, as proposed by Peterson and Brown (2005) for the correlation coefficient. However, this method is not recommended by Aloe and Thompson (2013) due to uncertainties about the properties of the resulting effect size point estimate and variance.

5) Synthesising the semi-partial correlation coefficient effect size r_{sp} in place of the standardised slope coefficient (Aloe & Thompson, 2013): $r_{sp} = \frac{t_\beta\sqrt{1-R_Y^2}}{\sqrt{n-p-1}}$. where R_Y^2 is the squared multiple correlation for the regression model (equal to the coefficient of determination for a linear model including constant), t_β is the t-statistic associated with the treatment effect coefficient β and n-p-1 the degrees of freedom. However, the drawback of the approach is the correlation coefficient does not represent the magnitude of the change in outcomes and is therefore of less relevance for policy.

Appendix E

INCLUDED EFFECTIVENESS STUDY DESCRIPTIVES

Table E1 Included impact evaluations by region: study descriptive information

Study name	Intervention type	Country: programme name	Crop	Study design	Overall risk of bias	Outcome data reported for FFS participants (Code: X effect size calculable; x outcome measured but effect size not calculable; * standard errors calculable)						Cost data
						Knowledge	Adoption	Agriculture outcome	Health outcome	Environment outcome	Empowerment outcome	
East Asia and the Pacific												
Chi et al., 1999	IPM-FFS	Vietnam: FAO National IPM Programme, Thoi Long	Rice	Cross-section	High risk of bias	x	x					
Feder et al., 2004	IPM-FFS	Indonesia: National IPM Training Project Phase II (FAO, World Bank, GoI)	Rice	Longitudinal (DID regression)	Medium risk of bias		X*	X*				
Haiyang, 2002	IPM-FFS	China: Netherlands Poverty Alleviation Project (CNPAP), Huoshan	Rice	Cross-section	High risk of bias		x	x	x			x
Huan et al., 1999	IPM-FFS	Vietnam: FAO Programme for Community IPM in Asia	Rice	Cross-section	High risk of bias	X*	X*	X*				

Study name	Intervention type	Country: programme name	Crop	Study design	Overall risk of bias	Outcome data reported for FFS participants (Code: X effect size calculable; x outcome measured but effect size not calculable; * standard errors calculable)						Cost data
						Knowledge	Adoption	Agriculture outcome	Health outcome	Environment outcome	Empowerment outcome	
Kabir & Uphoff, 2007	ICM-FFS	Myanmar: Farmer field school for sustainable agriculture development	Rice	Cross-section	High risk of bias			x				
Mangan & Mangan, 1998	IPM-FFS	China: IPM-FFS Sichuan Province (FAO)	Rice	Longitudinal	High risk of bias							x
Mariyono, 2007	IPM-FFS	Indonesia: National IPM Training Project Phase II (FAO, World Bank, GoI)	Rice	Longitudinal	High risk of bias		x					
Murphy et al., 2002	IPM-FFS	Vietnam: FAO National IPM Program, Nam Dinh	Potato, vegetable	Cross-section	High risk of bias		X*					
Norvell & Hammig, 1999	IPM-FFS	Indonesia: National IPM Training Project Phase II (FAO, World Bank, GoI)	Vegetable	Cross-section (regression)	High risk of bias		X*					
Ooi and Kenmore, 2005	IPM-FFS	China, Vietnam: FAO IPM-FFS programmes for East & South Asia	Cotton	Longitudinal	High risk of bias			x				
Palis, 1998	IPM-FFS +input +marketing support	Philippines: Barangay Integrated Pest Management (BIPM) project, Central Luzon (IRRI, FAO, Philrice)	Rice	Longitudinal	High risk of bias		x	X*				
Pananurak, 2010	IPM-FFS	China: FAO/EU IPM Programme for Cotton in Asia	Cotton	Longitudinal (DID regression)	Medium risk of bias		X*	X*				

Study name	Intervention type	Country: programme name	Crop	Study design	Overall risk of bias	Outcome data reported for FFS participants (Code: X effect size calculable; x outcome measured but effect size not calculable; * standard errors calculable)						Cost data
						Knowledge	Adoption	Agriculture outcome	Health outcome	Environment outcome	Empowerment outcome	
Praneetvatakul & Waibel, 2006	IPM-FFS	Thailand: FAO/EU IPM Programme for Cotton in Asia	Rice	Longitudinal (DID regression)	Medium risk of bias		X*			X*		
Price, 2001	IPM-FFS	Philippines: Central Luzon (IRRI, FAO, Philrice)	Rice	Cross-section	High risk of bias	X*	x					
Rejesus et al., 2010	IPM-FFS	Vietnam: FAO Programme for Community IPM in Asia	Rice	Longitudinal (DID-regression)	Medium risk of bias	X*	X*	X*				
Rola et al., 2002	IPM-FFS	Philippines: FAO National IPM Programme	Rice	Cross-section	High risk of bias	x						
Van de Fliert, 2000	ICM-FFS	Indonesia: National IPM Training Project Phase II (FAO, World Bank, GoI)	Potato	Cross-section (regression)	High risk of bias		x	x				
Walter-Echols & Soomro, 2005	IPM-FFS	China: FAO/EU IPM Programme for Cotton in Asia	Cotton	Longitudinal	High risk of bias		x					
Walter-Echols & Soomro, 2005	IPM-FFS	Vietnam: FAO/EU IPM Programme for Cotton in Asia	Cotton	Longitudinal	High risk of bias		x					
Wu, 2010	IPM-FFS	China: FAO/EU IPM Programme for Cotton in Asia	Cotton	Longitudinal (DID regression)	Medium risk of bias		X*	X*				
Yamazaki & Resosudarmo, 2008	IPM-FFS	Indonesia: National IPM Training Project Phase II (FAO, World Bank, GoI)	Rice	Longitudinal (DID regression)	Medium risk of bias		X*	X*				
Yang et al., 2005	IPM-FFS	China: FAO/EU IPM Programme for Cotton in Asia,	Cotton	Cross-section	High risk of bias		X*	X*				

Study name	Intervention type	Country: programme name	Crop	Study design	Overall risk of bias	Outcome data reported for FFS participants (Code: X effect size calculable; x outcome measured but effect size not calculable; * standard errors calculable)						Cost data
						Knowledge	Adoption	Agriculture outcome	Health outcome	Environment outcome	Empowerment outcome	
		Hubei Province										
Yang et al., 2008	IPM-FFS	China: FAO vegetable IPM, Yunnan Province	Vegetable	Longitudinal (DID regression)	High risk of bias							
Yorobe et al., 2011	IPM-FFS	Philippines: IPM Collaborative Research Support Program (CRSP), Nueva Ecija (USAID)	Vegetable	Cross-section (IV regression)	Medium risk of bias		X*					
Latin America												
Bentley et al., 2007	IPM-FFS	Bolivia: potato integrated management (CIP-PROINPA)	Potato	Cross-section	High risk of bias							x
Cavatassi et al., 2011	IPM-FFS +input +marketing support	Ecuador: Plataformas Program (FAO)	Potato	Cross-section (PSM-WLS regression)	Medium risk of bias		X*	X*				
Cole et al., 2007	IPM-FFS +input +marketing support	Ecuador: EcoSalud	Potato	Cross-section	High risk of bias		X*					
Godtland et al., 2004	IPPM-FFS	Peru: CIP CARE Andean FFS	Vegetable	Cross-section (PSM)	Medium risk of bias	X*						
Labarta, 2005	IPM-FFS	Nicaragua: Project for IPM in Central America (PROMIPAC)	vegetable	Cross-section (IV regression)	High risk of bias		X*	X*	X*			
Mauceri et al., 2007	IPM-FFS	Ecuador: IPM Collaborative Research Support project (CRSP), Carchi	Potato	Cross-section (IV regression)	High risk of bias		X*					x

Study name	**Intervention type**	**Country: programme name**	**Crop**	**Study design**	**Overall risk of bias**	**Outcome data reported for FFS participants (Code: X effect size calculable; x outcome measured but effect size not calculable; * standard errors calculable)**						**Cost data**
						Knowledge	**Adoption**	**Agriculture outcome**	**Health outcome**	**Environment outcome**	**Empowerment outcome**	
Orozco Cirilo et al., 2008	"Integrated management"-FFS	Mexico: El Proyecto Manejo Sustentable de Laderas (PMSL)	Cereal	Longitudinal	High risk of bias	X*	X*	X*				
Rebaudo & Dangles, 2011	IPM-FFS	Ecuador: unclear potato IPM (CIP)	Potato	Cross-section	High risk of bias	X*						
Torrez et al., 1999	IPM-FFS	Bolivia: potato integrated management (CIP-PROINPA)	Potato	Cross-section	High risk of bias	X*		X*				
Van Rijn, 2010	ICM-FFS +input +marketing support	Peru: DE Foundation Coffee Project	Coffee	Cross-section (PSM)	Medium risk of bias		X*	X*			X*	
Zuger, 2004	IPM/ICM-FFS	Peru: Cajamarca FFS (CARE, CIP)	Potato	Cross-section (regression)	High risk of bias	x	x	X*				x
Central Asia												
Dinpanah et al., 2010	FFS (unclear)	Iran: unspecified FFS programmes	Rice	Cross-section	High risk of bias	X*	X*	X*				x
South Asia												
Ali & Sharif, 2012	IPM-FFS	Pakistan: Cotton IPM programme (FAO, EU, GoP)	Cotton	Cross-section (PSM)	Medium risk of bias	X*	X*	X*				
Birthal et al., 2000	IPM-FFS +input support	India: Maharashtra project (National Centre for Integrated Pest Management)	Cotton	Cross-section	High risk of bias		X*	X*				x
DANIDA, 2011	ICM-FFS +input +marketing support	Bangladesh: Agriculture Sector Programme Support 2 (DANIDA, MoA)	Rice	Cross-section (PSM)	High risk of bias			x	x			x

Study name	Intervention type	Country: programme name	Crop	Study design	Overall risk of bias	Outcome data reported for FFS participants (Code: X effect size calculable; x outcome measured but effect size not calculable; * standard errors calculable)						Cost data
						Knowledge	Adoption	Agriculture outcome	Health outcome	Environment outcome	Empowerment outcome	
Islam et al., 2006	IPM-FFS	Bangladesh: Strengthening Plant Protection Services (SPPS) Project	Rice	Cross-section	High risk of bias	x	x	x				x
Jones, 2002	ICM-FFS	Sri Lanka: INTEGRATED IPM project (CARE)	Rice	Cross-section	High risk of bias		x	x				
Khan et al., 2007	IPM-FFS	Pakistan: National IPM Programme, Khairpur	Cotton	Longitudinal	High risk of bias	X*	X*	X*				
Lama et al., 2003	IDM-FFS	Nepal: CIP IDM FFS	Potato	Cross-section	High risk of bias			x				
Mancini & Jiggins, 2008	IPM-FFS	India: FAO/EU IPM Programme for Cotton in Asia	Cotton	Longitudinal	High risk of bias	X	X*	X*				
Naik et al., 2010	ICM-FFS	India: Karnataka Community Based Tank Management Project (KCBTMP)	Cereal, groundnut	Cross-section	High risk of bias			X*				
Ooi and Kenmore, 2005	IPM-FFS	Bangladesh, India, Pakistan: various FAO IPM-FFS programmes	Cotton	Longitudinal	High risk of bias		x	x				
Pananurak, 2010	IPM-FFS	India: FAO/EU IPM Programme for Cotton in Asia	Cotton	Longitudinal (DID regression)	High risk of bias		X*	X*		X*		
Pananurak, 2010	IPM-FFS	Pakistan: FAO/EU IPM Programme for Cotton in Asia	Cotton	Longitudinal (DID regression)	Medium risk of bias		X*	X*		X*		
Pande et al., 2009	ICM-FFS +input +marketing support	Nepal: ICM FFS	Rice	Cross-section	High risk of bias			X*				x

Study name	Intervention type	Country: programme name	Crop	Study design	Overall risk of bias	Outcome data reported for FFS participants (Code: X effect size calculable; x outcome measured but effect size not calculable; * standard errors calculable)						Cost data
						Knowledge	Adoption	Agriculture outcome	Health outcome	Environment outcome	Empowerment outcome	
Pouchepparadjou et al., 2005	IPM-FFS	India: DoA Rice IPM project, Pondicherry	Rice	Cross-section (regression)	High risk of bias							
Rao et al., 2012	ISNM-FFS	India: Sree Ram Sagar Project (SRSP), Andhra Pradesh	Rice	Cross-section	High risk of bias	X*	X*					
Reddy & Suryamani, 2005	IPM-FFS	India: FAO/EU IPM Programme for Cotton in Asia	Cotton	Longitudinal	High risk of bias	X*						
Ricker-Gilbert et al., 2008	IPM-FFS	Bangladesh: National IPM Programme (FAO)	Rice, vegetable	Cross-section (IV regression)	High risk of bias		X*					x
Tripp et al., 2005	IPM-FFS	Sri Lanka: FFS for IPM in rice Southern Province (DoA, FAO)	Rice	Cross-section	High risk of bias	x	x					
Van den Berg and Amarasinghe, 2003	IPM-FFS	Sri Lanka: IPVM Project (FAO, UNEP)	Rice	Cross-section	High risk of bias		X*	X*				x
Walter-Echols & Soomro, 2005	IPM-FFS	Bangladesh: FAO/EU IPM Programme for Cotton in Asia	Cotton	Longitudinal	High risk of bias		x					
Walter-Echols & Soomro, 2005	IPM-FFS	India: FAO/EU IPM Programme for Cotton in Asia	Cotton	Longitudinal	High risk of bias		x			x		
Walter-Echols & Soomro, 2005	IPM-FFS	Pakistan: FAO/EU IPM Programme for Cotton in Asia	Cotton	Longitudinal	High risk of bias		x			x		
Williamson et al., 2003	IPM-FFS	India: Insecticide Resistance Management (IRM), Maharashtra	Cotton	Cross-section	High risk of bias		x	x				

Study name	Intervention type	Country: programme name	Crop	Study design	Overall risk of bias	Outcome data reported for FFS participants (Code: X effect size calculable; x outcome measured but effect size not calculable; * standard errors calculable)						Cost data
						Knowledge	Adoption	Agriculture outcome	Health outcome	Environment outcome	Empowerment outcome	
Sub-Saharan Africa												
Achonga et al., 2011	“Agrobio-diversity”-FFS	Kenya: Bondo Food Security Project (FAO)	Diverse crops	Cross-section (univariate regression)	High risk of bias							
Amera, 2009	IPM-FFS	Kenya: Cotton IPM project (EU & PAN-UK)	Cotton	Cross-section	High risk of bias		X*		X*			
Bunyatta et al., 2006	ISM-FFS	Kenya: KARI Farmer Field School Project	Potato, vegetable	Cross-section	High risk of bias	X*	X*					
Carlberg et al., 2012	IPM-FFS	Ghana: Peanut Collaboration Research Support Program (CRSP)	Groundnut	Cross-section (IV regression)	High risk of bias			X*				
Dankyi et al., 2005	IPPM-FFS	Ghana: Peanut Collaboration Research Support Program (CRSP)	Groundnut	Cross-section	High risk of bias	x	x					
David, 2007	ICPM-FFS	Cameroon: Sustainable Tree Crops Program (STCP) Phase II	Cocoa	Cross-section	High risk of bias	X*	x					
David & Asamoah, 2011	IPPM-FFS	Ghana: National Cocoa Disease and Pest Control Program (CODAPEC)	Cocoa	Cross-section (regression)	High risk of bias	X*						
Davis et al., 2012	IPPM-FFS	Kenya: East African Sub-regional Pilot Project Phase II (FAO)	Vegetable	Longitudinal (covariate matching)	Medium risk of bias			X*				
Davis et al., 2012	IPPM-FFS	Tanzania: East African Sub-regional Pilot Project Phase II (FAO)	Vegetable	Longitudinal (covariate matching)	Medium risk of bias			X*				
Davis et al., 2012	IPPM-FFS	Uganda: East African Sub-regional Pilot Project Phase II (FAO)	Vegetable	Longitudinal (covariate matching)	High risk of bias			X*				

Study name	**Intervention type**	**Country: programme name**	**Crop**	**Study design**	**Overall risk of bias**	**Outcome data reported for FFS participants (Code: X effect size calculable; x outcome measured but effect size not calculable; * standard errors calculable)**						**Cost data**
						Knowledge	**Adoption**	**Agriculture outcome**	**Health outcome**	**Environment outcome**	**Empowerment outcome**	
De Jager et al., 2009	ISM-FFS +marketing support	Kenya: INM Pilot Project in Central and Eastern Kenya	Cereals, vegetable	Cross-section	High risk of bias	x	x					
Endalew, 2009	IPM-FFS	Ethiopia: Jimma and Sidama FFS	Coffee	Cross-section	High risk of bias	X*	X*					
Erbaugh et al., 2010	IPM-FFS	Uganda: IPM Collaborative Research Support Program (CRSP)	Cereals, vegetable, groundnut	Cross-section	High risk of bias	X*						
Friis-Hansen & Duveskog, 2012	IPPM-FFS	Kenya: East African Sub-regional Pilot Project Phase II (FAO)	Vegetable	Cross-section	High risk of bias						x	
Friis-Hansen & Duveskog, 2012	IPPM-FFS	Tanzania: East African Sub-regional Pilot Project Phase II (FAO)	Vegetable	Cross-section	High risk of bias						x	
Friis-Hansen & Duveskog, 2012	IPPM-FFS	Uganda: East African Sub-regional Pilot Project Phase II (FAO)	Vegetable	Cross-section	High risk of bias						x	
Friis-Hansen et al., 2004	IPPM-FFS +input +marketing support	Uganda: East African Sub-regional Pilot Project Phase II (FAO)	Vegetable	Cross-section	High risk of bias		X*			X*		
Gockowski et al., 2005	ICPM-FFS	Nigeria: Sustainable Tree Crops Program (STCP) Phase II (IITA)	Cocoa	Cross-section	High risk of bias		x	x				

Study name	Intervention type	Country: programme name	Crop	Study design	Overall risk of bias	Outcome data reported for FFS participants (Code: X effect size calculable; x outcome measured but effect size not calculable; * standard errors calculable)						Cost data
						Knowledge	Adoption	Agriculture outcome	Health outcome	Environment outcome	Empowerment outcome	
Gockowski et al., 2010	ICPM-FFS +input support	Ghana: National Cocoa Disease and Pest Control Program (CODAPEC)	Cocoa	Cross-section (regression)	High risk of bias		X*	X*				
Hiller et al., 2009	IPPM-FFS	Kenya: Kenya Tea Development Agency/Lipton Sustainable Agriculture Project	Tea	Cross-section / longitudinal	High risk of bias	X*	x	X*			x	
Kelemework, 2005	"Integrated management practices"-FFS	Ethiopia: Integrated Management of Potato Late Blight (CIP, IFAD)	Potato	Longitudinal	High risk of bias	X*	X*					
Khalid, n.d.	IPM-FFS	Sudan: Gezira Scheme, FAO IPM in Vegetables	Vegetable	Cross-section	High risk of bias		X*					
Lund et al., 2010	IPM-FFS	Benin: Healthy Vegetables Through Participatory IPM in Peri-Urban Gardens Project	Vegetable	Cross-section	High risk of bias	x						
Maumbe & Swinton, 2003	IPPM-FFS	Zimbabwe: Cotton IPM-FFS, Sanyati district	Cotton	Cross-section (regression)	High risk of bias							
Mutandwa & Mpangwa, 2004	IPPM-FFS	Zimbabwe: Cotton IPM-FFS, Sanyati district	Cotton	Cross-section	High risk of bias	X*	X*	X*				
Odeyemi et al., 2005	ICM-FFS	Nigeria: Ogun State	Unknown	Cross-section	High risk of bias	x						
Olanya et al., 2010	IDM-FFS	Uganda: CIP IDM FFS (IFAD)	Potato	Cross-section	High risk of bias							

Study name	Intervention type	Country: programme name	Crop	Study design	Overall risk of bias	Outcome data reported for FFS participants (Code: X effect size calculable; x outcome measured but effect size not calculable; * standard errors calculable)						Cost data
						Knowledge	Adoption	Agriculture outcome	Health outcome	Environment outcome	Empowerment outcome	
Rusike et al., 2004	IPPM-FFS	Zimbabwe: Cotton IPM-FFS	Cereal	Cross-section	High risk of bias	x	x					x
Todo & Takahashi, 2011	"Participatory forest management"-FFS +input +marketing support	Ethiopia: Participatory Forest Management Project in the Belete-Gera Regional Forest Priority Area	Vegetable	Longitudinal (PSM-DID regression)	Medium risk of bias		X*	X*				
Waarts et al., 2012	"Good agricultural practices"-FFS	Kenya: Kenya Tea Development Agency/Lipton Sustainable Agriculture Project	Tea	Cross-section (regression)	High risk of bias	X*	x	X*				
Wandji et al., 2007	IPM-FFS	Cameroon: Sustainable Tree Crops Program (STCP) Phase II	Cocoa	Cross-section (regression)	High risk of bias			x				
Williamson et al., 2003	IPM-FFS	Kenya: CABI Bioscience FFS pilot project	Tomato	Cross-section	High risk of bias		x	x				

Notes: IPM: integrated pest management; IPPM: integrated production and pest management; ICM: integrated crop management; ICPM: integrated crop and pest management; IDM: integrated disease management; ISM: integrated soil management; ISNM: integrated soil nutrient management.

DETAILED OUTCOMES REPORTED

Table E2 Detailed outcomes variable: Knowledge and adoption

Study	Knowledge variable used	Other adoption variable used
Ali and Sharif, 2012	* Probability: farmer can differentiate beneficial and harmful pests	* Probability farmer adopted positive practices (pooled variable of percentage farmers adopting: pest scouting, pesticide timing, recommended varieties, deep ploughing)
Amera, 2009		* Percentage of farmers that use IPM techniques
Bunyatta et al., 2006	* Test score: mean knowledge of soil and crop management technology	* Mean score of an index measuring adoption of soil management technology
Chi et al., 1999	* Test score: pooled variable of mean entomological knowledge, insect-plant interaction knowledge and insecticide knowledge	* Percentage of farmers that applied insect control practices (pooled variable of baits, water management, small ducks)
Dankyi et al., 2005	* Probability: percentage of farmers that have knowledge: pooled variable of appropriate practices (recognise foliar pests early enough to apply a control measure, recognise beneficial insects or natural enemies)	* Percentage of individuals that used positive practices (pooled variable of test seeds before planting, plant resistance cultivars, disease control through spray, disease control through rogue, pest control through traps set, carried out row planting)
David & Asamoah, 2011	* Test score: knowledge of pruning, black pod management, farm sanitation, shade management, pest management and post harvest operations	
David, 2007	* Test score: knowledge of tree physiology, disease/pest management, rational pesticide use and post-harvest operations	* Percentage of farmers that adopt practices (pooled variable of pruned cocoa trees, adequate frequency of phyto-sanitary harvesting, managed shade of other trees, spray fungicide to moisten pods without run-off)
De Jager et al., 2009	Number of known technologies: average number technologies per farm mentioned to address soil decline	* Number of new soil fertility management practices adopted Number of new commercial activities
Dinpanah et al., 2010	* Test score: knowledge of biological control (score range 0–32)	* Index of adoption of biological control (score range 0–40)
Endalew, 2009	* Test score: mean knowledge of practices (score range 0–16)	* Index of adoption of coffee management practices (score range 0–13)
Erbaugh et al., 2010	* Test score: pooled variable of mean knowledge on maize, beans, sorghum, cowpea, groundnuts (iganga) and groundnuts (kumi)	
Friis-Hansen et al., 2004		Probability crops sprayed. * Probability of adopting IPPM fertiliser techniques (pooled variable of number of practices adopted: stopped burning, use of green manure, incorporated other residues, used compost, used chicken manure, planted green manure, used chemical fertiliser, used cattle manure to improve soil, fallowed to improve soil, mulched to improve soil fertility) * Probability of adopting IPPM pesticides techniques (pooled variable of number of practices adopted: used improved seeds, used the natural enemy to destroy the pest, improved soil fertility, monitored pest population, prepared the seed bed early enough, monitored weed population, sprayed the crops, did nothing to destroy the pests) Probability of adopting other IPPM techniques (pooled variable of number of practices adopted: contour ploughing, planted grass strips, planted cover crops, mulched, made terraces fanya juu or fnay chini, stopped removing plant residues)
Gockowski et al., 2005		* Number of prunings conducted in the 2004 season
Gockowski et al., 2010		Fertiliser use (kg applied in the cocoa season 2004–05) Number of positive agricultural practices adopted (pooled variable of number of

Study	Knowledge variable used	Other adoption variable used
		prunings, number of weedings conducted during the season 2004–05)
Godtland et al., 2004	* Test score: knowledge of IPM practices based on FFS curriculum (score range not specified)	
Hiller et al., 2009	* Test score: mean knowledge of good agricultural practices (score range 0–10)	* Percentage of farmers who implemented good agricultural practices (pooled variable) Change in plucking frequency
Huan et al., 1999	* Test score: composite index of knowledge of pesticide management practices (estimated from the following beliefs: applying insecticides will increase yields, killing natural enemies can cause more pests, leaf folders in first 40 DAS can cause severe damages, leaf folders in first 40 DAS can cause yield loss, spraying insecticides for leaf folders has to be done in early season) (score range 15–5) [index rescaled to show a positive effect when SMD>0]	
Islam et al., 2006	* Probability: percentage of individuals with high level of knowledge on IPM including knowledge on pest identification, pest management, insecticides and environmental awareness	* Percentage of individuals with high adoption of technology (as defined when adopts 67–100% of the 10 major IPM component technologies)
Kelemework, 2005	* Probability: improved knowledge on late blight (pooled variable across all education groups)	* Probability farmers used improved varieties (pooled variable across all education groups)
Khan et al., 2007	* Test score: growth in mean knowledge (pooled variable of decision-making, experimentation, biodiversity and social recognition test scores) (score range 0–100)	Field observations (hours per season)
Lund et al., 2010	* Probability: percentage of farmers aware of beneficial insects	
Mancini & Jiggins, 2008	* Test score: change over time in mean score of knowledge on identification score, functional score and ecology score	
Mariyono, 2007		Percentage of IPM technologies adopted including pest-resistant varieties, technical culture, mechanical rat control, chemical insect control, observation
Mauceri et al., 2007		* Average number of IPM practices adopted (score range 0–17)
Mutandwa & Mpangwa, 2004	* Test score: mean score on technical knowledge (score range 0–100)	
Norvell & Hammig, 1999		* Mean score of sustainability index, based on adoption of IPM practices (score range 0–100)
Odeyemi et al., 2005	* Variable definition is not reported	
Orozco-Cirilo et al., 2008	* Test score: change over time of knowledge of management of water (scoring system not reported)	* Growth in technology adoption index
Price, 2001	* Test score: change over time of mean score of entomological knowledge, insect-plant interaction and insect knowledge/practice	
Rao et al., 2012	* Test score: integrated soil and nutrition management (score range 0–27)	* Index of adoption of integrated soil and nutrition management techniques (score range 0–27)
Rebaudo & Dangles, 2011	* Test score: IPM knowledge (score range 0–5)	

Study	Knowledge variable used	Other adoption variable used
Reddy & Suryamani, 2005	* Test score: change over time in mean score on cotton pest and other crop management practices (score range 0–100)	
Rejesus et al., 2010	* Test score: growth rate of percentage of correctly answered questions	
Ricker-Gilbert et al., 2008	* Test score: knowledge of simple practices (score range 0–5), intermediate practices (score range 0–8) and complex practices (score range 0–3) [FFS neighbour group only]	* Number of 1) simple, 2) intermediate and 3) complex IPM practices adopted (pooled estimate)
Rola et al., 2002	* Test score: mean scores of pest management tests (pooled variable of nutrient management, seed health, pest resistant variety and certified seeds)	
Rusike et al., 2004	* Test score: mean score of knowledge of soil fertility and water management technologies (score range 0–100)	* Percentage of farmers reporting changed practices on any of the following: soil fertility, soil and water conservation, new varieties and planting methods
Todo & Takahashi, 2011		* Probability farmer adopted positive agricultural practice (pooled variable of probability of adopting: farm management, measure/compost, utilisation of small land, pest control, periodic observation/regular farm visit, proper use of fertiliser, preparation of seed bed, proper spacing, soil preparation, weeding, vegetable production, seed preparation before sowing, new varieties, appropriate sowing method)
Torrez et al., 1999	* Probability: percentage of people that correctly answer each of 8 IPM questions (pooled variable)	
Tripp et al., 2005	* Probability: percentage of farmers that correctly answer 4 insecticide use decision rules (pooled variable of answers to each) Number of known technologies:: number of natural enemies named	* Time spent in field inspection (hours per acre per week)
Van de Fliert, 2000		Percentage of farmers using fertilisers (pooled variable of N-fertiliser, P-fertiliser, K-fertiliser and organic fertiliser) Percentage of farmers that practice other beneficial agricultural practices (pooled variable of seed selection, good water management, field sanitation after experiencing weevil attack)
Van Rijn, 2010		* Probability farmer adopted positive agricultural practices (pooled variable of probability of adopting: shade management, application of organic material, use of chemical, organic fungicides, organic fertiliser, organic pesticides, growing seedling in a bag, management of seedling, pruning, selective harvest)
Waarts et al., 2012	* Test score: mean score on knowledge of good agricultural practices (score range 0–10)	
Zuger, 2004	Test score: mean score on IPM knowledge (score range not reported)	

Note: * standardised mean difference (SMD) effect size and standard error calculable. In all other cases, effect size or standard errors were not calculable and therefore these results are excluded from meta-analysis.

Table E3 Detailed outcomes variables: Pesticide use and agricultural outcome measures

Study	Pesticide use measure	Agricultural outcome measure
Ali and Sharif, 2012	* Pesticide use (litres per acre)	* Yield (kg per ha)
Amera, 2009	* Pesticide use: percentage of individuals that used pesticides (pooled variable of endosulfan, DDT, malathion, black powder, deltamethrin use)	
Birthal et al., 2000	Pesticide use (g per ha) * Pesticide costs (Rs, unclear if per ha)	Yield (quintal per ha) * Value of output (Rs per household) (unclear if used current or constant Rs)
Carlberg et al., 2012		* Yield (50kg bags per acre 2010)
Cavatassi et al., 2011	* Pesticide use (kg per ha insecticide applied)	* Yield (kg per ha) * Net revenue: gross margin (USD per ha) (unclear if used current or constant USD)
Chi et al., 1999	Pesticide use: Mean number of insecticide sprays during 0–40 days after sowing	
Cole et al., 2007	* Pesticide use (kg per ha)	
DANIDA, 2011		Annual income (BD taka per household)
Davis et al., 2012		* Growth rate in value of yield (growth rate in value in local currency per acre)
Dinpanah et al., 2010		* Yield (ton per ha) * Income (USD per year) (unclear if used current or constant USD and if income is per unit of land)
Feder et al., 2004	* Growth rate in pesticide costs (Rp per ha, 1998 prices) in the main rice plot	* Growth rate in yield (growth rate, kg per ha)
Gockowski et al., 2005	Pesticide use (kg per ha copper sulfate applied in 2004)	Yield (kg per ha 2004)
Gockowski et al., 2010		* Quantity of produce sold in 2004–05 season
Haiyang, 2002	Pesticide use (g per ha of chemical pesticides, fungicides, herbicides and rodenticides) Pesticide costs (USD per ha) (total expenditure on chemical pesticides, fungicides, herbicides, rodenticide)	Yield (kg per ha) Net income (USD per ha) (unclear if this is only for rice production; unclear if used current or constant USD)
Hiller et al., 2009		* Growth in yield (kg per acre)
Huan et al., 1999	* Pesticide use (number of insecticide sprays per season)	* Yield (ton per ha) (unclear if this is only for rice production)
Islam et al., 2006	Pesticide costs (taka per ha)	Yield (kg per ha)
Jones, 2002	Pesticide costs (Rs per ha)	Yield (kg per ha) (pooled variable of aubergine, chilli and potato yields) Net revenue (value per ha) (pooled variable of aubergine, chilli and potato)
Kabir & Uphoff, 2007		Growth of yield (ton per ha)
Khalid, n.d.	* Pesticide use (mL per feddan)	
Khan et al., 2007	* Growth in pesticide use (kg per ha insecticide) * Growth in pesticide costs (USD per ha)	* Growth of yield (kg per ha) Growth in net revenue: gross margin (USD per ha)
Labarta, 2005	* Pesticide use	* Yield * Net revenue
Lama et al., 2003.		Net revenue (N Rp per ha)

Study	Pesticide use measure	Agricultural outcome measure
Mancini & Jiggins, 2008	* Growth rate of pesticide use (ml a.i. per ha) (pooled variable of highly toxic and less harmful pesticide)	Growth rate of yield (kg per ha) (unclear if this is only for cotton production)
Murphy et al., 2002	* Pesticide use (number of times sprayed per farmer per year)	
Mutandwa & Mpangwa, 2004	* Pesticide costs (currency amount per acre)	* Yield (number of bales) (unclear if bales is per any unit of land)
Naik et al., 2010		* Yield (quintals of produce) * Net income (Rs.)
Ooi & Kenmore, 2005	Growth in pesticide cost (USD) (unclear if relative to any unit of land)	Growth in revenue: gross margin (USD per hectare)
Orozco Cirilo et al., 2008		* Growth in yield (ton per ha)
Palis, 1998	Growth in insecticide use and herbicide use (kg per ha) (pooled variable across dry and wet season)	* Growth in yield (ton per ha) (pooled variable of dry season and wet season) * Growth in net revenues (Ps. per ha) (pooled variable of dry season and wet season)
Pananurak, 2010	* Growth in pesticide costs (USD per ha)	* Growth in yield (kg per ha) * Growth in net revenue: gross margin (USD per ha)
Pande et al., 2009		* Yields (ton per ha) Net income (Rs.) over 5 years
Praneetvatakul & Waibel, 2006	* Growth in pesticide costs (total expenditure over reference period)	
Price, 2001	Pesticide use (number of insecticide sprays in 1997) Pesticide cost (Ps. per ha insecticide)	
Rejesus et al., 2010	* Growth rate in pesticide use (total number of insecticide sprays per ha)	* Growth rate in yields (tonnes per ha)
Todo & Takahashi, 2011		* Growth rate in value of production (Eth birr)
Torrez et al., 1999		Yield (no description of the outcome provided)
Tripp et al., 2005	Pesticide use: number of insecticide applications (2002–03)	
Van de Fliert, 2000	Pesticide use: number of pesticide applications per season	Yield (kg per ha) (unclear if this only potato yields)
Van den Berg and Amarasinghe, 2002	* Pesticide cost: total expenditure on fertilisers, insecticides, fungicides and herbicides (USD per ha)	* Yield (kg per ha) * Profit (USD per ha)
Van Rijn, 2010		* Yield (kg per ha, 2007) * Net revenue (Soles per kg per ha)
Waarts et al., 2012	Growth in pesticide cost (K Sh per bush)	Growth in yield (kg per acre) Net income (KSh.)
Walter-Echols & Soomro, 2005	Growth in pesticide use (kg per ha)	
Wandji et al., 2007		* Sales: Kg of cocoa sold in the 2004–05 season
Williamson et al., 2003	Pesticide cost: cash outlay on insecticide sprays, pheromone sprays, pheromone traps, preventative fungicide sprays, chilli extract sprays, curative fungicide sprays (USD per ha)	Net revenue: gross margin (USD per ha) Gross income (USD per ha)
Wu, 2010	* Growth in insecticide cost (USD per ha)	* Growth rate in yield (kg per ha)
Yamazaki and Resosudarmo, 2008	* Growth in pesticide cost (Rp per ha, 1998 prices) in the main rice plot	
Yang et al., 2005	* Pesticide use (litres per ha)	* Yield (kg per ha)

Study	Pesticide use measure	Agricultural outcome measure
	* Pesticide costs (USD per household)	* Net revenue: gross margin (USD per ha)
Yorobe et al., 2011	* Pesticide costs (pesos per ha)	
Zuger, 2004	Pesticide use (number of applications in season 2000–01	Yield (ton per ha)

Note: * response ratio effect size and standard error calculable. In all other cases, effect size or standard errors were not estimatable and therefore these results are excluded from meta-analysis.

Table E4 Detailed outcomes variables: environment, health and empowerment outcomes

Study	Environment outcomes	Health outcomes	Empowerment outcomes
Amera, 2009		* Probability of pesticide poisoning	
Cavatassi et al., 2011	* Change in environmental impact quotient (EIQ**) score		
DANIDA, 2011		Annual expenditure on health (Taka per household)	
Friis-Hansen et al., 2004	* Change in soil fertility		
Friis-Hansen & Duveskog, 2012			Pooled variable of self-reported empowerment indices: innovation uptake, access to services, engaging with markets and collective action/social relations
Hiller et al., 2009			Change over time in perception of empowerment (further detail in the definition of empowerment is not reported)
Labarta, 2005		* Incidence of respiratory difficulties, eye irritation, stomach ache, blurred vision	
Pananurak, 2010	* Growth rate of environmental impact quotient index (EIQ**) score		
Praneetvatakul & Waibel, 2006	* Growth rate of environmental impact quotient index (EIQ**) score		
Rusike et al., 2004			Pooled variable of share of famers reporting better position to solve local agricultural problems on their own and share reporting making new demands on extension staff
Van Rijn, 2010			* Pooled variable of probability of the farmers positively answering self-esteem questions: feeling capable of solving problems in the field, feeling comfortable in giving an opinion, participating in the community
Walter-Echols & Soomro, 2005	Change over time in environmental impact quotient (EIQ**) score		

Notes: * response ratio effect size and standard error calculable. In all other cases, effect size or standard errors were not estimatable and therefore these results are excluded from meta-analysis. ** EIQ calculation uses active ingredients of pesticides and applies a rating system in ten categories to identify a single value of the environmental impact rating. The ten categories include: (i) action mode of pesticides, (ii) acute toxicity to birds, (iii) fish, (iv) bees, (v) acute dermal toxicity, (vi) long-term health effects, (vii) residue half-life in soil and (viii) plant surface, (ix) toxicity to beneficial organisms, and (x) groundwater and runoff potential (Kovach et al., 1992).

Appendix F

RESULTS OF CRITICAL APPRAISAL: IMPACT EVALUATIONS

Study	Study design (analysis method)	Selection bias and confounding addressed?	Spillovers and contamination addressed?	Outcome reporting bias addressed?	Analysis reporting bias addressed?	Other sources of bias addressed?	Overall risk of bias assessment	Unit of analysis assessment
		1 = Yes, 2 = No, 8 = Unclear						
Achonga et al., 2011	Cross-section (univariate regression)	2	8	1	1	8	High risk	N/A
Ali & Sharif, 2012	Cross-section (PSM)	8	8	1	1	8	Medium risk	Unclear
Amera, 2009	Cross-section	2	8	2	8	8	High risk	Unclear
Bentley et al., 2007	Cross-section	2	2	1	1	8	High risk	Unclear
Birthal et al., 2000	Cross-section	2	8	2	2	8	High risk	Unclear
Bunyatta et al., 2006	Cross-section	2	2	1	1	8	High risk	High probability of error (UoA error correction applied)

Study	Study design (analysis method)	Selection bias and confounding addressed?	Spillovers and contamination addressed?	Outcome reporting bias addressed?	Analysis reporting bias addressed?	Other sources of bias addressed?	Overall risk of bias assessment	Unit of analysis assessment
		1 = Yes, 2 = No, 8 = Unclear						
Carlberg et al., 2012	Cross-section (IV regression)	8	2	1	2	8	High risk	Low probability of error
Cavatassi et al., 2011	Cross-section (PSM-WLS regression)	8	8	1	1	8	Medium risk	Low probability of error
Chi et al., 1999	Cross-section	2	8	1	2	8	High risk	Unclear
Cole et al., 2007	Cross-section	2	8	8	8	8	High risk	Unclear
DANIDA. 2011	Cross-section (PSM)	2	8	1	8	8	High risk	N/A
Dankyi et al., 2005	Cross-section	2	2	8	2	8	High risk	Unclear
David & Asamoah, 2011	Cross-section (regression)	2	8	1	1	8	High risk	Unclear
David, 2007	Cross-section	2	1	1	8	8	High risk	N/A
Davis et al., 2012 (Kenya)	Longitudinal (covariate matching)	8	8	8	1	2	Medium risk	Low probability of error
Davis et al., 2012 (Tanzania)	Longitudinal (covariate matching)	8	8	8	1	2	Medium risk	Low probability of error
Davis et al., 2012 (Uganda)	Longitudinal (covariate matching)	8	2	8	1	2	High risk	Low probability of error
De Jager et al., 2009	Cross-section	2	8	1	2	8	High risk	Unclear

Study	Study design (analysis method)	Selection bias and confounding addressed?	Spillovers and contamination addressed?	Outcome reporting bias addressed?	Analysis reporting bias addressed?	Other sources of bias addressed?	Overall risk of bias assessment	Unit of analysis assessment
		1 = Yes, 2 = No, 8 = Unclear						
Dinpanah et al., 2010	Cross-section	2	8	1	2	8	High risk	Unclear
Endalew, 2009	Cross-section	2	1	8	2	8	High risk	Unclear
Erbaugh et al., 2010	Cross-section	2	8	1	2	8	High risk	Unclear
Feder et al., 2004	Longitudinal (DID regression)	8	8	1	8	8	Medium risk	Low probability of error
Friis-Hansen & Duveskog, 2012	Cross-section	2	8	1	2	8	High risk	Unclear
Friis-Hansen & Duveskog, 2012	Cross-section	2	8	1	2	8	High risk	Unclear
Friis-Hansen & Duveskog, 2012	Cross-section	2	8	1	2	8	High risk	Unclear
Friis-Hansen et al., 2004	Cross-section	2	8	1	2	8	High risk	Unclear
Gockowski et al., 2005	Cross-section	2	8	1	2	8	High risk	Unclear
Gockowski et al., 2010	Cross-section (regression)	2	8	1	8	8	High risk	Unclear
Godtland et al., 2004	Cross-section (PSM)	8	1	8	1	8	Medium risk	Unclear
Haiyang, 2002	Cross-section	2	8	8	8	8	High risk	Unclear

Study	Study design (analysis method)	Selection bias and confounding addressed?	Spillovers and contamination addressed?	Outcome reporting bias addressed?	Analysis reporting bias addressed?	Other sources of bias addressed?	Overall risk of bias assessment	Unit of analysis assessment
		1 = Yes, 2 = No, 8 = Unclear						
Hiller et al., 2009	Cross-section (knowledge) / longitudinal (adoption, yields)	2	1	1	1	8	High risk	Unclear
Huan et al., 1999	Cross-section	2	8	1	8	8	High risk	Unclear
Islam et al., 2006	Cross-section	2	2	1	8	8	High risk	N/A
Jones, 2002	Cross-section	2	8	2	2	8	High risk	Unclear
Kabir & Uphoff, 2007	Cross-section	2	2	1	8	8	High risk	N/A
Kelemework, 2005	Longitudinal	2	8	1	8	8	High risk	Unclear
Khalid, n.d.	Cross-section	2	8	1	8	8	High risk	Unclear
Khan et al., 2007	Longitudinal	2	1	1	2	8	High risk	Unclear
Labarta, 2005	Cross-section (IV regression)	2	8	1	2	8	High risk	Low probability of error
Lama et al., 2003	Cross-section	2	8	2	2	8	High risk	Unclear
Lund et al., 2010	Cross-section	2	8	2	2	8	High risk	N/A
Mancini & Jiggins 2008	Longitudinal	2	1	8	2	8	High risk	Unclear

Study	Study design (analysis method)	Selection bias and confounding addressed?	Spillovers and contamination addressed?	Outcome reporting bias addressed?	Analysis reporting bias addressed?	Other sources of bias addressed?	Overall risk of bias assessment	Unit of analysis assessment
1 = Yes, 2 = No, 8 = Unclear								
						8		
Mangan & Mangan, 1998	Longitudinal	2	8	1	1	8	High risk	N/A
Mariyono, 2007	Longitudinal	2	2	1	8	8	High risk	N/A
Mauceri et al., 2007	Cross-section (IV regression)	8	2	1	8	8	High risk	Unclear
Maumbe & Swinton, 2003	Cross-section (regression)	8	2	1	2	8	High risk	Unclear
Murphy et al., 2002	Cross-section	2	2	8	8	8	High risk	N/A
Mutandwa & Mpangwa, 2004	Cross-section	2	2	1	8	8	High risk	Unclear
Naik et al., 2010	Cross-section	2	2	1	2	8	High risk	N/A
Norvell & Hammig, 1999	Cross-section (regression)	2	2	1	1	8	High risk	Unclear
Odeyemi et al., 2005	Cross-section	2	2	1	1	8	High risk	Unclear
Olanya, 2010	Cross-section	2	2	1	8	8	High risk	N/A
Ooi and Kenmore, n.d.	Longitudinal	2	1	1	2	8	High risk	Unclear

Study	Study design (analysis method)	Selection bias and confounding addressed?	Spillovers and contamination addressed?	Outcome reporting bias addressed?	Analysis reporting bias addressed?	Other sources of bias addressed?	Overall risk of bias assessment	Unit of analysis assessment
		1 = Yes, 2 = No, 8 = Unclear						
Orozco Cirilo et al., 2008 (yields)	Longitudinal	2	2	1	8	8	High risk	Unclear
Palis, 1998	Longitudinal	2	1	1	1	8	High risk	High probability of error (UoA error correction applied)
Pananurak, 2010 (China)	Longitudinal (DID regression)	8	8	1	8	8	Medium risk	Low probability of error (UoA error correction applied)
Pananurak, 2010 (India)	Longitudinal (DID regression)	2	8	1	8	8	High risk	Low probability of error
Pananurak, 2010 (Pakistan)	Longitudinal (DID regression)	8	8	1	8	8	Medium risk	Low probability of error
Pande et al., 2009	Cross-section	2	8	1	2	8	High risk	Unclear
Pouchepparadjou et al., 2005	Cross-section (regression)	2	2	1	8	8	High risk	N/A
Praneetvatakul & Waibel, 2006	Longitudinal (DID regression)	8	1	2	8	8	Medium risk	Low probability of error
Price, 2001	Cross-section	2	2	1	8	8	High risk	N/A
Rao et al., 2012	Cross-section	2	2	1	8	8	High risk	N/A
Rebaudo & Dangles, 2011	Cross-section	2	8	1	2	8	High risk	Unclear
Reddy & Suryamani, 2005	Longitudinal	2	1	1	1	8	High risk	Unclear

Study	Study design (analysis method)	Selection bias and confounding addressed?	Spillovers and contamination addressed?	Outcome reporting bias addressed?	Analysis reporting bias addressed?	Other sources of bias addressed?	Overall risk of bias assessment	Unit of analysis assessment
		1 = Yes, 2 = No, 8 = Unclear						
Rejesus et al., 2010	Longitudinal (DID regression)	8	2	8	1	8	Medium risk	High probability of error (UoA error correction applied)
Ricker-Gilbert et al., 2008	Cross-section (IV regression)	2	2	1	1	8	High risk	High probability of error (UoA error correction applied)
Rola et al., 2002	Cross-section	2	8	1	8	8	High risk	N/A
Rusike et al., 2004	Cross-section	2	8	2	2	8	High risk	N/A
Todo & Takahashi, 2011	Longitudinal (PSM-DID regression)	8	8	1	8	8	Medium risk	Unclear
Torrez et al., 1999	Cross-section	2	8	1	2	8	High risk	Unclear
Tripp et al., 2005	Cross-section	2	8	1	2	8	High risk	N/A
Van de Fliert, 2000	Cross-section (regression)	2	8	1	1	8	High risk	Unclear
Van den Berg and Amarasinghe, 2002	Cross-section	2	1	1	1	8	High risk	Low probability of error
Van Rijn, 2010	Cross-section (PSM)	8	8	1	2	8	Medium risk	Low probability of error
Waarts et al., 2012	Cross-section (regression)	2	2	1	8	8	High risk	N/A
Walter-Echols & Soomro, 2005	Longitudinal	2	1	8	2	8	High risk	Unclear

Study	Study design (analysis method)	Selection bias and confounding addressed?	Spillovers and contamination addressed?	Outcome reporting bias addressed?	Analysis reporting bias addressed?	Other sources of bias addressed?	Overall risk of bias assessment	Unit of analysis assessment
		1 = Yes, 2 = No, 8 = Unclear						
Wandji et al., 2007	Cross-section (regression)	2	2	1	1	8	High risk	N/A
Williamson et al., 2003	Cross-section	2	8	1	2	8	High risk	N/A
Wu, 2010	Longitudinal (DID regression)	8	1	1	8	8	Medium risk	Low probability of error
Yamazaki & Resosudarmo, 2008	Longitudinal (DID regression)	8	8	1	1	8	Medium risk	Low probability of error
Yang et al., 2008	Longitudinal (DID regression)	8	8	1	1	8	Medium risk	N/A
Yang et al., 2005	Cross-section	2	8	1	1	8	High risk	Unclear
Yorobe et al., 2011	Cross-section (IV regression)	8	1	1	8	8	Medium risk	Unclear
Zuger, 2004	Cross-section (regression)	2	8	8	8	8	High risk	Unclear

RESULTS OF CRITICAL APPRAISAL: QUALITATIVE EVALUATIONS

Study	Research aim	Context	Sampling	Sampling characteristics	Data collection	Data recording	Analysis	Link to relevant lit./ theory	Appropriate methodology	Appropriate sampling	Appropriate methods of data collection	Appropriate analysis	Triangulation	Clarity of analysis and conclusions	Conflict of interest considered/ addressed	Ethical considerations mentioned
1 = Yes, 2 = No, 8 = Partially, 9 = Unclear																
DANIDA, 2011	1	1	1	1	1	8	8	1	1	1	1	2	1	8	2	2
David, 2007	1	1	1	1	1	2	2	1	8	8	8	8	1	8	2	2
Dolly, 2009	1	1	1	1	1	2	2	1	8	8	8	2	1	8	2	2
Friis-Hansen, 2008	1	1	8	1	1	2	8	1	8	8	8	2	1	2	2	2
Friis-Hansen et al., 2012	1	1	1	1	1	1	1	1	8	8	1	8	1	8	2	1
Gottret & Córdoba, 2004	1	1	1	1	1	8	8	1	8	8	8	8	1	8	2	2
Hiller et al., 2009	1	1	1	1	1	8	2	8	8	8	8	8	8	1	2	2
Hofisi, 2003	1	1	8	1	1	2	8	1	1	8	1	1	1	1	2	1
Isubikalu et al., 2007	1	1	1	1	1	1	1	1	1	1	1	8	1	8	2	2
Karanja-Lumumba et al., 2007	1	1	1	8	8	2	2	1	8	8	8	9	1	8	2	2
Machacha, 2008	1	1	1	1	1	2	8	1	1	1	8	8	1	8	2	2
Mancini et al., 2007	1	1	8	1	1	8	1	1	1	9	1	8	8	8	2	2
Najjar, 2009	1	1	1	1	1	8	1	1	1	1	1	1	1	1	1	1
Palis, 2002	1	1	1	1	1	2	1	1	8	8	8	8	1	8	2	2
Pedersen et al., 2008	1	1	1	1	8	1	2	2	8	1	8	9	1	2	1	2
Rola & Baril, 1997	1	1	1	1	1	2	2	8	9	8	8	2	1	8	2	2
Simpson, 1997	1	1	1	1	1	1	2	1	1	1	8	8	1	8	1	1
Van de Fliert, 1993	1	1	1	1	1	1	8	1	1	1	1	8	1	1	2	9
Van Der Wiele, 2004	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
Winarto, 2004	1	1	8	1	1	2	2	1	1	9	8	8	8	8	8	2

Appendix G

META-ANALYSES BY PROGRAMME NAME

Figure A18 Knowledge outcomes by programme name

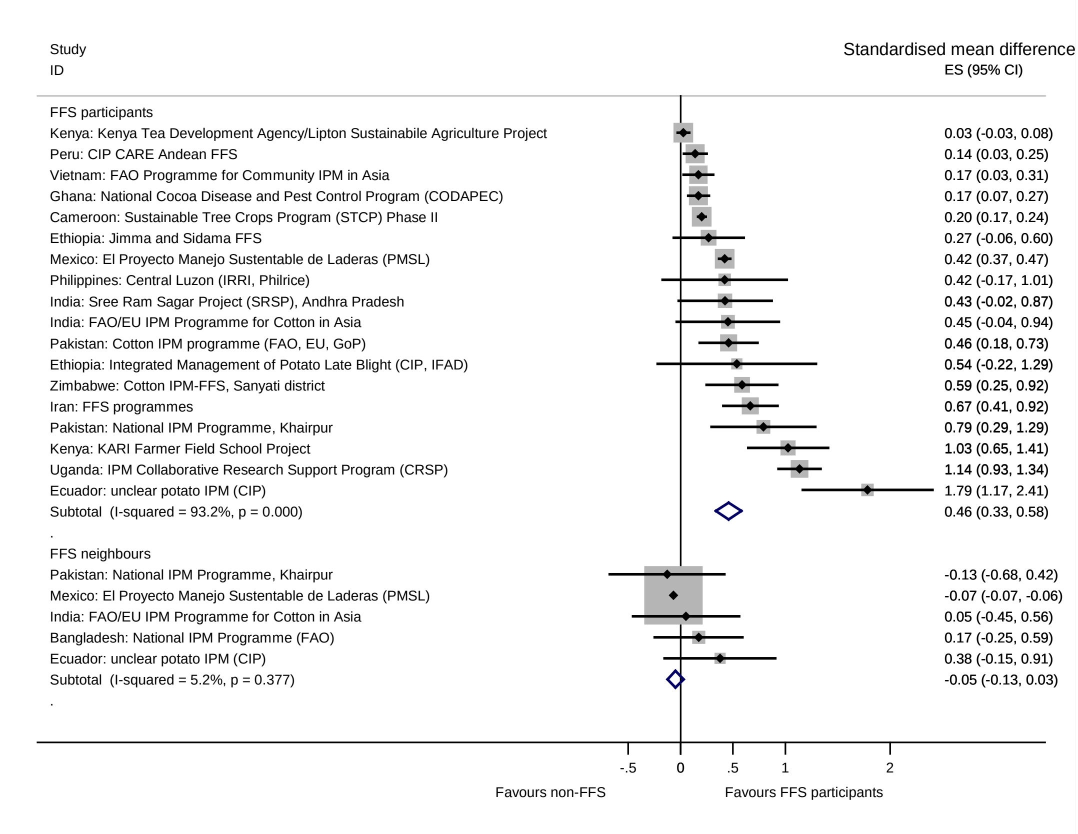


Figure A19 Pesticide use by programme name

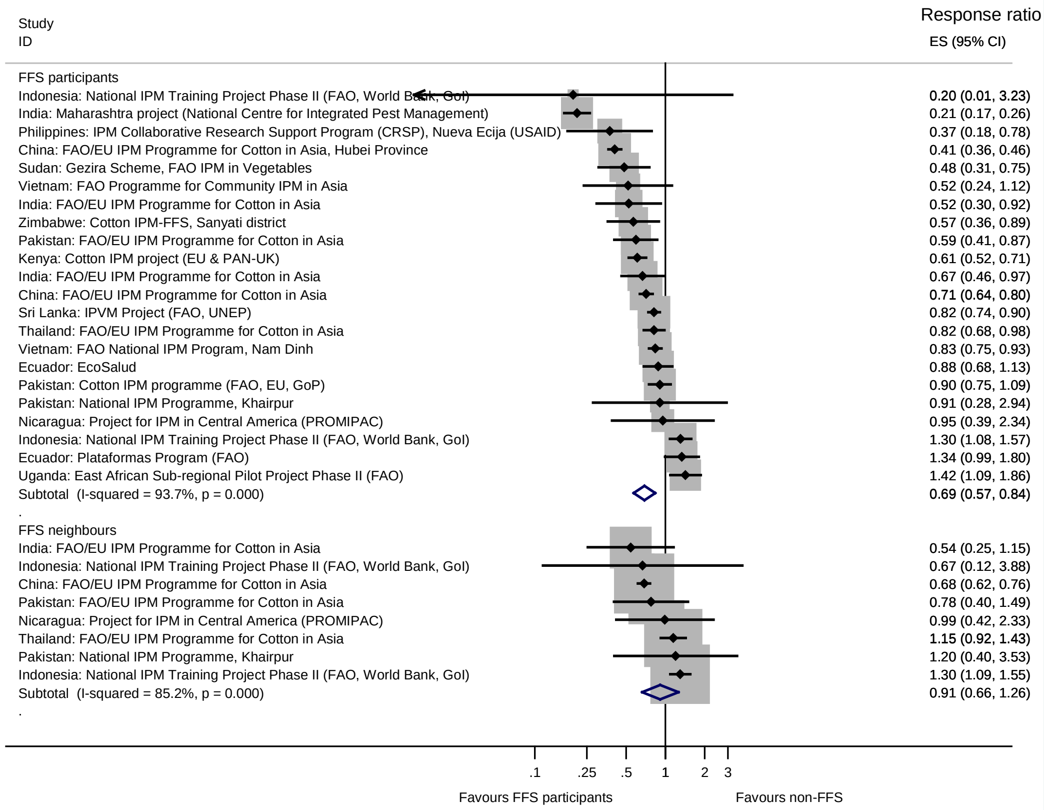


Figure A20 Other adoption measures by programme name

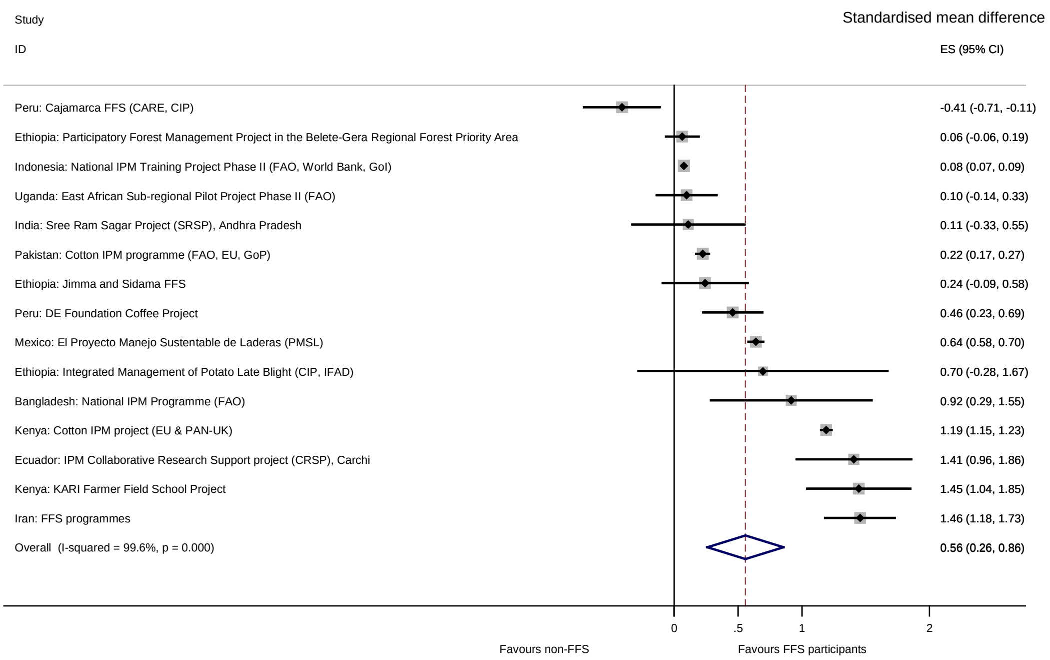


Figure A21 Yields by programme name

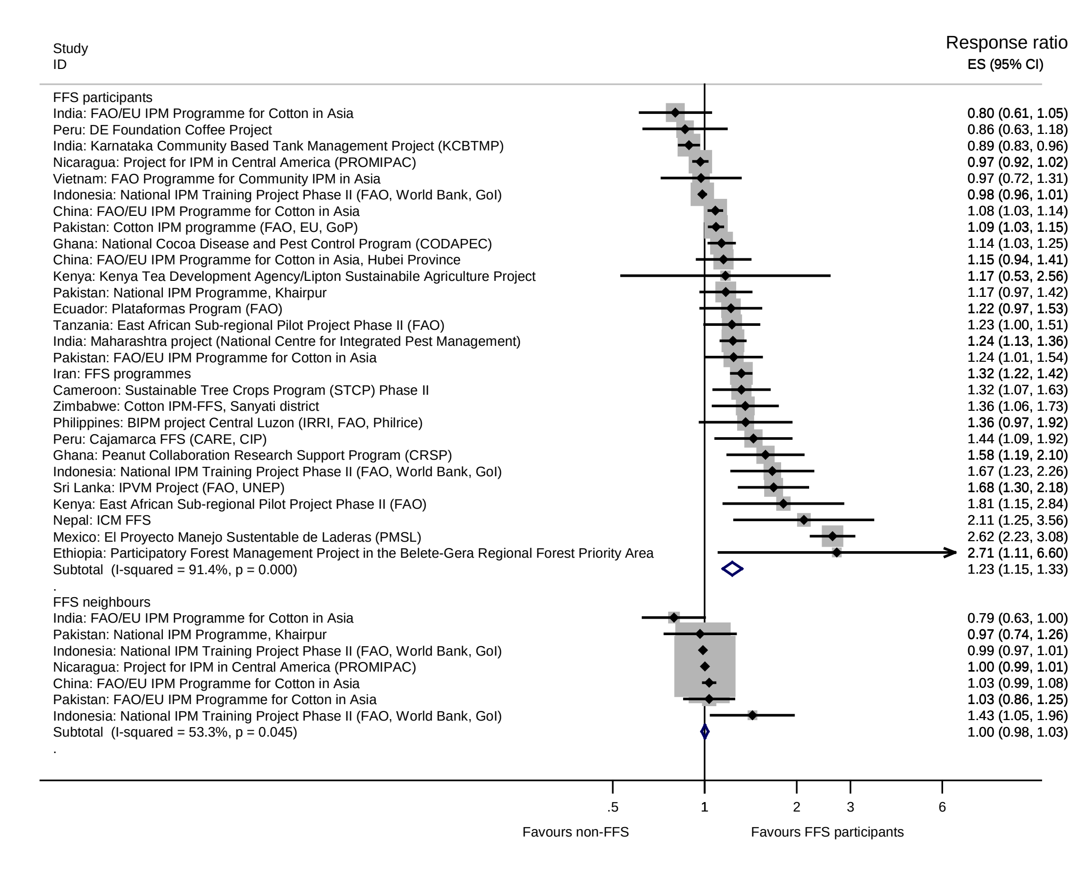
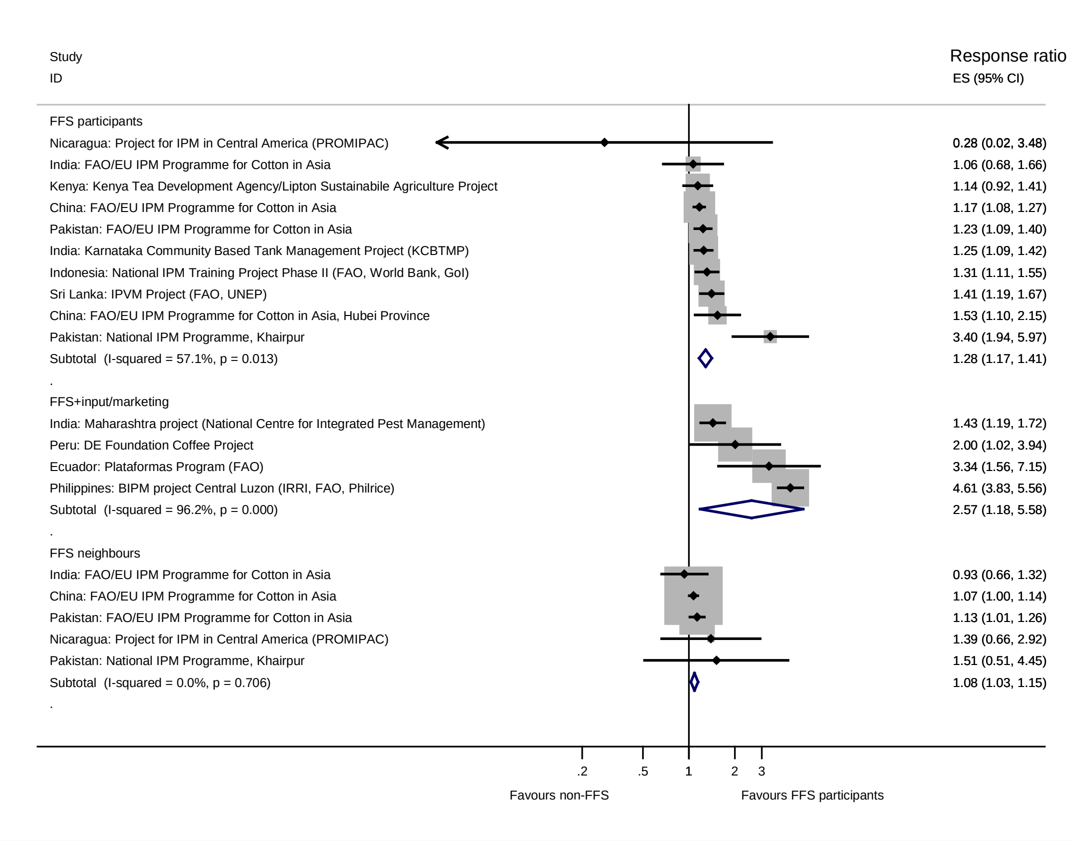


Figure A22 Net revenues by programme name



META-ANALYSES INCLUDING ALL STANDARD ERRORS CORRECTED FOR POSSIBLE UNIT OF ANALYSIS ERRORS

Figure A23 Knowledge outcomes corrected for possible unit of analysis error: all studies

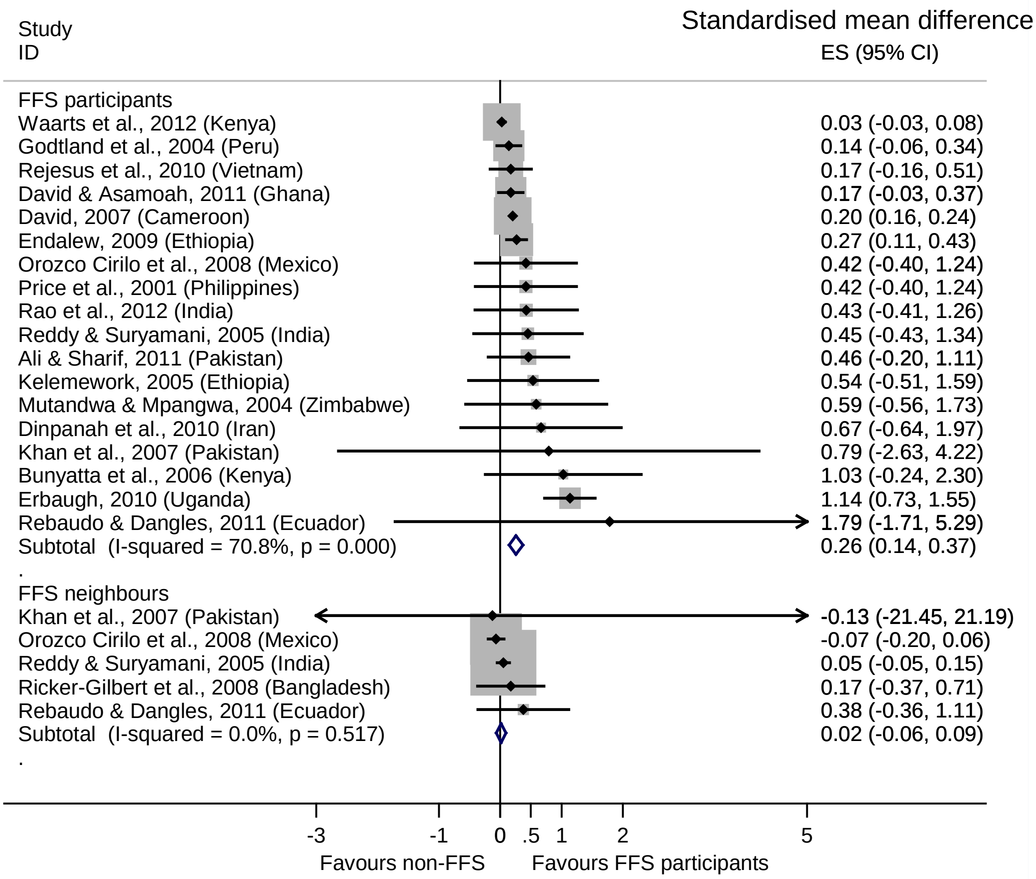


Figure A24 Knowledge outcomes corrected for possible unit of analysis error: excluding high-risk-of-bias studies

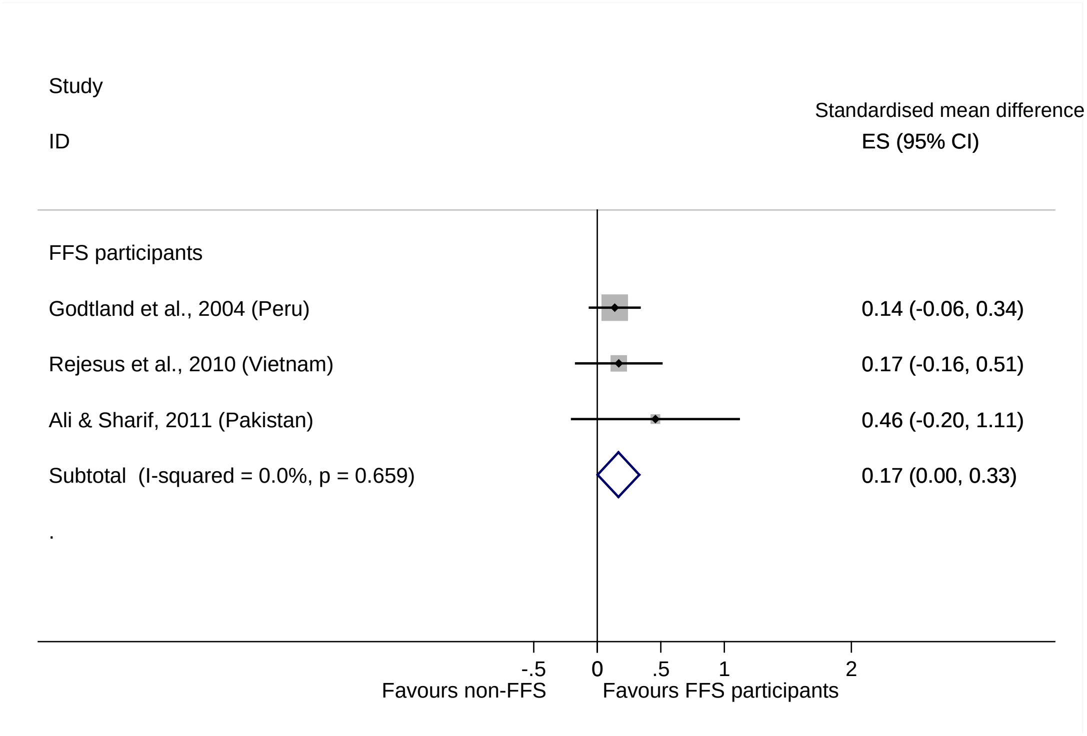


Figure A25 Pesticide use corrected for possible unit of analysis error: all studies

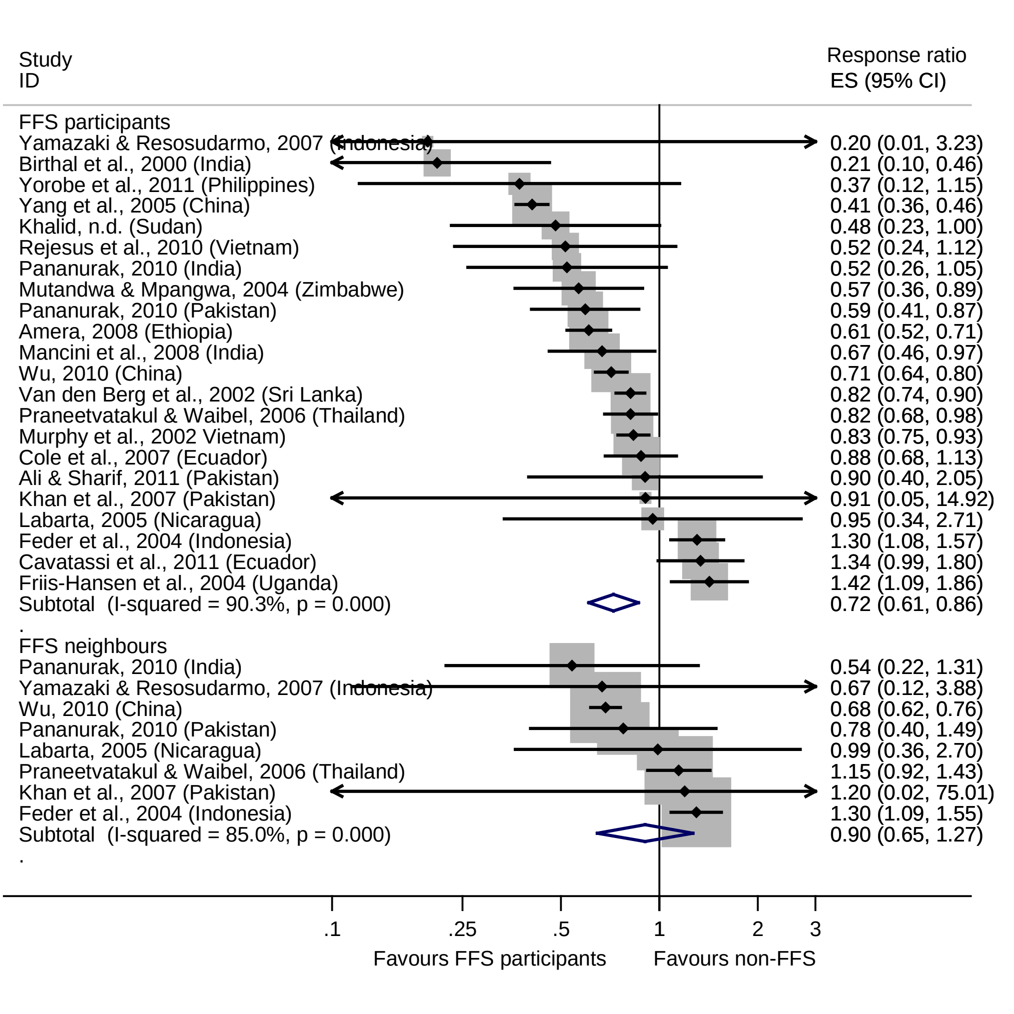


Figure A26 Pesticide use corrected for possible unit of analysis error: excluding high-risk-of-bias studies

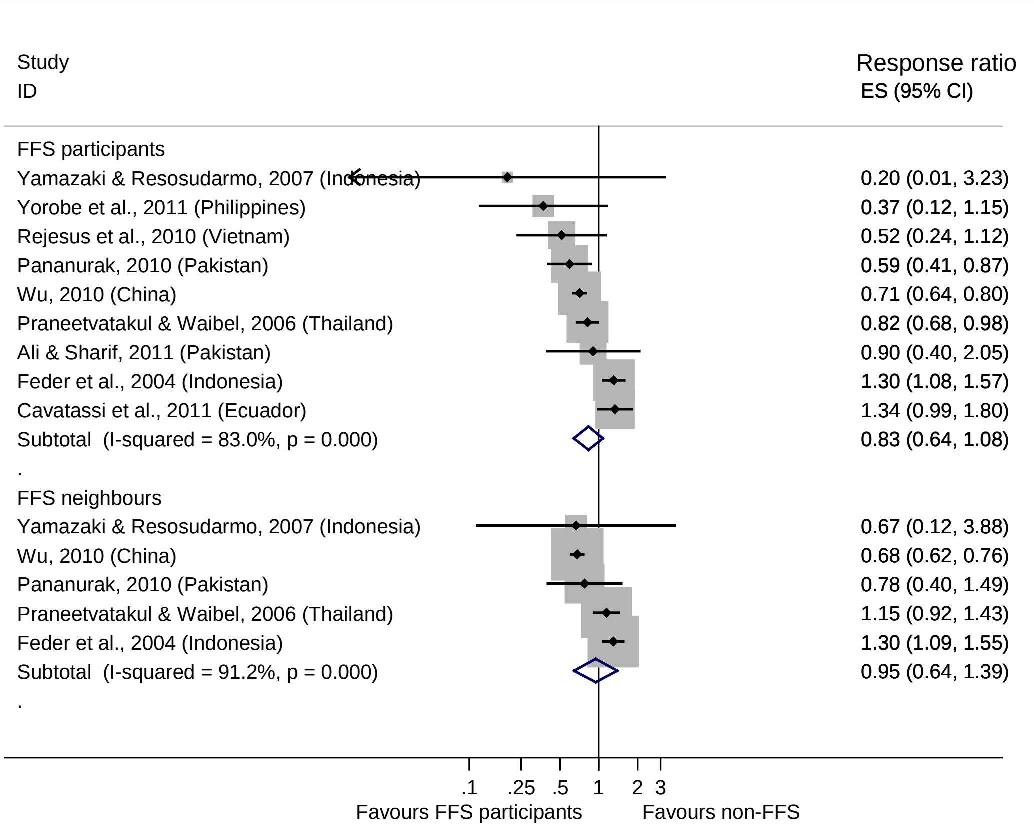


Figure A27 Other adoption measures corrected for possible unit of analysis error: all studies by risk of bias status

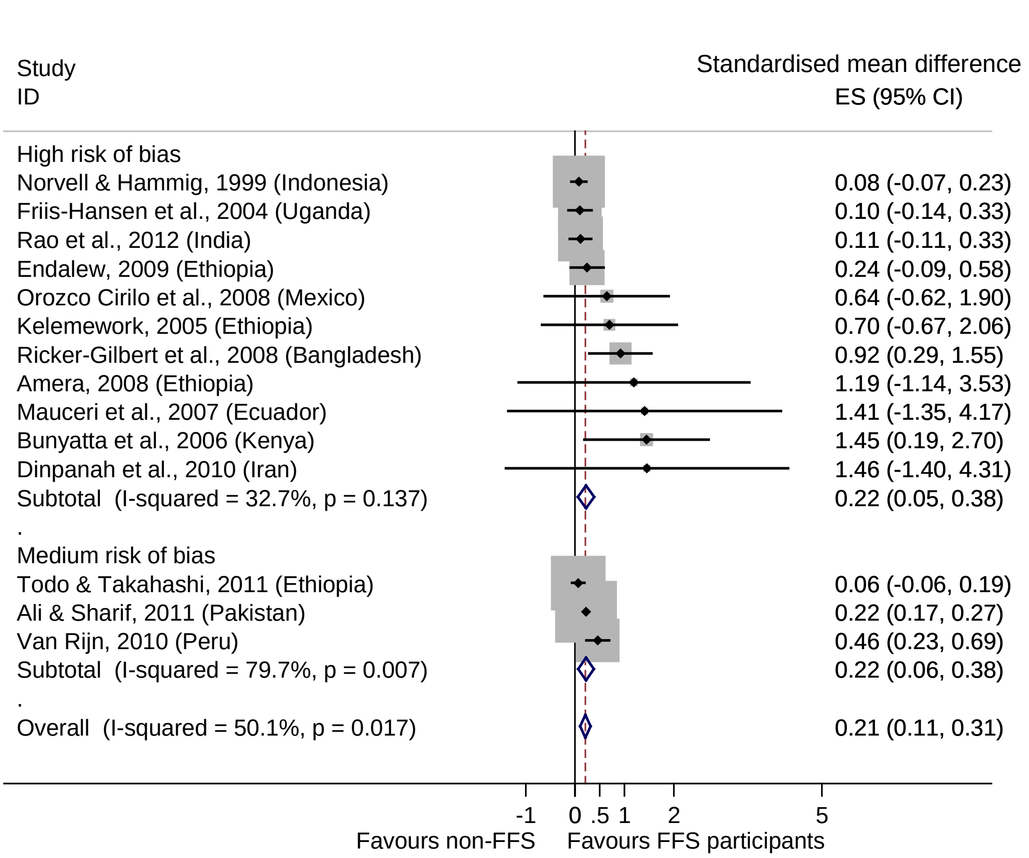


Figure A28 Yields corrected for possible unit of analysis error: all studies

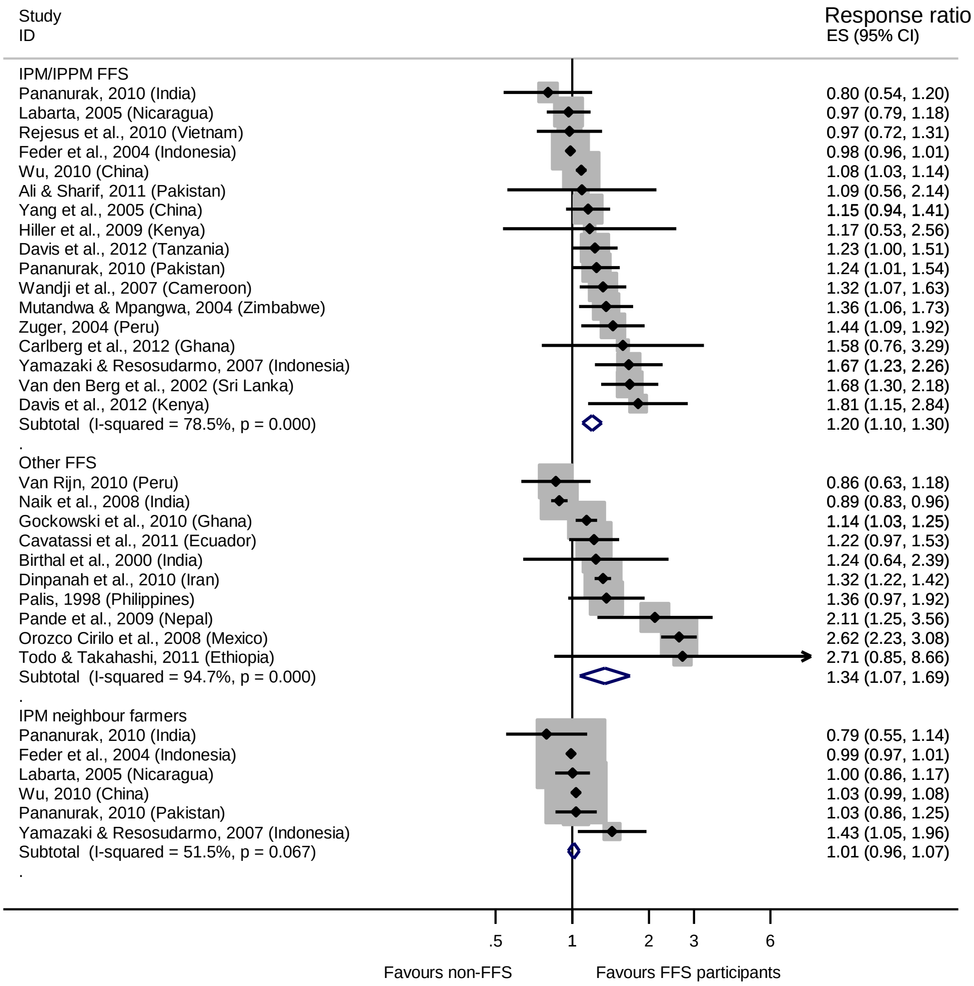


Figure A29 Yields corrected for possible unit of analysis error: excluding high-risk-of-bias studies

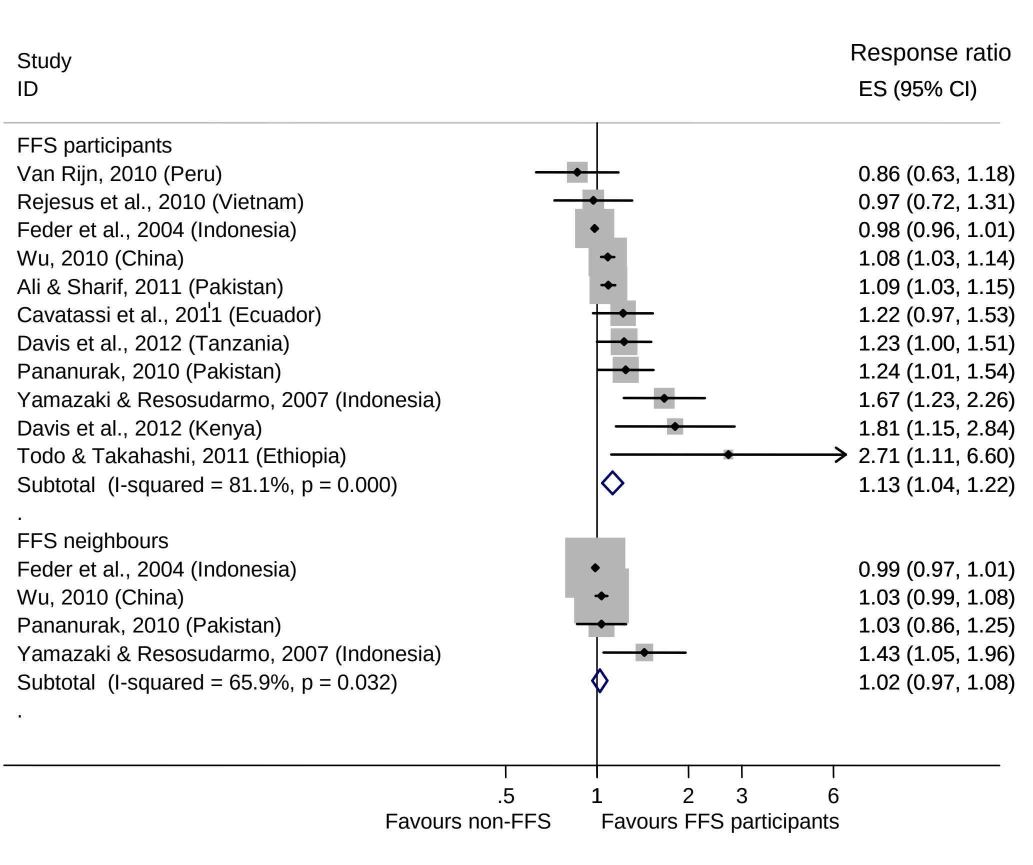


Figure A30 Net revenues corrected for possible unit of analysis error: all studies

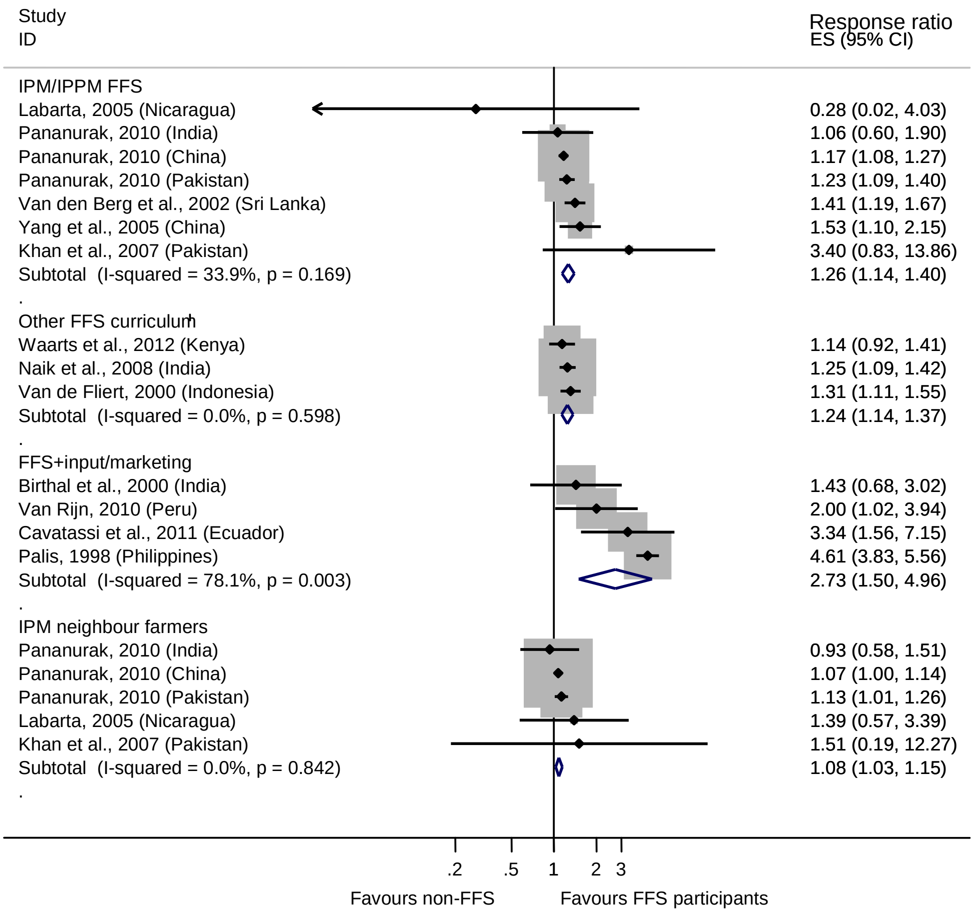


Figure A31 Net revenues corrected for possible unit of analysis error: excluding high-risk-of-bias studies

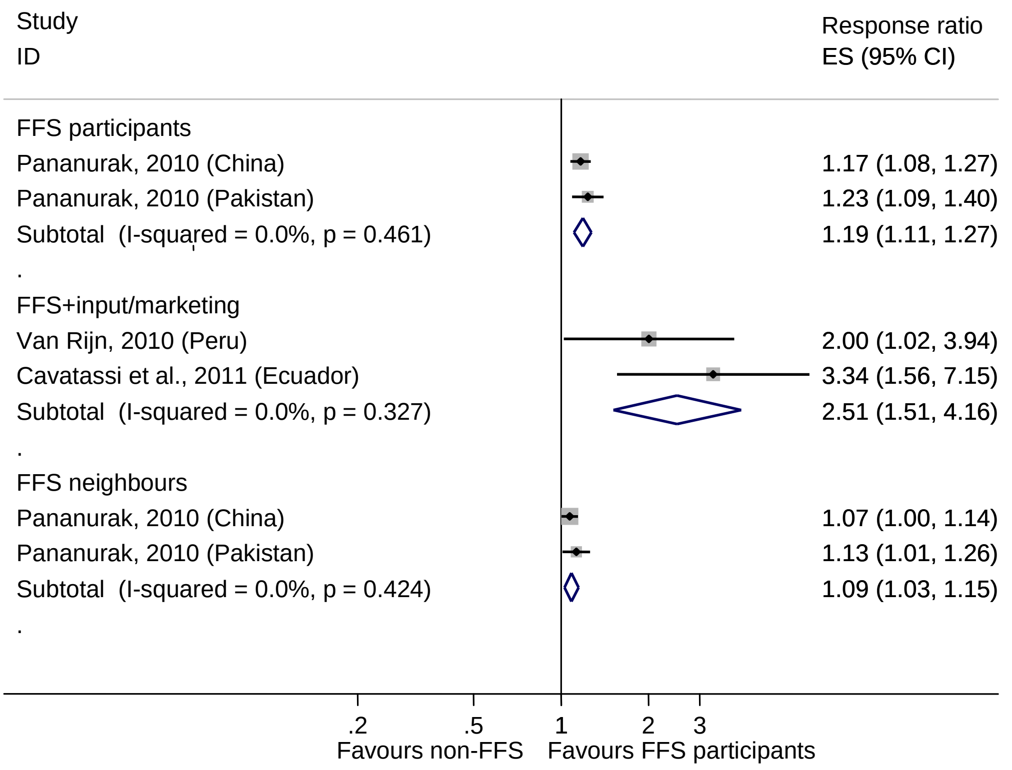


Figure A32 Sensitivity analysis: pesticide adoption for IPM/IPPM FFS, excluding Feder et al. (2004) and Yamazaki and Resosudarmo (2008)

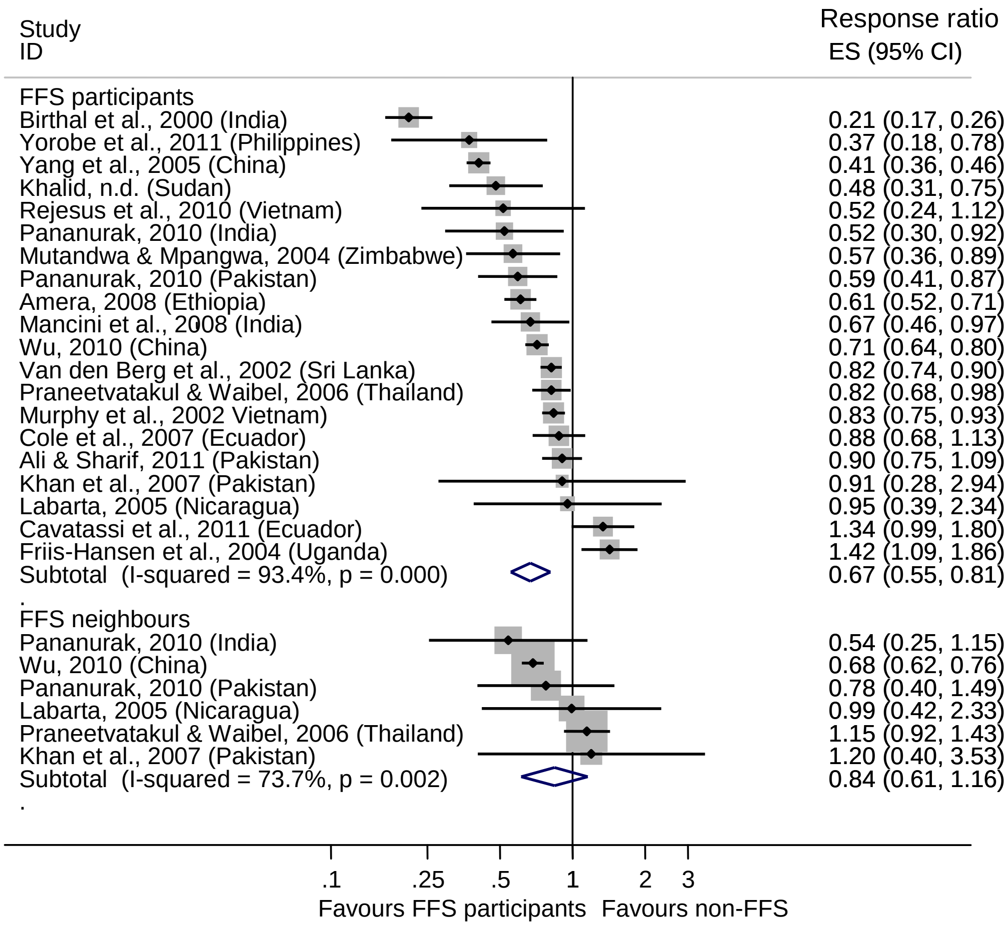


Figure A33 Sensitivity analysis: pesticide adoption IPM/IPPM FFS farmers by risk of bias status, excluding Feder et al. (2004) and Yamazaki and Resosudarmo (2008)

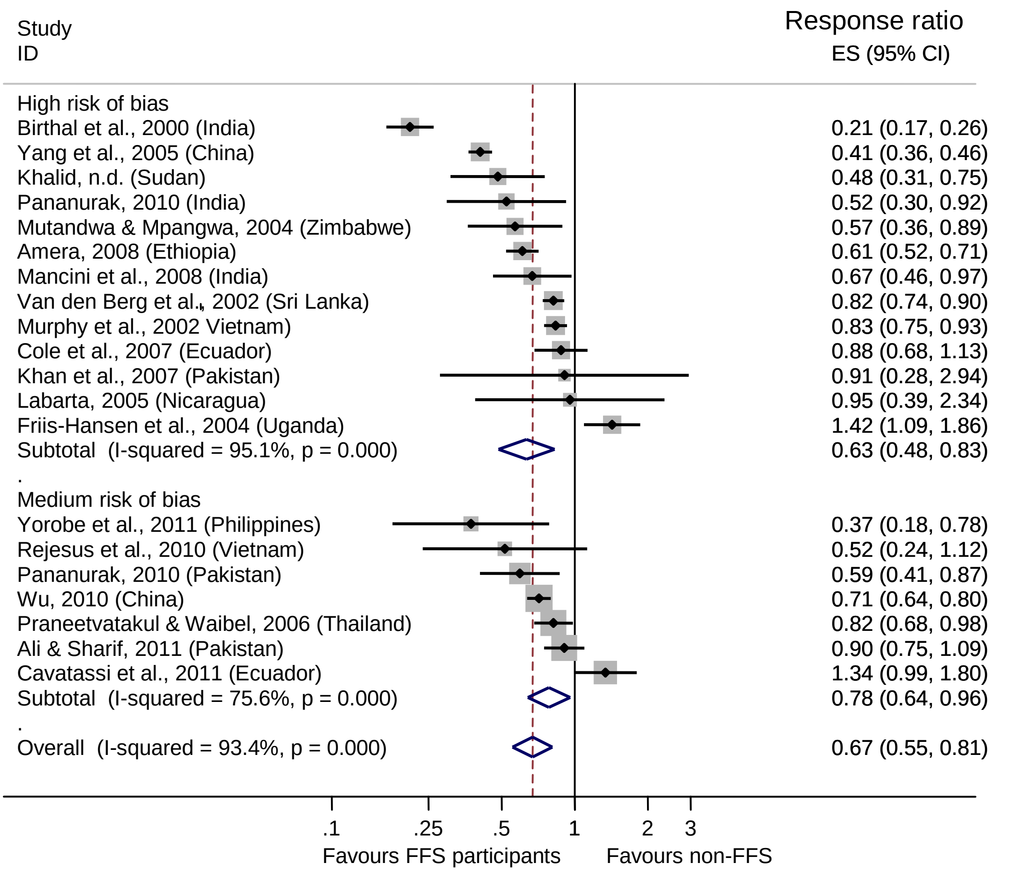


Figure A34 Sensitivity analysis: yields for FFS farmers, excluding Feder et al. (2004) and Yamazaki and Resosudarmo (2008)

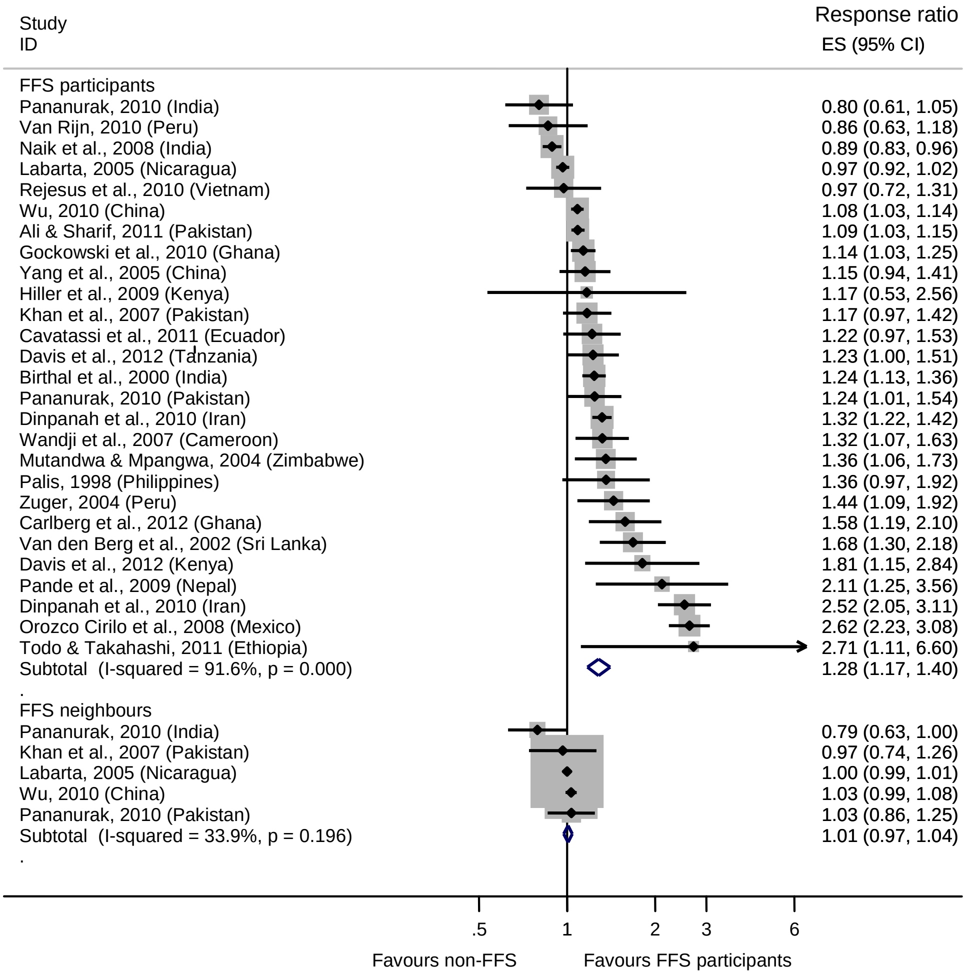


Figure A35 Sensitivity analysis: yields for FFS farmers by risk of bias status, excluding Feder et al. (2004) and Yamazaki and Resosudarmo (2008)

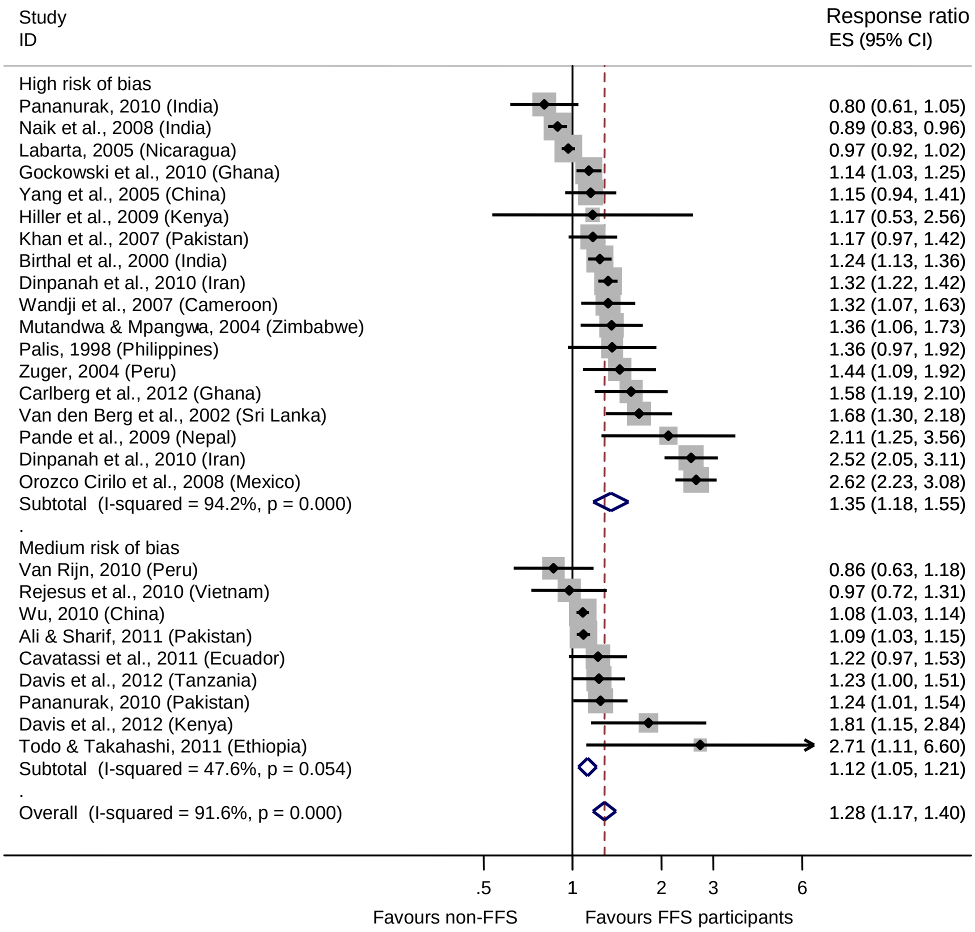


Figure A36 Disaggregated IPM practices adopted by FFS farmers (Ricker-Gilbert et al., 2008, Bangladesh)

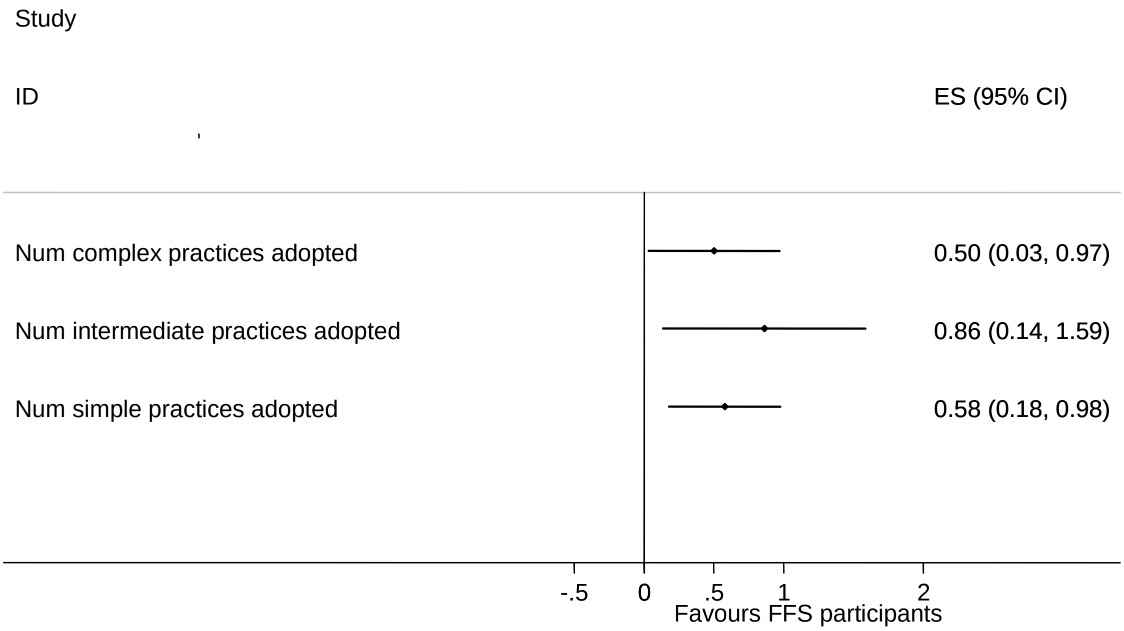
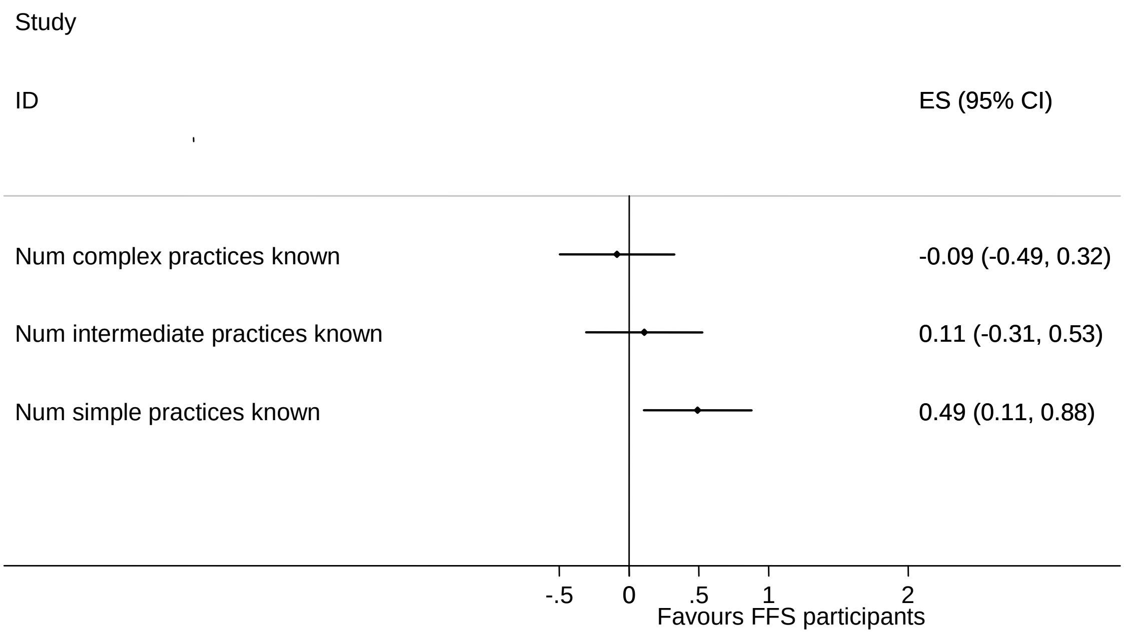


Figure A37 Disaggregated IPM practices known by FFS neighbours (Ricker-Gilbert et al., 2008, Bangladesh)



Appendix H

DESCRIPTIVE SYNTHESIS OF FINDINGS FROM QUALITATIVE STUDIES

From the line by line coding of the primary studies we extracted descriptive themes (following Thomas & Harden, 2008), which remained close to the findings in the primary studies. We summarised relevant findings from each study and synthesised emerging themes into statements and concepts. This descriptive synthesis provided the basis for the causal chain synthesis and is reported below. The statements in bold represent different descriptive themes identified based on the findings of the included studies.

Targeting and participation

Targeting, participant selection and group composition

An important factor for FFS effectiveness is that appropriate farmer groups are targeted and that participants are motivated and able to attend field schools throughout the full season. While studies provide information on targeting, and selection procedures and group composition, their link to FFS effectiveness is not well explored. Twelve studies out of twenty report some information on targeting, selection and composition of FFS groups (DANIDA, 2011; Friis-Hansen, 2008; Gottret & Córdoba, 2004; Hofisi, 2003; Machacha, 2008; Najjar, 2009; Palis, 2002; Pedersen et al., 2008; Rola & Baril, 1997; Simpson, 1997; Van de Fliert, 1993; Van Der Wiele, 2004). Six studies report on factors affecting participation and drop-out rates. Only four studies directly or indirectly discuss the implications of targeting and group composition on FFS effectiveness (Gottret & Córdoba, 2004; Hofisi, 2003; Machacha, 2008; Pedersen et al., 2008).

Targeting procedures appear to vary from context to context. In some instances, **farmers were selected according to predetermined criteria** (DANIDA, 2011; Palis, 2002; Simpson, 1997). In the Philippines, participants had to be active farmers, able to attend all FFS sessions, and able and willing to share what they learned with other farmers (Palis, 2002). The chairman responsible for selecting participants also tried to ensure geographic representation among participants. Similarly, in Cambodia, participants had to be active rice farmers, willing to learn and willing to share what they learned with other farmers (Simpson, 1997). Participation of women was encouraged.

One study mentions that **participants were targeted through established contact people** associated with the implementing agency (Van Der Wiele, 2004). The study notes that less than half of the interviewed participants[75] had farming as their main occupation, suggesting that this targeting approach may not have been effective.

In Bangladesh, Indonesia and Cambodia **the elite and more affluent members of the community were selected for participation in the FFS** (DANIDA, 2011; Simpson, 1997; Van de Fliert, 1993). In Cambodia, participants were selected by village leaders who were privileging members of the community that were well connected with the local leader or the NGO. The selection criteria "implicitly excluded poor farmers, especially widows as criteria included literacy, numeracy and social standing", thereby excluding more than one-fifth of the community (Simpson, 1997, pp. 146–147). In Bangladesh, the selection procedures excluded the landless and share-croppers (DANIDA, 2011). In Indonesia, FFS groups were composed of the more affluent and more informed farmers. The author suggests that this is the result of selection procedures being "strongly based on customary social patterns in Javanese society" (Van de Fliert, 1993, p. 227).

Three studies found that **targeting procedures led to some women and the poor being excluded from participating in FFS** (DANIDA, 2011; Najjar, 2009; Simpson, 1997)**.** In Cambodia, many women and poorer families could not participate because farmers were required to be literate in order to participate and widows were often overlooked during selection procedures (Simpson, 1997). Similarly, in Bangladesh, the selection procedures excluded women-headed households, widows, the landless and share-croppers (DANIDA, 2011). In Kenya, while the majority of participants were women, female-headed households, divorced and single mothers faced prohibitive recruitment procedures, such as selection by local administration or recruitment in public barazas (Najjar, 2009).

In many instances, farmers self-selected into FFS groups, chose not to participate or were prevented from participating by various factors unrelated to targeting. Eleven studies explored the motivating factors for self-selection and reasons for non-participation in FFS (DANIDA, 2011; Friis-Hansen, 2008; Friis-Hansen et al., 2012; Gottret & Córdoba, 2004; Hofisi, 2003; Machacha, 2008; Najjar, 2009; Rola & Baril, 1997; Van de Fliert, 1993; Van Der Wiele, 2004).

In some instances, **participants chose to attend FFS based on their interest in learning** (Friis-Hansen, 2008; Hofisi, 2003; Najjar, 2009). In Zimbabwe, elite farmers did not think they would benefit from participation in FFS and perceived farmer learning as a waste of time. However, the study also mentions that some innovative elite farmers did not share these views and took pride in participating in the FFS (Hofisi, 2003). In Kenya, non-participating farmers mentioned lack of interest or their attachment to previously held knowledge as reasons for non-

[75] The authors interviewed around two-thirds of all FFS participants.

participation. The study also notes lack of interest as one of the reasons for non-participation by the youth (Najjar, 2009). In Uganda, the implementing agency conducted a sensitisation around a common interest in learning new skills prior to group formation (Friis-Hansen, 2008, p. 519). The sensitisation was not entirely successful but farmers not interested in learning soon left the groups as they did not consider the time investment worth the benefits. Those that remained were those who shared willingness to "invest time and effort in learning and in conducting joint activities" (Friis-Hansen, 2008, p. 519).

Those attending FFS reported that **improving livelihoods was a motivating factor for joining FFS** (DANIDA, 2011; Friis-Hansen et al., 2012; Najjar, 2009). In one FFS in Kenya, both men and women were seeking to gain new skills, increase food production and increase income (Najjar, 2009). Friis-Hansen and colleagues (2012) report similar findings from their study in Kenya. They note that "frustration over their livelihoods and aspirations for a better life ultimately became the key motivators for joining FFS" (Duveskog et al., 2011, p. 1,535). In Bangladesh, the motivating factor was the acquisition of knowledge that would improve farmers' agricultural production and incomes (DANIDA, 2011). Two studies note **poverty and poor health as reasons for non-participation** (Gottret & Córdoba, 2004; Najjar, 2009). A study notes that many poor farmers in Honduras are unable to participate unless they are to be paid for their time spent in FFS (Gottret & Córdoba, 2004). In Kenya, the youth lacked access to land, but also did not participate due to poor health (Najjar, 2009). A study from Honduras reported that more educated farmers with positions of responsibility were more likely to participate (Gottret & Córdoba, 2004).

Five studies found that **women were often not able or allowed to participate** (DANIDA, 2011; Hofisi, 2003; Najjar, 2009; Van de Fliert, 1993; Van Der Wiele, 2004). In Indonesia, no women were observed to participate in FFS (Van de Fliert, 1993) and in Liberia women participants tended to be in the minority despite intentions for equal representation of genders (Van Der Wiele, 2004). In Bangladesh, the wives of men who did not have time to attend FFS were not allowed to take their husbands' place due to the presence of other men in the group (DANIDA, 2011).

Two other studies report that some women were not allowed to participate by their husbands (Hofisi, 2003; Van Der Wiele, 2004). In Liberia and Kenya, some women, especially those heading households, divorced and single mothers, did not have time to participate due to child-care requirements and other household responsibilities (Najjar, 2009; Van Der Wiele, 2004). Other barriers to women's participation included lack of access to land (Van Der Wiele, 2004; Hofisi, 2003), appropriate tools and lack of opportunities to practise their FFS skills in the fields as husbands considered this a waste of time (Van Der Wiele, 2004). The women farmers noted that "there is need to work with the local leadership such as chiefs and headmen on FFS so that women farmers (who are the majority of those who attend schools) are given land from where to practise if they are not given land by their husbands" (Hofisi, 2003, p. 42). A study in Kenya likewise found that participation of female-headed households, divorced and single mothers was limited due to stigma (Najjar, 2009).

Other studies report on FFS where **women were well represented in the FFS groups** (Hofisi, 2003; Machacha, 2008; Najjar, 2009; Rola & Baril, 1997). In some cases this was because the men could not attend the FFS due to off-farm work commitments and seasonal out-migration (Najjar, 2009; Hofisi, 2003). However, in Kenya, multiple key informants noted that while men may not attend field schools, they remain the decision-makers on farms (Machacha, 2008, p. 9), implying that women FFS participants may not always be able to apply their FFS knowledge and skills in the fields. A study from Kenya found that men often did not participate because they did not want to be involved on an equal standing with women or did not want to be in groups led by women (Najjar, 2009). Although the study also mentions that the curriculum failed to attract male participants because it did not of focus on the issues of most concern to men, including commercial farming and livestock (Najjar, 2009).

Targeting, participation and FFS effectiveness

Four studies directly or indirectly discuss links between targeting and FFS effectiveness (Gottret & Córdoba, 2004; Hofisi, 2003; Machacha, 2008; Pedersen et al., 2008). Pedersen and colleagues (2008) suggest that **lack of appropriate targeting might be a barrier** to successful FFS. The authors found that the selection of participants in a Tanzanian FFS was not refined enough, with all participants being admitted regardless of whether they were suitable or not. The authors suggest that this may have contributed to lack of knowledge and skills formation, yet they do not provide additional information to substantiate this claim.

Two studies suggest that **distance to FFS may be an important factor for effective FFS functioning** (Hofisi, 2003; Machacha, 2008). A study from Uganda suggests that large distances between members' homes were an important factor in FFS performance. Farmer facilitators had trouble reaching the remote-living farmers and the author suggests that this has contributed to the disintegration of the group (Hofisi, 2003). A study from Kenya suggests that the most successful FFS was also the one whose members lived closest together (Machacha, 2008).

Finally, two studies suggest that **participant characteristics may affect the extent to which they can benefit from FFS** (Gottret & Córdoba, 2004; Hofisi, 2003). These refer particularly to education levels and the skills they developed through informal learning (Gottret & Córdoba, 2004). A study from Zimbabwe likewise reports that FFS with good attendance and confident and motivated farmers performed better than FFS with poor attendance and shy farmers (Hofisi, 2003).

Participant drop-out

Participant drop-out is another factor that is likely to affect FFS effectiveness. Six studies discuss participant drop-out. Five studies report **high levels of drop-out** (Friis-Hansen, 2008; Gottet & Córdoba, 2004; Machacha, 2008; Najjar, 2009; Rola & Baril, 1997; Winarto, 2004). In Indonesia, Winarto (2004) reports on having to abandon field work in one of the hamlets due to the high level of drop-outs, noting that the FFS would not reach its objectives as participants were replaced by group members who were not farmers (Winarto, 2004, p. 34). The study does not provide reasons for this high drop-out rate.

Studies that do report reasons for drop-out suggest that **drop-out was due to unmet expectations of hand-outs or loan availability** (Friis-Hansen, 2008; Hofisi, 2003; Machacha, 2008; Najjar, 2009). In Zimbabwe, farmers joined due to seed loans and ended up leaving when the loans were stopped. The study notes that participants replacing drop-outs found it difficult to catch up on previously covered material (Hofisi, 2003). A study in Uganda reporting high levels of drop-out (with up to half of the FFS group members leaving within the first year), notes that despite a sensitisation process, some farmers “still joined FFS groups primarily because of an interest in accessing external funds” (Friis-Hansen, 2008, p. 519). Two studies from Kenya report that many farmers dropped out or refrained from participating when realising that cash was not forthcoming (Machacha, 2008; Najjar, 2009).

One of the studies also mentions **increases in individual commitments as factors leading to participants dropping out** (Machacha, 2008). The study suggests that absences and drop-outs are a barrier to effective FFS functioning, as there are not enough members to care for the communal plot. The study refers to an FFS targeting youth and notes that “the fact that not all the members are always present due to commitments at school or work, and that those starting new careers or families move away, have contributed to operational difficulties for the group” (Machacha, 2008, p. 38).

Additional reasons for drop-outs included **farmers not being interested in the curriculum and limited access to transportation** (Gottet & Córdoba, 2004).

FFS facilitators

Facilitator selection and characteristics

The facilitators play a key role in the FFS, and ensuring that this role is performed by suitable candidates may influence the success of the FFS. Four studies included themes pertaining to facilitator selection and characteristics (DANIDA, 2011; Hofisi, 2003; Machacha, 2008; Van Der Wiele, 2004)

Three studies suggest **appropriate criteria for selecting facilitators are important for identifying suitable candidates, with personal attitude and**

leadership skills appearing important (DANIDA, 2011; Hofisi, 2003; Machacha, 2008). Hofisi (2003) attributes the poor performance of some groups to poorly performing facilitators, and suggests an important reason for this was that many of the FFS groups adopted inadequate criteria when selecting their facilitators, focusing on high level of education, rather than attitude, maturity, literacy and farming experience. Consequently, some of the selected facilitators were not suitable and poorly performing. In Bangladesh the personal facilitation, organisational and leadership skills were found to be important criteria for selecting good facilitators (DANIDA, 2011). Similarly, a study from Kenya found that good leadership, rather than the education level of the facilitator was important for FFS performance (Machacha, 2008).

Two studies suggest that **women preferred female facilitators** (Hofisi, 2003; Van Der Wiele, 2004). In Zimbabwe women reported being more comfortable working with a female facilitator (Hofisi, 2003). In Liberia, women reported being comfortable training with men, but also preferred having a female facilitator as they considered she would have a greater understanding of their problems and perspectives (Van Der Wiele, 2004).

FFS facilitator training and performance

Adequate training of facilitators is a key assumption for FFS effectiveness. If facilitators are not adequately trained this has serious implications for the quality of the training received by farmers, affecting knowledge formation, adoption and final outcomes. Nine of the included studies report on themes relating to the training and performance of FFS facilitators (DANIDA, 2011; Gottret & Córdoba, 2004; Hofisi, 2003; Najjar, 2009; Pedersen et al., 2008; Rola & Baril, 1997; Simpson, 1997; Van de Fliert, 1993; Winarto, 2004).

One of the studies from Indonesia (Van de Fliert, 1993) found that **facilitators received training, were knowledgeable and had good facilitation skills.** The facilitators had previously performed the role as pest observers, and received training over a 15-month period prior to taking up their positions as FFS facilitators. The facilitators'/pest observers' facilitation skills and practical knowledge brought acceptance among farmers, while the performance of the extension workers varied more, depending on their interest in IPM and relationship with the pest observer.

Another study from Indonesia (Winarto, 2004), suggests that farmers' views of the facilitators were more lukewarm. It highlights that **facilitators did not have previous experience of farming, nor extension** before taking on their role as FFS facilitators. Prior to entering the training to become facilitators the pest observers focused on monitoring pest populations and developing control strategies that relied heavily on the use of pesticides. Some of the IPM farmers also expressed dissatisfaction with trainers not practising what they preached - the facilitators did not implement the practices together with the farmers, and did not cultivate rice themselves, to allow for farmers to observe their outcomes and be more confident in the messages.

Six studies report issues related to a **lack of appropriate training, resources and ongoing support of facilitators** (DANIDA, 2011; Gottret & Córdoba, 2004; Hofisi, 2003; Pedersen et al., 2008; Rola & Baril, 1997; Simpson, 1997). While extensionists in Tanzania were provided with a season-long FFS training-of-trainers course (Pedersen et al., 2008), the study found that the facilitators lacked the skills and dynamics to deliver high-quality FFS. The reason for this was a combination of lack of sufficient initial training, clear terms of reference, infrequent field monitoring and backstopping from the district, and lack of inputs (e.g. meals, fuels, allowances) for facilitators to run FFS.

In Nicaragua, the training provided to the facilitators did not cover marketing and commercialisation, despite this being part of the FFS curriculum (Gottret & Córdoba, 2004). While the facilitators recognised the importance of these topics, they lacked the tools and methodologies needed to facilitate sessions on these topics. In Bangladesh and Cambodia the curriculum for the training of trainers was found to be too technical, with insufficient focus on developing participatory facilitation skills (DANIDA, 2011; Simpson, 1997).

Two studies, from the Philippines and Zimbabwe, highlight that sufficient financial incentives were lacking (Hofisi, 2003; Rola & Baril, 1997). This left facilitators demoralised, with some not spending sufficient time at the field school and farm visits. This in turn demoralised the farmers, who felt unable to hold the facilitator to account as he/she was not answerable to the farmers.

Relationship between farmers and facilitators

Finally, five studies highlight themes relating to the relationship between farmers and facilitators (Isubikalu, 2007; Machacha, 2008; Najjar, 2009; Simpson, 1997; Van de Fliert, 1993). Three of the studies suggest an **imbalance in the farmer–facilitator relationship as a potential barrier to farmers learning and adoption** (Isubikalu, 2007; Najjar, 2009; Simpson, 1997). Two studies from Uganda and Kenya suggest that in many cases the facilitators failed to treat farmers as co-learners, but rather as students (Isubikalu, 2007; Najjar, 2009). In Kenya, they dictated notes and in some cases imposed a crop to be cultivated in the field school, with negative implications for farmers' learning. Nevertheless, the study also reports instances of facilitators being more open for farmers' participation in discussions and actively soliciting participants' opinions (Najjar, 2009).

Similarly, in Cambodia the facilitators preferred a more formal approach to the FFS training, retaining control of the sessions. Farmers on the other hand did not feel comfortable with voicing concerns or making suggestions to the facilitators because the facilitators were from urban and educated backgrounds and "must therefore be respected ... He knows many things so we listened to him. Sometimes I didn't fully understand him but I did not interrupt" (Simpson, 1997, p. 141).

In Indonesia Van de Fliert (1993) found that while the pest observers succeeded in facilitating, rather than teaching in the farmer field schools, **they struggled to balance facilitation with leadership.** The study found that the facilitators at times struggled with providing leadership to groups and performing tasks such as managing the time, calling off discussions that were too long and reigning in participants that were too dominant in order to provide room for others to participate. The author suggests that this might be due to facilitators' fears of being too dominant and suggests more training in group leadership is needed to improve the facilitation skills of the facilitators.

Drawing on four case studies, a study in Kenya suggests that the **rapport between facilitators and farmers may influence FFS effectiveness** (Machacha, 2008). In three of the FFS in the study the rapport between the farmers and their facilitators was reported to be excellent, aiding the success of the group, while in one group the relationship between the members and the facilitator was found to be out of harmony, as evidenced by low attendance rates by both farmers and facilitators.

Discourse and language of instruction used in farmer field schools

Four of the studies included themes pertaining to the discourse and language of instruction adopted in the farmer field schools (Dolly, 2009; Najjar, 2009; Van de Fliert, 1993; Winarto, 2004).

Two of the studies, both from Indonesia, found that **the use of alien and complex concepts was a barrier to knowledge formation and adoption** (Van de Fliert, 1993; Winarto, 2004). Facilitators used new foreign and scientific terms such as "economic threshold level" (ETL) and "ecosystem", which were part of their vocabulary, but these terms were not easily understood by the farmers. While such terms were to a certain extent incorporated into the language of IPM farmers, their use of these terms was more limited and the concepts were interpreted in different ways. Other terms, such as "natural enemy" (musuh alami) or "farmers' friends" (teman petani) were more easily understood.

On the other hand, the **use of common concepts and metaphors facilitated knowledge formation and adoption** (Dolly, 2009; Winarto, 2004). The use of analogies and metaphors was an important part of the farmers' learning process. In the paradigm that preceded IPM in Indonesia the use of the analogy of spraying crops with "medicine" to combat pests had been prevalent, and the use of metaphors such as calling pesticides "poison", predators "farmers' friends and helpers" (p. 347) and "understanding the pest's behaviour" (p. 358) were found to be important in enhancing farmers' understanding of the scientific knowledge which forms the basis of IPM and changing the paradigm regarding pesticide use. In Trinidad and Tobago, the farmers, scientists and extension officers developed a common vocabulary over time (Dolly, 2009).

In Bangladesh, Kenya and Indonesia **knowledge acquisition was influenced by the language of instruction** (DANIDA, 2011; Najjar, 2009; Van de Fliert, 1993). In Kenya the use of Swahili instead of relevant local languages as the language of instruction was a barrier for women's participation and learning (Najjar, 2009). In Bangladesh the use of Bangla instead of local languages was found to be inappropriate, suggesting important messages may have been lost in translation, and hampered by cultural and religious differences between the participants and facilitators (DANIDA, 2011). On the other hand, in Indonesia (Van de Fliert, 1993) farmers' understanding was found to be enhanced when trainers used the local language instead of Indonesian, the national language. The assumption that farmers were sufficiently fluent in their national language to be able to comprehend the content of the FFS appeared to be incorrect.

Mode of delivering FFS training

The theory of FFS stresses the participatory, discovery-based learning underlying learning in the field schools and this is considered one of the main differences between FFS and more traditional extension approaches. Few of the themes identified in the descriptive synthesis are repeated in more than a handful of studies, but well over half of the included studies included themes pertaining to the way in which FFS were delivered (DANIDA, 2011; Dolly, 2009; Friis-Hansen, 2008; Gottret & Córdoba, 2004; Hofisi, 2003; Isubikalu, 2009; Machacha, 2008; Najjar, 2009; Pedersen et al., 2008; Rola & Baril, 1997; Van de Fliert, 1993; Winarto, 2004).

Four studies from Cambodia, Uganda, Tanzania and Kenya suggest that overall **FFS were delivered in a top-down manner, using a transfer of technologies approach** rather than in a participatory, discovery-based manner (Isubikalu, 2009; Pedersen et al., 2008; Najjar, 2009; Simpson, 1997). For instance, in Uganda farmers' participation in agro-ecosystem analysis (AESA) was limited to collecting data, with facilitators managing the experiments (Isubikalu, 2009). There was a bias towards talk, rather than practice, and the author suggests that "this converts extension practice back into the model it displaced – Training and Visit". In Tanzania the programme followed a participatory approach for group formation, but the overall delivery of the FFS was characterised by a top-down, or "guided-choice" approach to budgeting, monitoring and provision of inputs provided (Pedersen et al., 2008). Similarly, in Kenya the FFS programme was mainly focused on transferring technologies and the author suggests that a lack of adaptation of the intervention to the Kenyan context might be a reason for the lack of local innovation (Najjar, 2009). There were also reports of coercion affecting the learning conditions. Finally, in Cambodia there was a lack of consultation during both the planning and implementation of the intervention. The author suggests that the decision to implement IPM-FFS was made by international aid organisations. While the farmers reported to enjoy the practical and non-formal aspects of the FFS, the study suggests that the experiments were led by the facilitators and that the farmers did not feel empowered to conduct their own experiments (Simpson, 1997).

The descriptive themes from the findings in the other studies are more positive. Nine studies from Bangladesh, Trinidad and Tobago, Uganda, Kenya, Honduras, Zimbabwe, the Philippines and Indonesia suggest that **FFS were delivered in a participatory, bottom-up manner** (DANIDA, 2011; Dolly, 2009; Friis-Hansen et al., 2008; Gottret & Córdoba, 2004; Hofisi, 2003; Machacha, 2008; Rola & Baril, 1997; Van de Fliert, 1993; Winarto, 2004).[76] The training was mainly delivered through facilitation following experiential learning and empowerment approaches rather than lecturing, and focused on principles rather than predetermined recommendations. For instance, in Zimbabwe Hofisi (2003) found that the FFS was implemented in a participatory manner, with farmers being involved in experimentation and development and adaptations of the curriculum. Farmers were encouraged to experiment and the innovations resulting from farmers' experiments were taken seriously. According to the participating farmers, the active experimentation and information sharing enhanced their learning and increased knowledge and ownership of the resulting farming systems (Hofisi, 2003).

Nevertheless, one of the studies from Indonesia (Winarto, 2004) also found that trainers did at times slip back to the "chalk and talk" methods typically used in extension. In Honduras the FFS training was found to be delivered in a participatory manner, although the community sometimes agreed to cover crops they were not interested in, in order to stay on good terms with the community leaders (Gottret & Córdoba, 2004). Similarly, in Kenya the training sessions were found to be participatory, and while there was farmer experimentation and some involvement in curriculum design, the facilitating organisation was the main decision-maker (Machacha, 2008).

FFS content and coverage

The relevance of the FFS curriculum to farmers' needs and appropriateness of new practices to the local context are important assumptions of successful FFS. Thirteen of the studies included themes relating to the coverage and content of the curriculum (DANIDA, 2011; David, 2007; Dolly, 2009; Gottret & Córdoba, 2004; Hiller et al., 2009; Hofisi, 2003; Isubikalu, 2007; Mancini et al., 2007; Najjar, 2009; Palis, 2002; Simpson, 1997; Van de Fliert, 1993; Van Der Wiele, 2004).

Appropriateness of the FFS content and coverage

Eleven of the studies that included themes relating to the content and coverage of FFS report findings pertaining to the relevance and appropriateness of FFS to the local context (DANIDA, 2011; Dolly, 2009; Gottret & Córdoba, 2004; Hiller et al., 2009; Hofisi, 2003; Isubikalu, 2007; Mancini et al., 2007; Najjar, 2009; Simpson, 1997; Van de Fliert, 1993; Van Der Wiele, 2004).

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[76] The description and analysis of actual implementation of FFS is limited in both Friis-Hansen (2008) and Friis-Hansen et al. (2012). They provide what is a rather generic description of an "ideal type" FFS, backed up with very limited description and no data on implementation.

Of these, seven studies of FFS implemented in Bangladesh, Trinidad and Tobago, Nicaragua, Kenya, Zimbabwe, India and Indonesia suggest that the **curriculum was relevant and appropriate to the local context**, facilitating knowledge acquisition and adoption (DANIDA, 2011; Dolly, 2009; Gottret & Córdoba, 2004; Hiller et al., 2009; Hofisi, 2003; Mancini et al., 2007; Van de Fliert, 1993).

For instance, in India and Trinidad and Tobago the FFS curriculum responded to local concerns over the economic and environmental costs of pesticides respectively (Dolly, 2009; Mancini et al., 2007). In Bangladesh the majority of technologies included in the FFS curriculum seemed relevant, although some curriculum components included technology which was too expensive or inappropriate, and therefore considered irrelevant (DANIDA, 2011). While the curriculum was considered relevant by farmers in Honduras, a greater focus on cash crops would have been desirable (Gottret & Córdoba, 2004).

Participants in Zimbabwe in general found that the topics covered in the FFS were applicable to their situation (Hofisi, 2003).The relevance of each topic depended on the problems different farmers faced, and the farmers would focus on the solutions they found most relevant to their problems. The **inclusion of indigenous knowledge increased the sense of ownership and motivated farmers' learning**, as well as contributing to the relevance of the curriculum (Hofisi, 2003).

On the other hand, three studies included themes relating to **a lack of relevance and appropriateness of the curriculum to the local context** (Isubikalu, 2007; Najjar, 2009; Simpson, 1997). In Kenya the information provided regarding soil fertility and pest management was only appropriate and accurate for farmers from the high potential areas (Najjar, 2009). The focus of the FFS was intended to be on diversification of food production, yet the crop which most FFS focused on was maize (this crop was also inappropriate for most of the area).

In Uganda, where pesticide use is not a major problem, IPM was found to be less appropriate (Isubikalu, 2007). The major technical component of FFS was improved crop varieties, but these lacked the features valued by most subsistence farmers such as good taste. The study also suggests that the practices proposed in most FFS were too labour- and time-intensive to be affordable for most farmers, and suggest that they may be more appropriate for commercially oriented farmers.

In Cambodia the IPM programme focused on environmental problems, but farmers were more concerned about soil fertility and income generation (Simpson, 1997). One of the intended benefits of the IPM training was a reduction in farmers' spending on pesticides, but this was already low among the participants. The most successful experiment was the use of cow dung to fertilise crops, but the level of cow dung required was well beyond what farmers could access, and farmers were therefore unable to replicate this practice in their fields.

In Liberia **practices that reduced farmers' vulnerability were relevant and**

appropriate (Van Der Wiele, 2004). The FFS in Liberia aimed at reducing farmers' vulnerability in a context of chronic conflict and instability, but some of the practices, such as cultivation of vegetable crops or beekeeping, required significant commitment of time and financial resources and were perceived to increase vulnerability. On the other hand, practices which reduced farmers' reliance on purchased inputs reduced vulnerability and were more readily adopted.

Comprehensiveness of FFS content and coverage

Six of the studies that included themes relating to the content and coverage of FFS report findings pertaining to the comprehensiveness of FFS content and coverage (DANIDA, 2011; Mancini et al., 2007; Najjar, 2009; Pedersen et al., 2008; Van de Fliert, 1993; Winarto, 2004). Five of these studies suggest that the FFS **curriculum was not sufficiently comprehensive** in its coverage (DANIDA, 2011; Mancini et al., 2007; Najjar, 2009; Van de Fliert, 1993; Winarto, 2004). While the focus of the FFS might be relevant and appropriate, farmers often have a range of concerns. Failure to incorporate a broader range of concerns in the curriculum was found to be a major weakness in several studies. For instance, in Kenya, the lack of focus on water, irrigation, marketing and societal issues impeding agricultural production was found to be a major weakness (Najjar, 2009). Similarly, in India farmers had a range of concerns, such as water management, crop rotation, crop diversification and marketing. Discussions with farmers suggest that focusing on more than one crop, and adopting a broader systems approach might have improved the effectiveness of the IPM-FFS (Mancini et al., 2007). In Indonesia it was found that the inclusion of other issues, such as fertilisation, in the FFS curriculum would also have been relevant for participating farmers (Van de Fliert, 1993). The farmers did not gain sufficient knowledge and skills to be able to deal with the range of complex issues they face in their fields, including how to deal with a new, unfamiliar pest (Winarto, 2004; Van de Fliert, 1993).

Two studies found the **curriculum was too broad to cover the selected topics comprehensively** (Hofisi, 2003; Pedersen et al., 2008). The FFS programme in Kenya included 19 different crops and this was too high a number to ensure the technical quality of the curriculum, and a smaller number of crops would likely have improved the quality of the intervention. In Zimbabwe farmers felt that the introduction of organic production to the FFS curriculum was overwhelming. Adding this additional component after farmers had practised FFS for a few seasons may have been better (Hofisi, 2003).

Both studies from Indonesia found **inadequate coverage of pesticides in the curriculum** (Van de Fliert, 1993; Winarto, 2004), including a failure to explain the theory underlying IPM and pesticides appropriately, making the curriculum less convincing to farmers (Winarto, 2004). The authors note that this omission may have led to inappropriate pesticide use. For example, farmers to a certain extent replaced pesticide-spraying with granular applications, or started applying lower doses of pesticides which can accelerate the development of pesticide-resistant pest varieties (Van de Fliert, 1993). The authors suggest a fear of appearing to approve of pesticide use may be the reason for the failure to include this as a topic in the curriculum.

Complexity of FFS content and coverage

Nine of the studies included findings pertaining to the complexity, observability and relative advantage of FFS knowledge and practices (David, 2007; Dolly, 2009; Gottret & Córdoba, 2004; Hofisi, 2003; Machacha, 2008; Palis, 2002; Simpson, 1997; Van Der Wiele, 2004; Winarto, 2004).

Studies from Honduras and Indonesia found that the **complexity of IPM made it difficult for farmers to implement** all the IPM practices on their crops, as did insufficient time and financial resources (Gottret & Córdoba, 2004; Van de Fliert, 1993; Winarto, 2004). Some of the analytical tools used were too complex and perceived as impractical in relation to the time, energy and resources they required (Winarto, 2004). For instance, the use of forms to record field sampling with formulas to calculate percentages for damages and prevalence of insects was found to be of little practical use for the farmers who abandoned this in favour of simply recording what they observed in their fields (Van de Fliert, 1993).

Assessing FFS in Cameroon, David (2007) found that **practical knowledge was more easily understood than theoretical concepts**. When asked about what they learned in FFS farmers focused on practical aspects such as specific management practices and hardly ever mentioned principles and concepts of agro-ecosystem analysis.

All of these studies suggest that due to the complexity of the IPM curriculum **observability is important for farmers to trust the messages and develop analytical skills** (Dolly, 2009; Hofisi, 2oo3; Machacha, 2008; Palis, 2002; Simpson, 1997; Van Der Wiele, 2004; Winarto, 2004). The observability of IPM practices and their relative advantage compared with conventional methods was found to be important in enhancing farmers’ confidence and belief in the truth of IPM messages.

For instance, in Indonesia demonstration plots allowed farmers to study IPM empirically, and in doing so appeared to be an important part of farmers’ knowledge formation (Winarto, 2004). Through experimentation in the demonstration plot the farmers were able to observe and understand the concept of beneficial and harmful insects, facilitating IPM practice (Palis, 2002). While farmers feared that insects would spread from neighbouring fields, experimentation and observation changed farmers’ beliefs about this. The farmers also observed that their yields remained the same even if they did not spray, and the author suggests that this explains why farmers continued to practise IPM.

In some cases farmers had to observe the benefits of techniques in the field of other farmers before implementing them in their own fields (Hofisi, 2003; Van Der Wiele, 2004). In the case of Liberia people were particularly risk averse and vulnerable, and observing the relative advantage of the practices promoted through FFS appeared to be particularly important (Van Der Wiele, 2004). Farmers were initially reluctant to experiment with vegetable crops as it was perceived as risky, but were starting to consider diversifying their crops when noticing the relative advantage of vegetables.

Failure to demonstrate observable benefits can also act as a barrier to adoption. In Cambodia the facilitators were unable to demonstrate that farmers' crops could be improved through knowledge and techniques, rather than inputs (Simpson, 1997). And in Trinidad and Tobago the FFS did not generate results which were sufficient to convince farmers of the relative advantage of IPM (Dolly, 2009).

Service delivery quality

The quality of the implementation of FFS is likely to influence effects of the intervention on farmers' outcomes. Five studies included evidence on the resources devoted to FFS and the quality of the training delivered to farmers (Hofisi, 2003; Machacha, 2008; Najjar, 2009; Pedersen et al., 2008; Winarto, 2004).

In Tanzania one study suggests that **lack of adequate resources, including inputs and finances, was the main reason for failure** (Pedersen et al., 2008). The study found evidence of major implementation failures, including insufficient and incidental provision of inputs, and difficulties with logistics and dissemination. The number of implemented FFS fell short of those planned. The majority of financial resources did not reach the FFS, suggesting failed and delayed payments contributed to these problems. The discrepancies between budgeted and received amounts were substantial and a lack of knowledge of how much money the FFS should be receiving contributed to limited (financial) accountability to participants.

Another study found that **lack of funding and inappropriate FFS sites** were limitations of the FFS programme in Kenya (Najjar, 2009). It reports a lack of funding for irrigation, and inappropriate selection of FFS sites. The sites were remote, with limited irrigation and poor soil fertility, limiting the crops and practices which could be grown at the demonstration plots. In Indonesia the **lack of adequate follow-up and support during pest outbreaks** was noted as a constraint on farmers' willingness to continue practising IPM during outbreaks (Winarto, 2004).

In Zimbabwe **FFS implementation was adapted to suit the needs of participating farmers** (Hofisi, 2003). The training schedule was adjusted to better suit farmers' work schedules and the size of FFS groups was reduced to improve farmers' learning opportunities. In Kenya farmers felt that the **regular**

location and time of FFS meetings was an advantage and the time when meetings took place was also appropriate for parents as the FFS group met when children were in school (Machacha, 2008).

Policy context and institutional set-up

Six out of twenty studies discuss the role of policy context and institutional set-up in influencing the success of FFS (Isubikalu, 2007; Mancini et al., 2007; Pedersen et al., 2008; Simpson, 1997; Van de Fliert, 1993; Winarto, 2004).

Four studies suggest that the **institutional legacy of existing extension systems influenced the implementation of FFS in** Uganda, India and Indonesia (Isubikalu 2007; Mancini et al., 2007; Van de Fliert, 1993; Winarto, 2004). In Uganda the institutional structures associated with earlier top-down agricultural extension systems, such as T&V remained and contradicted the bottom-up, participatory approach of FFS (Isubikalu, 2007).

Similarly, while some supportive policies were in place in Indonesia, such as the banning of pesticides and removal of subsidies,[77] conflicting mechanisms associated with the conventional extension system continued to contradict IPM adoption (Van de Fliert, 1993; Winarto, 2004). The government-run rice intensification programmes, including subsidised input schemes and trickle-down messages, remained (Winarto, 2004, pp. 337–338). Under the subsidised credit scheme, farmers were offered a "preset technology package" – a forced selling scheme of inputs that did not allow farmers to choose the included inputs or refuse unwanted items such as pesticides and foliar fertilisers, despite government regulation to the contrary (Van de Fliert, 1993, p. 225; Winarto, 2004).

Moreover, two studies suggest that the **pesticide industry maintained close links with the extension system at the local level** (Mancini et al., 2007; Van de Fliert, 1993). In both Indonesia and India the involvement of extension workers and local cooperatives in pesticide promotion may have hampered farmers' efforts to practise IPM. Extension workers acted as intermediaries in input distribution between the local cooperatives, salespeople and the farmers, receiving commission for input sales. Consequently some used their position to promote pesticides and other inputs.

Three studies suggest **diverging institutional incentives and objectives influenced service delivery quality** (Isubikalu, 2007; Pedersen et al., 2008; Simpson, 1997). In Uganda, the institutional and hierarchical structure of extension

[77] The Presidential Decree of 1986 (Inpres 3/1986) represented a "commitment to a national policy of Integrated Pest Management (IPM) to replace the method of pest control that depended on pesticides only (Oka 1991; Fox 1991)" (Winarto, 2004, p. 23). The decree included a ban of broad-spectrum pesticides, the removal of pesticide subsidies and gave high importance to the improvement in human resource development (through official instructions of both official agricultural officials and farmers), and biological and cultural controls in pest management (Van de Fliert 1993; Winarto, 2004, p. 23).

services, where each involved party promotes the mandates of their institutions (international development community, national and local institutions), was found to be crowding out the beneficiaries' needs and interests (Isubikalu, 2007). Similarly, a study from Cambodia suggests that the national government was "disconnected from the IPM-FFS initiative, acting only as a 'rubber stamp' for international aid organisation decisions" (Simpson, 1997, pp. 136–137).

In Tanzania, the spearheading of FFS from a regional level was identified as a barrier resulting in insufficient extension visits and lack of hands-on implementation (Pedersen et al., 2008). Two studies further note the potential role of decentralisation, institutional set-up and funding structure (Isubikalu, 2007; Pedersen et al., 2008). For instance, according to the study in Uganda (Isubikalu, 2007), the system was set up to prioritise implementation of projects whose objectives were the uptake of new or improved technologies. Decisions about which projects to accept or reject were made by senior civil servants who had little or no practical experience in the field and lacked understanding of the problems and needs of farmers. The involvement of a multitude of institutions resulted in each impacting on the design, content and implementation of Ugandan FFS.

Availability of inputs, labour and markets

Five studies highlight issues related to availability of inputs, labour and markets (DANIDA, 2011; Machacha, 2008; Mancini et al., 2007; Najjar, 2009; Van Der Wiele, 2004). Four studies from India, Bangladesh, Liberia and Kenya note the **non-availability of inputs as a barrier to uptake** of FFS practices (Mancini et al., 2007; DANIDA, 2011; Van Der Wiele, 2004; Machacha, 2008). The studies highlight factors such as lack of access to capital (DANIDA, 2011; Machacha, 2008), unavailability of inputs in the market (Mancini et al., 2007) and bad experiences with service providers cheating the farmers on the quality and quantity of agricultural products (DANIDA, 2011). In Kenya farmers noted that they pooled attention and inputs for the group plots, but that the necessary supplies and labour was often lacking on individual farms (Machacha, 2008, p. 64). A different study from Kenya found that both men and women emphasised **access to markets and funding as essential factors** for enhancing the FFS programme (Najjar, 2009).

Community and context

Contextual factors are potentially important in moderating FFS effectiveness. Seven studies discuss the role of the community and contextual factors as enablers of and barriers to FFS effectiveness (Dolly, 2009; Machacha, 2008; Najjar, 2009; Palis, 2002; Simpson, 1997; Van Der Wiele, 2004; Winarto, 2004).

Four studies from Trinidad and Tobago, Nicaragua, the Philippines and Cambodia included themes related to the **role of existing social capital in influencing**

FFS effectiveness (Dolly, 2009; Gottret & Córdoba, 2004; Palis, 2002; Simpson, 1997). In Trinidad and Tobago, Nicaragua and the Philippines collective action through existing farmer groups may have facilitated group learning and action (Dolly, 2009; Gottret & Córdoba, 2004; Palis, 2002). For instance, in the Philippines, FFS participants were members of a cooperative and the "camaraderie existing among the members of the cooperative gave the participants a collective will to learn and succeed in the training" (Palis, 2002, p. 78). The study suggests that this gave farmers the courage to implement IPM, including not spraying their fields, which farmers were particularly anxious about.

In the Philippines social capital was found to facilitate sustained IPM diffusion and adoption (Palis, 2002). FFS villages were characterised by high levels of social capital, with conversations and informal discussions taking place in the neighbourhood, the market, the pavilion and the farm (Palis, 2002). Social capital was high among kin networks, household neighbourhoods, farm neighbourhoods and farmers' associations. The chairman of the farmers' association was a trusted opinion leader and played an important role in convincing the farmers not to spray by encouraging them to unite to fight the pests and trust the IPM practices promoted in the FFS.

On the other hand, Simpson (1997) suggests that in Cambodia the low level of social capital influenced how farmers perceived some of the FFS practices, including collective action. He found that there was little sense of community in the FFS villages, with the "communities" not being more than geographic entities, characterised by class divisions and individualistic practices.

Similarly, farmers in Indonesia found that **practising IPM was challenging when not reinforced by the rest of the community** and FFS farmers found it difficult to practise new strategies when the rest of the community continued applying "old" practices (Winarto, 2004). On the other hand, when the cultural rules about the appropriate pest-control strategies for a pest were still "in the making", as was the case during a pest outbreak of the white rice stem borer, the FFS-IPM approach seemed to prevail, facilitated by the ability of FFS-IPM farmers to reach a consensus about the most appropriate strategy for its control (p. 357). However, the farmers still had to face discouragement and disbelief from their untrained peers, especially at the early stages of introducing the new ideas. To counteract this pressure, the trained farmers sought to legitimise their new identities as schooled farmers in the community.

In Liberia a **context of vulnerability affected the decision-making of FFS households** (Van Der Wiele, 2004). Due to chronic conflict and instability people's planning horizons were relatively short term, with overuse of resources and under-investment in long-term projects characterising farming practices. Thus, practices requiring less time and resources investments were more likely to be adopted.

Diffusion to non-participant farmers

The extent to which the practices promoted in FFS diffuse to non-FFS farmers is a key issue in the debate about FFS effectiveness and cost-effectiveness. Eleven studies included themes relevant to the diffusion of FFS knowledge and practices to non-participants (David, 2007; Gotret & Córdoba, 2004; Hiller, 2009; Karanja-Lumumba et al., 2007; Machacha, 2008; Mancini et al., 2007; Palis, 2002; Rola & Baril, 1997; Simpson, 1997; Van de Fliert, 1993; Winarto, 2004).

As in the case of knowledge acquisition and adoption by FFS participants, complexity and observability appear to be factors affecting diffusion of knowledge and practices to the broader community. Four studies highlight the **complexity and the experiential nature of FFS learning as a barrier to diffusion** (David, 2007; Mancini et al., 2007; Van de Fliert, 1993; Winarto, 2004). They note that despite high awareness of IPM by non-participants (Van de Fliert, 1993; Winarto, 2004), the skills and practices are complex and their experiential nature makes them difficult to convey via verbal communication (Mancini et al., 2007; Van de Fliert, 1993; Winarto, 2004).

Thus Winarto concludes, “even though knowledge transmission to the lay farmers did occur throughout the course of pest outbreaks, the received ideas were not always in the same form or were not comprehensively disseminated” (Winarto, 2004, p. 356). FFS participants also felt that their understanding of the meaning and interpretation of developments in the field diverged from those of the non-participants, which also undermined diffusion. In another study non-participants reported not feeling confident to implement the new practices they had heard about from their FFS neighbours (Mancini et al., 2007).

In two studies where diffusion was observed, the findings suggest **concrete practices were more likely to diffuse than theoretical concepts and principles** (David, 2007; Hiller et al., 2009), with relatively easy practices, such as pruning and weeding techniques, being more easily disseminated.

Seven studies highlight the **importance of observability for convincing non-FFS farmers** to adopt FFS practices (David, 2007; Gotret & Córdoba, 2004; Palis, 2002; Machacha, 2008; Simpson, 1997; Winarto, 2004; Van de Fliert, 1993). For instance, Winarto notes that observing the pests in their own fields and observing the practices of FFS participants were important in building non-participants’ understanding of IPM practices. Several studies suggest that observing the successful harvests of FFS farmers triggered interest and requests for advice from non-participants (David, 2007; Machacha, 2008; Palis, 2002). On the other hand, in Cambodia the results observable in IPM farmers’ plots were less convincing and hence, non-IPM farmers were not convinced of the benefits of IPM (Simpson, 1997).

In both Honduras and Kenya **non-FFS farmers perceived FFS practices as having a relative advantage** compared with existing practices, facilitating interest in IPM (Gotret & Córdoba, 2004; Hiller et al., 2009). The study from Honduras suggests that the perceived economic advantage of FFS was an important factor in convincing non-FFS farmers to adopt IPM. In Kenya non-FFS farmers were most interested in information about practices aimed at increasing productivity.

As in the case of knowledge acquisition and adoption by IPM participants, social and contextual factors may also be important for diffusion. Five studies included findings suggesting **existing levels of social capital play a role in diffusion of FFS knowledge and practices** (David, 2007; Gotret & Córdoba, 2004; Palis, 2002; Rola & Baril, 1997; Simpson, 1997). In the Philippines social capital, and in particular kinship ties, facilitated diffusion of IPM (Palis, 2002; Rola and Baril, 1997). Farmer sharing of IPM concepts with non-IPM farmers was found to be directed more towards kinship – this is attributed to the Filipino normative expectations and obligations among members in a kin group, especially siblings and members of the nuclear household. The author recommends using social capital in the form of kinship ties and farm location to enhance the efficiency of farmer-to-farmer diffusion of IPM (Palis, 2002).

On the other hand, in both Cambodia and Cameroon, low levels of social capital and limited reach of social networks were found to act as barriers to diffusion. In Cameroon FFS participants explained their lack of sharing of knowledge from FFS with others by the fact that all their friends were also FFS participants (David, 2007). In Cambodia low levels of social capital and cohesion limited communication within the community, preventing diffusion of IPM knowledge (Simpson, 1997).

One study highlights that **socioeconomic differences between FFS participants and non-participants impeded diffusion** (Van de Fliert, 1993). The Indonesian FFS was designed to encourage participants to train other group members and promote communication with the rest of the community, for example through field days and folk theatre. However, the author found that the non-representative composition of the FFS groups impeded interaction between participants and non-participants. FFS participants communicated to a “selective audience in the villages” and made no deliberate efforts to train other members of the community in IPM principles. At the same time, the status difference between group members and the untrained farmers seems to also have contributed to the disinterest of the community in the organised field days (Van de Fliert, 1993).

Another study from Indonesia highlights the **role of opinion leaders in dissemination of knowledge about IPM practices**. A few inquisitive farmers played a prominent role in the ongoing process of knowledge formulation and transmission. These farmers progressively established their position within the community as “experts”, “farmer professors” and “consultants” (Winarto, 2004, p. 351). However, the study also notes the difficulties of this process in the face of unyielding perspectives. The author notes that “without the provision of consistent policies, assistance, and rewards from fellow farmers and government officials, these farmers had difficulty maintaining their spirits and the efforts to learn" (p. 351). The importance of an organised approach to diffusion is further highlighted by the experience from Kenya, where **FFS networks[78] actively encouraged diffusion of adoption**. The FFS networks supported information-sharing among farmers, organised field days, exchange visits and tours; and set up demonstration fields (Karanja-Lumumba et al., 2007).

Sustainability

Sustainability of FFS practices in farmer communities is an important issue for cost-effectiveness of FFS interventions. Eleven out of twenty studies discuss factors affecting sustainability of FFS (DANIDA, 2011; David, 2007; Dolly, 2009; Friis-Hansen, 2008; Gottret & Córdoba, 2004; Karanja-Lumumba et al., 2007; Machacha, 2008; Simpson, 1997; Van de Fliert, 1993; Van Der Wiele, 2004; Winarto, 2004).

Seven studies suggest that **ongoing support and/or follow-up are important for sustainability of FFS practices** (DANIDA, 2011; David, 2007; Dolly, 2009; Gottret & Córdoba, 2004; Simpson, 1997; Van Der Wiele, 2004; Winarto, 2004). Four studies note lack of ongoing support and follow-up as an important barrier to the sustainability of the FFS approach (Dolly, 2009; Gottret & Córdoba, 2004; Simpson, 1997; Winarto, 2004). In Indonesia farmers also reported a lack of "consistent support to back up their struggles in creating and maintaining the new schemas of interpretations and practices" in the face of recurrent pest and disease outbreaks and continuing recommendations to use pesticides (Winarto, 2004, p. 363). In Trinidad and Tobago, farmer associations felt that there was not enough technical assistance from researchers to support farmers in continuing development of local practices (Dolly, 2009). A study from Honduras highlights insufficient support from the implementing agency to the local partner organisations, their ability to support farmers being limited by lack of time and access to technical backstopping (Gottret & Córdoba, 2004). Similarly, another study mentioning the absence of follow-up activities notes that there was a lack of clarity in communication regarding the responsibility for follow-up activities between the implementing agency and the local NGO (Simpson, 1997).

Four studies highlight the **role of support and follow-up on the establishment and sustainability of FFS-related activities** (DANIDA, 2011; Karanja-Lumumba et al., 2007; Machacha, 2008; Van Der Wiele, 2004). In Liberia, the implementing agency hoped that FFS groups would develop into community-

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[78] The FFS networks arose independently of the FAO-implemented East African Sub-Regional Pilot Project for Farmer Field Schools, with the aim to "sustain Farmer Field Schools, link Farmer Field Schools to input and output markets, link farmers to information sources and facilitate information flow, form a forum for Farmer Field Schools for information exchange and experience sharing in relation to farming and promote the FFS concept as an extension methodology in addressing emerging issues especially in agricultural development" (Karanja-Lumumba et al., 2007, p. 1,347).

based organisations that would continue meeting and working together. The study relates the positive results of the most successful of these groups to the involvement of implementation staff, noting that it was the only group that received follow-up and support from the agency (Van Der Wiele, 2004). In Bangladesh, FFS farmers were encouraged to establish farmer clubs, which continued to be supported by the implementing agency. The authors suggest that additional sessions on club formation were "an asset to the establishment of sustainable and effective groups and an improvement of the practices used" (DANIDA, 2011, p. 36). Two studies from Kenya found that there was no support for FFS-related follow-up activities and the sustainability of group activities depended on the willingness of officials to serve on a voluntary basis, as well as the capacities of the different FFS groups (Karanja-Lumumba et al., 2007; Machacha, 2008).

The motivation of FFS participants is likely to be an important factor for the sustainability of FFS practices after completion of the training. However, only one study reports on this issue. The study found that **reimbursing participants for FFS attendance may have undermined sustainability of the FFS groups** (Simpson, 1997), noting that FFS students did not see themselves continuing to learn and share information following graduation.

Four studies highlight group-related factors affecting sustainability (DANIDA, 2011; David, 2007; Machacha, 2008; Van Der Wiele, 2004). One study mentions **consistent membership participation being important for sustainability** (Machacha, 2008). A study from Cameroon found **group support and validation important in building up confidence in FFS practices of FFS graduates** (David, 2007) and three studies found that strong **collective goals and activities were important for the sustainability of the groups after the end of FFS training** (Van de Fliert, 1993; Van Der Wiele, 2004). The leader of a successful FFS group turned community organisation attributed the group's ability to start and successfully complete projects to a common understanding/mindset among participants, as well as respect among the members, regularity of meetings and a high interest by group members (Van Der Wiele, 2004). A study from Indonesia found that in the absence of a common pest problem, or when the group members' and leaders' interests diverged, farmer would stop engaging in collective follow-up activities (Van de Fliert, 1993). In another study from Bangladesh, members of farmer associations and farmer clubs noted the **importance of leadership in the sustainability of farmer clubs** established from FFS groups (DANIDA, 2011).

Perceived outcomes: gender and empowerment

Only four studies included in the effectiveness synthesis collected quantitative data on some measure of empowerment. The analysis suggests a beneficial effect on the probability of the farmers positively answering questions on self-esteem, including feeling capable of solving problems in the field, feeling comfortable in giving an opinion, and participating in the community. However, empowerment is a multi-dimensional concept that is inherently difficult to measure. The impact of an intervention on empowerment is context- and time-specific, and difficult to capture directly. The use of a single index is insufficient and combined indices can often hide the differential impact of an intervention on the various dimensions of empowerment (Narayan, 2005). To complement the findings of the effectiveness studies this section reports on findings from qualitative studies regarding farmers' perceptions about the role of FFS in gender relations and empowerment.

Eleven out of twenty studies discuss the role of FFS in gender relations and farmer empowerment (DANIDA, 2011; Dolly, 2009; Friis-Hansen, 2008; Friis-Hansen et al., 2012; Hofisi, 2003; Machacha, 2008; Mancini et al., 2007; Najjar, 2009; Simpson, 1997; Van Der Wiele, 2004; Winarto, 2004).

Empowerment

All ten studies discussing empowerment of participants suggest that participation in FFS was an empowering experience for the participating farmers (Dolly, 2009; Friis-Hansen, 2008; Friis-Hansen et al., 2012; Hofisi, 2003; Machacha, 2008; Mancini et al., 2007; Najjar, 2009; Simpson, 1997; Van Der Wiele, 2004; Winarto, 2004). Some studies also found that these benefits extended to the non-participants in the intervention communities.

Nine studies suggest that FFS led to **improved confidence, decision-making skills and enhanced agency**. Farmers felt that FFS increased their self-confidence (Dolly, 2009; Friis-Hansen, 2008; Friis-Hansen et al., 2012; Hofisi, 2003; Machacha, 2008; Mancini et al., 2007; Simpson, 1997; Van Der Wiele, 2004; Winarto, 2004), decision-making skills in agriculture (Hofisi, 2003; Mancini et al., 2007) and improved their ability to articulate their demands to service providers and engage with stakeholders (Dolly, 2009; Friis-Hansen, 2008).

Winarto suggests that these increases in self-confidence in Indonesia were gained during farmers' efforts in resolving the various problems they encountered during and following their FFS-IPM training (Winarto, 2004). Similarly, a study from Zimbabwe suggests that farmer-driven experimentation has taught farmers to recognise their ability to identify and solve problems, improving self-confidence (Hofisi, 2003). The farmers felt confident enough to take on leadership roles, including facilitation of FFS sessions (Friis-Hansen, 2008; Friis-Hansen et al., 2012; Winarto, 2004). However, in one study, the authors note doubts about the extent to which increases in self-confidence would translate into future activities, noting that farmers did not feel confident enough to carry out their own experiments (Simpson, 1997).

In two studies, FFS participants reported perceiving **stronger social ties, improved collaboration and collective action** (Mancini et al., 2007; Najjar, 2009). In an Indian FFS, the gains in social capital also extended to the non-participating neighbours in the intervention communities through the formation of clubs that conducted on-site experimentation and social activities designed to support the poor and vulnerable members of the community (Mancini et al., 2007).

Four studies also mention that FFS graduates acquired **enhanced status within the community** (Friis-Hansen, 2008; Friis-Hansen et al., 2012; Machacha, 2008; Winarto, 2004). FFS farmers felt that they were treated with more respect (Machacha, 2008), and adopted leadership roles, becoming informal leaders in Kenya (Friis-Hansen et al., 2012), farmer group leaders in Uganda (Friis-Hansen, 2008) and IPM experts or "farmer professors" in Indonesia (Winarto, 2004). In the last case, the authors note that "the social positions or categories of the famers have become less significant than the reliable and valid information they could provide", suggesting that FFS knowledge allowed farmers to break out of their traditional community roles and relationships (Winarto, 2004, p. 351).

Gender

Six out of twenty studies directly discuss the part of FFS in gender roles and relationships and women's empowerment specifically (DANIDA, 2011; Dolly, 2009; Friis-Hansen et al., 2012; Machacha, 2008; Mancini et al., 2007; Najjar, 2009). All of these studies suggest that **FFS contributed to women's personal empowerment** (DANIDA, 2011; Dolly, 2009; Friis-Hansen et al., 2012; Machacha, 2008; Mancini et al., 2007; Najjar, 2009). The studies present subjective reports of women perceiving an increased sense of confidence (DANIDA, 2011; Dolly, 2009; Friis-Hansen et al., 2012). In India, women perceived that their human and social capital had increased following FFS participation, and that FFS allowed them to gain recognition for their skills and abilities. In Kenya women from one FFS reported that they were "beginning to recognize themselves as a viable source of knowledge, particularly for issues outside the maintenance of the household (e.g. farming)" (Friis-Hansen et al., 2012, p. 52). In Trinidad and Tobago, women perceived that FFS had increased their self-confidence to share their ideas on matters where they would previously not have done so (Dolly, 2009), and in Bangladesh, women felt more confident in public speaking. They also reported that their status and role in the household and the community had improved (DANIDA, 2011).

One study from Kenya found that FFS have established a favourable **group composition and atmosphere that enabled breaching traditional community roles and relationships** (Friis-Hansen et al., 2012)**.** The study described an FFS that established a dynamic and positive atmosphere in the groups and a structure that dictated that all participants should be equally involved in all activities. This, according to the authors, led to the creation of a "safe space" where both women and men could take on roles not traditionally accepted outside the groups, and collaborate on carrying out practices that were normally gendered (Friis-Hansen et al., 2012, pp. 49–53). The FFS participants also reported that the participation in FFS had **improved gender relations** within groups and at household level, including men's regard and opinion of women. The changed attitude to women appeared to be a key factor in changing household relations, including increased collaboration and joint decision-making. Households reported a reduction in quarrels, and improved incomes thanks to the increased economic activities of women, including in commercial agriculture which was traditionally considered a taboo (Friis-Hansen et al., 2012).

However, two studies suggest that **women did not always acquire greater economic and other decision-making powers** (DANIDA, 2011; Najjar, 2009). A study from Bangladesh found that, while women were more likely to be consulted, men still had the final say in “big decision-making” on issues such as larger agricultural investments and land ownership, child marriage, child labour, polygamy, male employment and migration. Women’s control over income has in the majority of cases not improved, with men retaining decision-making power on women’s spending. This was the case even when women were allowed to take out loans from farmer groups (DANIDA, 2011).

A study from India suggests that “the increased household cash flow – perceived by both men and women IPM-FFS participants – translated into the purchase of new physical assets mostly for men” (Mancini et al., 2007, p. 108). In Bangladesh and Kenya, women and minorities remained poorly represented in the leadership and decision-making of local organisations (DANIDA, 2011; Najjar, 2009). The authors of the study from Bangladesh suggest that the limited impact on female empowerment was largely due to a failure to fully address intra-household relations and socio-cultural / gender issues, noting that engagement with gender and socio-cultural issues were considered “add-ons” rather than integral parts of the FFS approach (DANIDA, 2011).

Three other studies similarly found that **traditional gender roles remained within the groups** (Dolly, 2009; Machacha, 2008; Najjar, 2009). Two studies found that men’s views dominated in the FFS group fora and proceedings (Dolly, 2009; Machacha, 2008). A study from Kenya found gender preferences for group composition resulting in gender-segregated groups. Men traditionally preferred single-sex groups. Women preferred mixed groups so that men could take on some traditionally male tasks. Within mixed groups, men adopted production-oriented male roles, while women would persevere in subsistence-oriented and reproductive roles. Where groups were mixed, FFS did not address gender balances sufficiently. Men would adopt leadership positions even where FFS groups were composed predominantly of women participants. Cultural roles (which for instance prevented travel) and household duties were reported as barriers to women taking on more active roles (Najjar, 2009).

The studies from Kenya seem to have contradictory findings with regards to the success of FFS in breaking down traditional gender roles. Unfortunately, since the Friis-Hansen studies (2008, Friis-Hansen et al., 2012) do not provide any information about the FFS project under study, it is not possible to evaluate whether this difference is due to differences in project design or implementation, or whether in fact, the studies refer to the same project but reach contradictory conclusions.