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ABSTRACT

Agricultural Water Management (AWM) interventions for development need a well-designed monitoring and evaluation framework that captures the holistic picture of its planned and unplanned effects on the watershed, or landscape, and livelihoods of people. An M&E framework is context-specific and should be developed with local stakeholders to inform the desired effects and acceptable and unacceptable limits and thresholds of change. Inclusion of impact indicators in an AWM M&E framework in addition to project indicators can help the project capture and learn from impacts beyond the project area and timeframe. This will help to fully assess potential and actual positive and negative changes, including possible "negative externalities". Since budgets for M&E are often limited, it is important to tailor the M&E framework to the specific goals and context of the project.

In this report, we present relevant indicator themes that have been synthesised from several other organisations' M&E frameworks. Each synthesised M&E framework has its own specificity, and the indicators it utilises may be too theme-specific for every AWM project. However, the synthesised indicator themes represented in this report can be used to: 1) analyse existing M&E frameworks to identify gaps or areas of improvement; 2) provide a starting point for thinking about necessary project-specific indicators; and 3) as a starting point for developing a baseline assessment.

1 INTRODUCTION

A recent attempt to synthesise impacts of Agricultural Water Management (AWM) interventions (Barron *et al.*, 2010; Joshi *et al.*, 2008) suggests that when these interventions aim to achieve change for livelihood improvement in developing contexts, there are multi-dimensional effects on natural, social, human, physical and financial capitals. AWM interventions are designed to both enhance agricultural production for poverty alleviation and maintain or enhance environmental sustainability. Bachelor *et al.* (2003), however, describe how the impacts of AWM interventions on livelihoods and on land and water resources at the larger watershed scale are not well understood. Effects on, for example, the wider hydrology of the watershed or on livelihoods of different groups of people have often been left unnoticed with, in some cases, long-term negative effects on future livelihoods (Bachelor *et al.*, 2003; McCartney *et al.*, 2007). Working together with local people is required to ensure the multi-dimensional effects of AWM interventions contribute to change that is both desirable and sustainable.

Monitoring and evaluation (M&E) frameworks that are utilised in AWM projects aim to inform short-term management of interventions in order to mitigate negative side effects during the project and in the long term. However, "monitoring practices often fall short of their potential for learning in complex rural development issues that involve collaborative action by a changing configuration of stakeholders" (Guijt, 2008). AWM interventions particularly work within a complex context: taking place within a defined hydrologic unit of a watershed they also take place within political and social networks that can either reach far beyond the watershed or occur on a smaller spatial scale within the watershed. Few M&E systems attempt to assess impacts beyond the direct project implementation boundaries (World Bank, 2008). Further, when evaluation takes place it is often focused on either biophysical or socio-economic impacts at the spatial and temporal scale of adoption (i.e. during or just after project implementation) (Barron *et al.*, 2010). Rarely does AWM project M&E focus on capturing both biophysical and socio-economic impacts.

Despite large investments in AWM interventions to address rural poverty, the impacts remain inconsistently reported in many projects and initiatives. A World Bank toolkit (2008), created specifically to assist M&E in AWM projects, reviewed AWM projects globally and found several common flaws: projects usually do not distinguish between monitoring and evaluation; project M&E often inadequately covered progression toward overarching goals like poverty alleviation and the Millennium Development Goals; projects often only focus on project indicators; and over half of the projects reviewed did not have any baseline information with which to compare project impact.

In an effort to address some of these concerns, this document presents guidelines that can help new and ongoing AWM intervention projects develop their M&E framework, taking into account the multi-dimensional effects of these interventions. First, the report discusses available communication processes and methods that can help facilitate learning from changes in the complex AWM intervention environment. Second, relevant indicator themes are presented that have been synthesised from several other organisations' M&E frameworks. The themes are intended to guide information flows between stakeholders to assess and learn from the social, human, financial, physical and environmental impacts that occur at farm, community and watershed level, the meso-scale (1-10,000 km^2). Third, to illustrate how these indicator themes can be used, the M&E frameworks of a global level and a local level organisation are reviewed and an illustration of a baseline assessment conducted using the synthesised indicator list is presented.

2 OVERVIEW OF THE CONCEPTS

There is a wealth of monitoring and evaluation guidelines for project and program management, many of which are useful for developing M&E to assess potential multi-dimensional impacts of AWM. The references at the end of this report are only a small selection. These guidelines describe four main purposes for monitoring and evaluation:

- to document the process of implementation;
- to facilitate decision-making by project management;
- to take remedial action; and
- to learn from experience and provide feedback (MDF, 2003).

Both monitoring and evaluation are processes that should be adjusted throughout the project or programme to address changes such as involved actors drop out and/or new ones join in, the political situation shifts, or unforeseen environmental limits are reached. M&E activities should be part of the project design and have their own budget assigned. When done correctly, formal and informal discussions about gathered data and further analysis by partners and stakeholders can inform future decisions.

2.1 MONITORING

Monitoring should be thought of as "an evolving methodology for structuring information flows and knowledge production and use" (Guijt, 2008). It is not simply a data-gathering exercise focused on quantitative data. To monitor in a useful and efficient way, both the information needs of and the information collected by the various involved stakeholders must be clearly determined. First, knowing what data is available from different sources such as other organisations, academic literature, and/or reports from previous projects will help to decide what data is still necessary to collect. This ensures the project budget is used most efficiently. Second, to establish context-relevant indicators, many have advocated for the use of 'participatory impact M&E', which is involvement of stakeholders and participants in the design, collection and analysis of data. Participatory M&E can improve the accuracy and relevance of the data that is collected, it can help to build local institutional capacity, and can enhance the capacity of local people to record and analyse change (IFAD, 2002). It is also found to be more cost-effective because it utilises local capabilities while increasing the likelihood that the results of data collection will be used (Stroud, 2004). Participatory M&E also has the potential to facilitate learning, but only if it is done in a context specific way that aims to build trust between stakeholders and where the intervention takes M&E as an evolving methodology that guides information flows (Guijt, 2008; IFAD, 2002). One potential downside of participatory M&E is that it increases the burden for local people if the time required for data collection is significant (Guijt, 1998). This may make M&E more difficult to sustain in the longer term, due to its voluntary nature (Stroud, 2004).

There are many references about how to undertake and set up participatory M&E (IFAD, 2002; Herweg and Steiner, 2002; Guijt, 1999, Guijt 2008). These guidelines clarify that adapting to a changing context should ultimately be done by the participants themselves because any AWM intervention project will conclude after a period of time. Planning regular feedback meetings with stakeholders of the project can direct changes that need to be made in the activities conducted by the project. It can also help to reflect on the measures that are used, the indicators that are missing, and indicators that capture unnecessary information. Through joint analysis of data, the relationships developed can increase learning for all stakeholders.

2.2 EVALUATION

Evaluation, on the other hand, is a systematic and objective assessment of the design, implementation and results of an ongoing or completed project, programme, or policy (OECD, 1991) in order to assess its relevance, efficiency, effectiveness, impact and sustainability. To be able to evaluate changes over time within the wider context of the watershed and livelihood strategies as shown in figure 1, a baseline assessment is needed at the start of the project or even before the design of the intervention. Evaluation can then be carried out at intervals during the project and after completion (Hernández, 1995) by comparing the baseline with monitoring information to assess the positive and negative impacts of both the direct implementation area and areas beyond the project boundary (MDF, 2003).

While it is ideal to collect baseline data on a large number of useful indicators both of project beneficiaries and people living in areas beyond the project boundary, in some interventions it is not clear which households will become a beneficiary and who could be part of a control group. It can be that the beneficiaries are self-selecting because only when farmers purchase a technology do they become part of the project. In order to create a baseline for evaluation, the data could be collected for randomly selected households in an area. When the area of work of the project grows over time another baseline assessment can be done when a threshold of, for example, a minimum uptake of technology has occurred. As budgets are often constrained it is critical to make setting a baseline an efficient and useful data gathering exercise that after analysis provides a holistic view of the watershed or work area.

The particular timing of the evaluation intervals should be based on the specific goals and design of the project. Some projects also evaluate the project after a period of time has elapsed post completion. This can be a good way to capture long-term impacts that may not appear during project implementation or upon project completion. Thus, if evaluating four times you could include: baseline, ongoing/intermediate, completion, and post-completion (Palanisami *et al.*, 2009).

There are three principal ways to evaluate the impact of a project: it can be done through comparing 1) the situation before the project and at times during and/or after the project; 2) what has changed compared to what was planned to change; and 3) data from direct participants with data from uninvolved stakeholders living in another area in the watershed or downstream from the project. In all three methods, different sources of data can be used: data from other organisations, academic literature, and/or reports from other projects in the area.

It is also important to prepare terms of reference for the organisation conducting the evaluation in order to ensure that the information collected and analysed will answer pertinent questions for the different parties involved (project staff, participants, internal and external stakeholders, and funders). For example, funders are less likely to be interested in detailed surveys and results of how the uptake of the AWM technology is going. They are interested in more general information such as the total number of farmers taking up the technology in the watershed. Project staff and participants might want to know about the process of uptake in more detail to inform new activities in areas where fewer farmers have taken up the technology. They can then focus their efforts on overcoming the difficulties farmers face in, for example, getting the basic material for the technology together.

2.3 LOOKING BEYOND THE PLANNED INTERVENTION

Researchers have found that even in projects that were deemed "successful" due to increased crop production and income, there were also negative side effects that were not captured for example in cases in Sub-Saharan Africa described by McCartney *et al.* (2007). Small dam projects did not foresee and capture information about the increase in incidences of malaria and schistosomiasis. Batchelor *et al.* (2003), when describing the watershed development programmes in South India, assert: "when negative trade-offs are taken into account, watershed development has either no significant water-related impact or has a negative water-related impact on the livelihoods of poorer social groups and, in particular, poor women and children." One potential cause of this disconnect is that most projects use monitoring to track progress and assess efficiency and effectiveness of planned activities. While this is one major use of monitoring, it only answers the question 'Are we doing things right?' and fails to capture the broader question 'Are we doing the right things?' (Herweg and Steiner, 2002). Focusing on project indicators ensures capture of the former question while impact indicators ensure capture of the latter. Thus, both project and impact indicators should be included in monitoring and evaluation for AWM projects in order to identify and learn from environmental and livelihoods impacts that stretch beyond the planned intervention. It can help to inform short-term adaptive management to mitigate negative side effects during the project and in the long term (McCartney *et al.*, 2007).

A method called 'impact monitoring' has been developed to help projects include both types of indicators. Herweg and Steiner (2002) describe the process of initiating an impact monitoring system: impact monitoring changes the emphasis from looking at pre-defined results to looking at actual change brought about by the project. In addition, frequent feedback sessions are held with involved stakeholders to enable better decision-making and priority-setting during the project (Hernández, 1995). Another example of an M&E method that looks at impacts of a project is called 'Most Significant Change' (Davies and Dart, 2004). This method does not use indicators or impact hypotheses but collects information based on stories of people answering a question such as 'During

Box 1: Major Considerations to Capture Impacts with M&E

To accomplish a shift in focus from technology adoption to socio-economic and environmental impact (Batchelor et al. 2003; Douthwaite *et al*., 2003; German *et al*., 2006; Stroud, 2004; World Bank, 2008):

Proper methodology
- Importance of farmer participation/participatory M&E.
- Need for pre/post assessments and evaluation.
- Need to compare beneficiary results with independent control groups.
- M&E as a process
- M&E should be part of the implementation process, not just evaluation at the end.
- M&E during the process requires a high degree of flexibility.
- It is an evolving methodology throughout the project that aims to facilitate learning.
- Any logical/results frameworks or indicators lists should be used more as management tools or guidelines than blueprints.

Adaptation
- Insights often come through identifying farmer innovations.
- Adaptation of the technologies to local conditions is critical, instead of delivering 'finished' technologies.
- Need to monitor technology "spillover".

Social considerations
- Need to embrace a more nuanced understanding of social networks and benefits.
- Need to track social innovations as well as technological ones.
- M&E should cover institutional aspects.
- Impact assessments mean different things to different people. How to measure impact are rooted in these different values (i.e. important to consider different points of view).

the last month, in your opinion, what was the most significant change that took place for participants in the program?' Impact assessment creates more transparent accountability and helps all involved to gain a greater understanding of the process (Stroud, 2004). Box 1 delineates some key considerations which can be specifically relevant for developing M&E for AWM interventions aimed at large-scale uptake and adoption.

3 DESIGNING THE M&E FRAMEWORK

When scaling up AWM technologies, it is important to ensure sustainability and avoid so-called "negative externalities". To accomplish this, cascading and aggregated impacts by large-scale adoption need to be captured before and during implementation. Starting with a well-designed framework helps projects to appropriately answer questions about the holistic picture of social, human, environmental, financial and physical impacts (de Graaff, 2007). The guidelines (World Bank, 2008; IFAD, 2002; FAO, 1995; DFID, 1999; Layke, 2009; Palanisami *et al.*, 2009; UNEP, 2002; BACP, 2009; de Bruin, 2005; Barron *et al.*, 2010; MDF, 2002; McCartney *et al.*, 2007; Herweg and Steiner, 2002) describe several methods for M&E design, however, all well designed M&E systems contain a framework of information, questions, indicators and measures. The framework should suit the project focus, include different indicators that reflect the diversity of the project objectives (Palanisami *et al.*, 2009), and be flexible enough to evolve over time when changes inside and outside the organisation take place (Guijt, 2008). There are many existing approaches that can help to set up the framework such as the Logical Framework (MDF, 2003), Outcome Mapping (Earl *et al.*, 2001) (an example of a method that takes the logical framework a step further) and Participatory Impact Pathways Analysis that uses an Outcomes Logic Model (Douthwaite *et al.*, 2007) (another example of an approach that builds on outcome mapping). The points made above should however be taken into account. Projects tend to fill in the matrices of goals, purpose and activities, indicators and methods of verification and then leave them untouched until the project ends five years later. This does not facilitate learning in the project by different stakeholders. Also the frameworks can make monitoring feel very logicical and the intervention a linear process, but projects work in a complex context with many factors influencing participants. These framework approaches can help learning as long as they remain flexible, context specific and are evaluated over time.

3.1 SETTING UP THE INFORMATION QUESTIONS

Taking into account the different reasons for conducting M&E, the framework of indicators and measures should be able to address questions related to the relevance, effectiveness, efficiency, impact and sustainability of the project. Examples of these questions (MDF, 2003) are:

- Has the project addressed the major problems (priorities) of the main stakeholders?
- To what extent has the envisaged improvement been achieved?
- What have been the costs (not only in terms of dollars but also in terms of dis-benefits) per produced result and has the time planning been respected for the various results?
- To what extent have the different overall objectives been achieved? What other substantial indirect effects (positive and negative, planned and unplanned) can be observed?
- How probable is it that the improvements will continue (to be produced) in the after-project period?

The design and implementation of the framework should be both context-specific and relevant to all stakeholders of the project. Before project onset, scenarios can be discussed with local experts to gain an understanding of activities that could ameliorate both positive and negative effects of scaling up the suggested AWM interventions in the watershed. Additionally, factors that can mitigate the negative effects of scale-up should be mapped and discussed. These steps ensure that the project will be relevant to the local context and main stakeholders. They also form a starting point for M&E indicators by asking, 'what areas are crucial in the watershed and will show change?' and, 'what aspects should be monitored to inform mitigation strategies for the project?'

3.2 SELECTION OF INDICATORS

Indicators, when measured, provide information to answer the relevant information questions about the project and its impacts. Budget and time constraints limit what a project is capable of measuring and not all indicators are equally important to measure. In order to establish context-relevant indicators and define the boundaries and thresholds of how much and in what way the project takes change to be 'positive' or 'negative', discussion between project stakeholders is necessary. Box 2 summarises what may be taken into account when developing the data collection side of M&E. When designing the appropriate framework,

Box 2: Indicator selection

- When selecting indicators, the following points should be addressed (de Bruin, 2005):
- A causal relationship between the information need and the indicator should exist.
- The appropriate methods have to be selected to measure the indicator.
- These methods should accomplish this with sufficient accuracy.
- The indicator has to be sensitive enough to represent a change.
- The criteria should be defined to select the people that will provide the information.
- Who will collect it? The necessary level of participation should be defined.
- Who will analyse it and when will the results be discussed with local stakeholders?
- The conditions or assumptions under which the indicator is valid should also be verified.
- The timing of each component of information collection should be established

several elements must be considered in indicator selection.

First, spatial and temporal issues must be considered. It is important to have indicators that take into account the different spatial levels of impact a project might have; the indicators should cover the household level, community level, up-stream and down-stream areas, and the complete watershed. It is not necessary to measure each indicator at every scale and with the same frequency. The timing, spatial resolution and methodology to measure each selected indicator should reflect its final use.

Capturing change in external factors is a second important element to consider during framework design (see figure 1). An example of an external factor is climate variability. A project might include tree planting and try to measure change by looking at "change in forested area (natural and planted)". When a severe drought hits the area and people are forced to use the wood to make and sell charcoal, the negative change in forest area should not be fully attributed to the project. However, project management should adapt the project strategy to take into account the effects of the drought. Measuring indicators that relate to the different levels of project strategy (project progress, impacts, and external changes) is a way to ground project impacts in the external context within which the project is operating. These indicators help to capture unforeseen consequences or adaptations, and inform the project about possible negative impacts that could influence the projects' success.

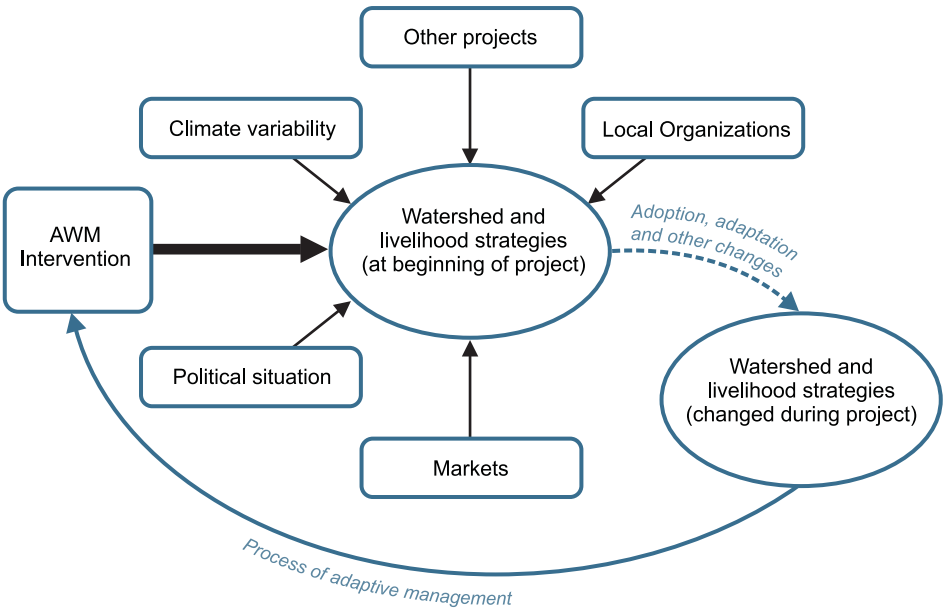

Figure 1: A simplified representation of other factors influencing the watershed and livelihoods context. Arrows indicate the influence of a factor. The dashed line represents time.

Thirdly, environmental effects of the technologies used in an AWM project and the possible up-scaling of these technologies should be captured and analysed. Monitoring environmental effects such as changes in groundwater levels up and down-stream, agro-chemical pollution of water courses, changes in biodiversity, and greenhouse gas emissions related to CO_2 and nitrogen can highlight existing and potential negative side effects of AWM interventions and point the way toward mitigation strategies. Actively addressing environmental sustainability in this manner will increase the likelihood that more positive project impacts continue after the project period ends. Some other examples of potentially useful environmental indicators are shown in Appendices A and B under 'natural capital'.

A fourth important element is capturing adaptation. German *et al.* (2006) argues that the impacts of AWM are often measured through the number of technologies developed and introduced into the supply chain, even though this approach has been long criticised. This pro-innovation bias encourages a focus on externally-introduced and fixed technologies which lack consideration of household and local farming system characteristics. Projects often fail to capture the re-invention process that happens after on-farm adoption. Thus, through solely monitoring adoption, the full range of impacts such as adaptation and farmers innovation, may be overlooked (German *et al.*, 2006). This bias is demonstrated by the fact that all of the reviewed frameworks (see Section 4.1) did not include an indicator to capture the adaptation process. Thus, we included an additional indicator in our list of synthesised indicator themes in table 1 and added this in Appendices A and B under "human capital". The adoption and adaptation process should not be considered an "unexpected" impact, but monitored as part of M&E such that the positive impacts of adaptation can be absorbed into the intervention itself. This technology adaptation is a perfect example of the need for adaptive management shown in figure 1. M&E provides the feedback loop necessary to learn from this changed state and incorporate these changes back into the intervention design.

Lastly, representativeness should be taken into account when designing M&E. Some areas, livelihoods strategies or communities may be studied in more detail than others under the assumption that the change within these locations or populations is representative of other similar places or people. Selecting these representative areas or groups should be done with input from local people and re-assessed throughout the project duration to ensure that they are actually representative and not an anomaly. Section 4.3 provides an example of a baseline assessment that was set up so that the results of four in-depth case studies were verified over a larger area with local people. This resulted in a watershed-level baseline assessment that saved both time and money.

3.3 MEASURING THE INDICATORS

Each indicator can be captured by various measures, and specific measures should be chosen on a project-by-project basis with stakeholder input. A useful measure will be one that will capture enough detail, and not more detail than necessary, for the analysis to be useful. The level of detail relates to accuracy in numbers, spatial detail in maps, as well as to the number of samples or people analysed. Each measure should contribute to answering an information question. Where appropriate, measures should be designed to capture both quantitative and qualitative aspects of the same indicator.

The qualitative aspects could for example include perceptions of people on the issue at hand. This information will help put the collected quantitative aspects into a context for the analysis. A good example that shows this added value of capturing perceptions of people is the assessment of flood impacts. As Peters *et al.* (2009) asserts "Mapping of manageability is more helpful for the local and municipal authorities than that provided by water depth and duration maps alone. It helps authorities to recognise those areas where most vulnerable households can be found in order to determine the levels of flooding they can manage and at which point external assistance may be required." This study tried to answer when flooding would be a threat to people. It took into account not only quantitative data but also perceptions and coping strategies of people.

That measures should be context specific is illustrated by this next example of a study that tried to capture the adaptations farmers made to the proposed AWM technologies of a project. Farmers in Peru were supplied with irrigation drip kits (Levelt, 2004). Due to the low water pressure farmers manually drilled out the nozzles. One of the measures used in this study was the distribution uniformity of the adapted irrigation and comparing this with the original design of the drip kits. Interestingly, it showed that the foreseen uniformity based on higher pressure and smaller nozzles was similar to that of the adapted irrigation kit of the farmers to their local context. Understanding why the farmers had changed the kits informed what aspects were measured. The study then also assessed

how the adapted technology was distributed beyond the direct beneficiaries of the project and what markets influenced the adapted design. In each AWM intervention different adaptations will be made based on the local difficulties farmers have to overcome and adapt to. Therefore measures to assess why and how farmers adapt the technology will be different for each intervention.

Measuring indicators can be done in many ways, at different spatial and temporal scales and with as many or as little measurements, interviews or surveys. Most importantly, all the collected data will need to be analysed and should contribute to answering the information questions set before data collection is undertaken. Similar to the other elements of the monitoring and evaluation framework, measures should be reviewed before another phase of data collection takes place to ensure necessary changes are made.

4 A SYNTHESISED FRAMEWORK AND ITS APPLICATIONS

AWM interventions contain a wide range of different components including agricultural and forest production, land-use changes, biodiversity and conservation measures, water resources management, and a multiplicity of associated poverty alleviation efforts. Keeping track of the various elements and disentangling their impacts is a complex task. Yet many frameworks exist that can lend indicators for AWM intervention M&E. In an effort to create a general framework that highlights important themes yet is not a blueprint for every project we synthesised several existing frameworks. The themes can guide the design of information flows between stakeholders, help identify gaps in existing M&E frameworks, or be used as a starting point for developing M&E for a new AWM intervention or investment. The synthesis reviewed M&E documentation by a wide range of organisations with expertise in AWM interventions (World Bank, 2008; IFAD, 2002; Hernández, 1995; DFID, 1999; Layke, 2009; Palanisami *et al.*, 2009; UNEP, 2002; BACP, 2009; de Bruin, 2005; Barron *et al.*, 2010). Further details about the methodology can be found in Appendix F.

The frameworks all cover M&E from a different angle, often related to their organisational interest or thematic aim. For example the World Bank Toolkit specifically focuses on AWM projects, but the World Resources Institute working paper by Layke (2009) aims to improve ecosystem services indicators of AWM interventions. Consequently, not all sources cover the same breadth of indicators or indicators for all of the five livelihood assets. Financial capital is covered by all of the sources, although the World Bank Toolkit and Palanisami *et al.* (2009), for IWMI-ICRISAT, contain the most detailed indicators to capture changes in financial capital. Human capital is covered by all sources except for the BACP; the BACP source specifically hones in on indicators that relate to products and policies for enhancing biodiversity.

Indicators to capture change in natural capital, such as changes in water resources, land use, vegetative cover, biodiversity, etc. are described by all sources to varying degrees. However, the IWMI-ICRISAT framework (Palanisami *et al.*, 2009) includes the largest number of natural capital indicators (excluding water quality). The FAO framework (Hernández, 1995) about watershed management projects covers resource availability, hydrology and soil and production-related indicators. The World Bank Toolkit mainly focuses on production and water quality. Interestingly, the World Bank Toolkit has a strong emphasis on indicators related to physical assets whereas DFID's focus is predominantly on capturing change in social capital. We conclude that each of these frameworks has been developed with their own specific agenda and aim, and therefore, the indicators they utilise may be too theme-specific for every AWM project. However, when combined, the various frameworks give a balanced set of M&E indicators to capture intended and unintended impacts of AWM interventions.

The different frameworks also focus on different scales. The FAO reference describes indicators that should be measured at the watershed scale whereas the World Bank Toolkit focuses primarily on project-level indicators. The BACP indicators span both the project level and policy level. The WRI framework by Layke (2009) highlights the need for indicators to be measured at different levels - local, national and regional - and different times to capture impacts on all of the flows of ecosystem services.

4.1 INDICATOR THEMES FOR AWM INTERVENTIONS

Since budgets for M&E are often limited, it is important to tailor the M&E framework to the specific goals and context of the project. It is useless to spend time and money collecting information that is irrelevant to the project at hand. However, the synthesised list of indicator themes in table 1 can provide a starting point for an AWM project team to think through the more specific indicators and locally valid measures for their project M&E. The five capitals (financial, human, natural, physical and social capital) of livelihood assets within the sustainable livelihoods framework (DFID, 1999) are used to ensure a holistic picture of assessment. In this way, the social, human, and environmental indicators are included along with the financial and physical indicators that are more commonly part of M&E of AWM interventions.

Both project and impact indicator themes are included (as discussed in section 2.1 above.) Examples of possible measures for each indicator theme in table 1 are shown in Appendices A and B. Not all example measures are valid or useful for every AWM intervention. Indicator themes at project level and the measures in Appendix B capture those that are specifically focused on keeping the project on track to reach milestones through measurement of inputs

Table 1: Impact and project indicator themes for AWM interventions

Livelihood capital	Impact indicator themes	Project indicator themes
Financial capital	Income and wealth Agricultural production Cost of production Sources of income Assets, savings Access to capital/credit Business development	Income and wealth Cost of production Assets, savings Buyers and other value-chain participants of the targeted commodities integrate biodiversity criteria in the value chain Financial products, biodiversity-friendly, available to the actors in the targeted commodities and countries Economic returns to investment in AWM intervention
Human capital	In and out migration Agricultural training Literacy level Schooling Health Food security/nutrition Labour Technology adaptation	Agricultural training Technology adaptation
Natural capital	Soil Quantity and quality of water resources Land use Forest/vegetation Biodiversity management Production related Irrigation related	Soil Quantity and quality of water resources Production related
Physical capital	Infrastructure Water infrastructure Housing	Water infrastructure
Social capital	Changes in knowledge exchange Institutions/governance for resource management Financial organisations Collective action Empowerment Equity	Institutions/governance for resource management Policies Financial organisations Empowerment

and outputs. Project indicator themes and measures in Appendix A focus on indicators that may be important at the watershed level and indicate the indirect effects of the intervention. Here we also include indictors that could relate to external factors (figure 1 in section 3.2). An example is the rainfall throughout the year (in appendix A: natural capital, hydrology).

In some cases, the indicator theme could be applicable either as a project or impact indicator. Depending on the project details, measurement of change in, for example, "assets and savings" can be either attributed to the project as an output, or could be considered an impact. If the project contains a significant market-development component, this theme could be considered to track project progress. However, if the project has a minimal market-development component, any change in this theme could be an indirect effect of the project's work or might have happened for other reasons. Thus, it would be considered an impact, or even en external

factor. This example further highlights the conclusion that the synthesised list of indicator themes are useful only as a starting point and each project must select the most valuable indicators and measures for the goals and potential impacts at hand.

An important part of AWM interventions is addressing gender issues. The indicator themes of empowerment and equity under 'social capital' both relate to gender issues, but they go further. They focus on equity for, and empowerment of, any group in society that is marginalised because of gender, age, religion, ethnicity or livelihood strategy. The example measures in appendices A and B for these two themes should be read using this broader focus.

4.2 M&E FRAMEWORKS OF TWO ORGANISATIONS IMPLEMENTING AWM INTERVENTIONS

One important use of the synthesised indicator themes is reflection on existing frameworks to reveal gaps or useful additions. As an example, we reviewed some of the M&E indicators of two organisations that work at different scales. The first organisation, International Development Enterprises, works globally with several different country offices and programmes. The second organisation, IDE-India1, works on projects within India. Both aim to develop supply chains for AWM technologies in order to improve the condition of smallholder farmers.

International Development Enterprise (IDE)

IDE is one organisation involved in implementing interventions that use AWM technologies. From their website (IDE, 2010) "IDE is a social enterprise dedicated to ending poverty in the developing world not through handouts, but by helping farm families access the tools and knowledge they need to increase their income." To accomplish this goal, IDE attempts to strengthen the supply chains within which smallholders operate. Local distributors and dealers are trained to manufacture and sell irrigation technologies such as drip irrigation kits and treadle pumps while IDE business associates help farmers with extension services and connection to markets.

IDE developed their M&E framework (IDE, 2007) for the purposes of accountability to stakeholders, external communication, and internal learning for improved decision-making. The framework standardises M&E across the different country programs through the use of multiple tools. These tools include rolling baseline households surveys, farming system case studies, livelihood impact case studies, qualitative studies, natural resource impact assessments, focus group discussions with smallholders, and customer satisfaction surveys. This combination of tools enables IDE to monitor a set of indicators which are presented in Appendix C. We compared their indicators with the indicator themes we suggested in table 1. Because IDE focuses on bringing AWM interventions to smallholder farmers through market actors, they have two additional indicator themes that were not included in table 1: "customer satisfaction" and "markets". These apply specifically to their approach and may or may not be valid for other AWM intervention programmes or projects. This once again illustrates that indicators should be made relevant to the organisation's specific goals and approach. The global framework explicitly mentions that the indicators can be adapted to increase relevance to each country context and project intervention. To make the process more cost effective and help build local capacity, IDE could encourage the country programs to establish their indicators together with local communities and stakeholders (as discussed in chapter 3).

The comparison in Appendix C shows that some natural capital indicators are included in IDE's framework, but these could be expanded upon to include impacts that go beyond the direct effects of the AWM interventions to ensure environmental sustainability of the interventions in the long term. The organisation is undertaking a two-year Environmental Impact Assessment to develop a tool that aims to "identify, evaluate and monitor the potential environmental impacts of existing and proposed projects and act as a screening tool for project feasibility in relation to environmental sustainability" (IDE, 2009). They are using two country programs to test and refine the tool. Once completed, the tool will assist all IDE country programs in assessing the potential environmental impacts of proposed projects prior to their inception and mitigate these from the onset of the project. The tool emphasises the assessment should be done for both participant and potential non-participant impacts, for example, the effects on those living downstream of the project area. The tool will help projects to assess, among others, impacts on water resources, irrigation, crops, domestic water supplies, flooding, agro-chemical use, ecology, and human health; a wide range of indicators

1 IDE-India was historically one country program of IDE. However, IDE-India successfully spun off from IDE in 2004. They are now completely autonomous organisations with different M&E systems, although they maintain a partnership.

that can help improve the M&E of existing and future IDE projects to address environmental impacts.

IDE-India

IDE-India is a country level organisation with a similar approach to IDE. In order to review M&E at the country level, we interviewed some people involved with M&E at IDE-India and analysed some of their evaluation documents. IDE-India's organisational structure has five layers: national office (Delhi); regional offices; field offices; business associates; dealers/distributors; and manufacturers. Information on both the smallholders and market participants is collected when each piece of equipment is sold; farmers obtain a warranty card based on their address. Monitoring at IDE-India is done on a monthly basis in order to compile this information and make it available at the various administrative levels of the organisation. The geographic information helps IDE-India to target promotional activities to areas with lower sales and training activities in areas with higher sales. The main aim of their monitoring is to provide feedback to the local level staff. The information captured through monitoring becomes input for periodic evaluations and is used to select farmers for interviews and other surveys that are part of the evaluation process.

IDE-India's evaluation strategy includes an internal review of their work every two years and external reviews at times requested by donors. The indicators used for internal evaluations have some, but not complete, overlap with those specified by donors. Their systematic evaluation provides them great benefit, and many impact indicators are thoroughly covered. Yet, by comparing their internal evaluation indicators with the indicator themes we developed in table 1, it becomes evident that some topics could be more thoroughly addressed to improve both understanding of impact and efficiency of future evaluation processes (see Appendix D). In the cases where a suggested indicator theme was not found in the reviewed reports, the table states that this theme has not been covered. There were two reports reviewed: one internal evaluation and one external evaluation. The internal assessment was done by The Energy and Resources Institute (TERI) and is a socio-economic-techno-environmental assessment of the treadle pump (IDE-India, 2007); it also assessed the potential for mitigating green house gases through using the pump. The external evaluation was done for the Lemelson Foundation and is a study of the social, economic and environmental impacts of the drip irrigation kit among customers in the states of Maharashtra, Madhya Pradesh, Karnataka and Tamil Nadu (IDE-India, 2008a). All measures in this report were asked in the context of 'has adoption of Drip led to…'. While it is likely that internal evaluations remain consistent, external evaluations may include additional or different indicators than those presented in the Lemelson Foundation external report. For example, an external evaluation conducted for the donor Acumen Fund entitled 'A fairy tale for all? A Rapid Assessment of IDEI's Treadle Pump Programme in Uttar Pradesh, and its Impact on Children's Welfare' (IDE-India, 2008b) focuses heavily on the social and human capitals, which is a marked difference from the Lemelson Foundation external report. However, the two reviewed reports provide a good example of the types of assessments made on IDE-India's work. Through comparing the assessment indicators with those in the livelihoods capitals table, it is possible to identify which areas could benefit from additional attention.

The comparison in Appendix D shows that social and human capitals are both captured through only one or two measures in both the internal and external evaluation examples. As mentioned above, the Acumen Fund evaluation report contained much more information on the impacts on human and social capitals. In order to capture the impacts of AWM in a more holistic way, IDE-India could potentially benefit from including the social and human capital indicators contained in the Acumen Fund evaluation report in all of their internal and external evaluations.

In both evaluations, the impact of the technology was assessed by interviewing both users and non users of the technology. This made it possible to highlight the barriers to purchasing the technology. It also highlighted the negative impacts on those who are not able or do not want to adopt the technology. A comparison was often made between the 'before' and 'after' situation of adopting the AWM technology. Both types of comparisons, as discussed in section 2.3 above, give a contextualised, yet different, set of insights into the impacts.

The TERI evaluation includes a groundbreaking assessment of CO_2 emissions that can be mitigated through using the treadle pump. Similar assessments should be made by other organisations or projects when AWM interventions stimulate the use of diesel pumps or motor pumps. Beyond the emissions assessment, however, neither the TERI nor the Lemelson Foundation evaluation assessed the effects of farmers using drip or treadle pump technology beyond the farmers' fields at scales of the community or the watershed. Although neither evaluation claimed to focus on environmental impacts, there is still room for improvement in that area. There are several examples of impacts that could

be included in future evaluations: effects on soils, for example the effect of increasing land intensification through availability of irrigation on soil fertility; on hydrology, especially groundwater levels and water quality due to typical increases in agro chemical application for increased production; and the effects on other natural resources in the area such as forests or biodiversity. Similar to the conclusion for IDE, it is important for IDE-India to capture information about environmental impacts, as discussed in section 3.2, and to go beyond the direct effects of drip or treadle pump technology which are currently the main focus of IDE-India's evaluations. This will help the AWM interventions to be sustainable in the long term.

4.3 EXAMPLE OF A BASELINE ASSESSMENT

Monitoring and evaluation is best begun with a baseline assessment; then periodic evaluation against the baseline will help a project or programme to assess change. The watershed-scale Baseline Assessment of the AWM Solutions project in the Mkindo watershed of Tanzania (Cinderby *et al.*, 2010) illustrates how the indicator themes in table 1 can also be used as a starting point for developing a baseline assessment. The aim of the work was to assess the current use of, and dependency on, local natural resources of different livelihood strategies in the watershed to understand the potential for AWM technologies. From this baseline, a new AWM intervention project could be designed to consider the diverse number of livelihood strategies and AWM technologies already existing within the area.

Researchers used the indicator themes in table 1 to guide the selection of potential measures. These measures were then discussed with local partners and adjusted to make them more appropriate to the local context. For example, a question was added after discussion with local partners: "do you have issues with other users of land or water?" Conflicts have previously developed in the area between pastoralists and those dependent on agriculture, so the partners felt it was an important aspect of livelihoods to capture. Appendix E shows the measures used in the baseline assessment for Tanzania.

In order to conduct a baseline assessment of the Mkindo watershed with a small budget and short time-span, four communities were selected for in-depth case studies. The results of this work took the form of livelihood narratives, which described the dependency of each livelihood strategy on natural resources. The communities were selected during discussions between the project team and the district authority. The criteria included: their position in the watershed (both upstream and downstream); accessibility of surface water; access to different water management technologies (including formal canal irrigation systems); the range of livelihood strategies present in each location (including crop producers and livestock specialists) and ease of engagement (in terms of both physical access and existing linkages to village councils or community representatives). The resulting narratives were verified as relevant throughout the watershed in a meeting with experts who worked within a portion of or the entire watershed.

A range of AWM technologies are already in use in the area and participants had ideas about ways to improve their crop and livestock management. Thus, the results from the baseline assessment could be useful for a new AWM initiative to create a package of AWM interventions that fits local concerns and takes into account already existing AWM technologies. The collected information could be compared with future surveys or participatory mapping activities to assess change over time due to the project and change outside of the project's influence. For example, the 'reliability of water sources' is an indicator that could highlight depletion of the water table in certain areas that could also have a reciprocal effect on the success of the project. The assessment could also be used to create important institutional links between the project staff and local organisations and people.

This chapter provides a way in which new or ongoing AWM interventions can keep track of their wide range of different components. Creating a useful M&E framework is a complex task, however the synthesised indicator themes represented in table 1 can be a starting point for thinking about necessary project-specific indicators. The examples of IDE and IDE-India illustrate how existing M&E frameworks can be analysed using the table to identify gaps or areas of improvement. The work in Tanzania shows how the table could be used as a starting point for developing a baseline assessment.

5 CONCLUSIONS

- AWM interventions need a well-designed monitoring and evaluation framework that captures the holistic picture of its planned and unplanned effects on the watershed and livelihoods of people.
- An M&E framework is context-specific and should be developed with local stakeholders to inform the acceptable and unacceptable limits and thresholds of change.
- An M&E that is designed before the project and includes a baseline will support learning during the project to help mitigate or even avoid negative side effects of developing water resources for agriculture ensuring environmental sustainability.
- Inclusion of impact indicators in an AWM M&E framework in addition to project indicators can help the project capture and learn from impacts beyond the project area and timeframe. This will help to fully assess potential positive and negative changes, including possible "negative externalities".
- Since budgets for M&E are often limited, it is important to tailor the M&E framework to the specific goals and context of the project.
- Both monitoring and evaluation are processes that should be adjusted throughout the project or programme to address changes such as: involved actors drop out and/or new ones join in; the political situation shifts; or unforeseen environmental limits are reached.
- Each synthesised M&E framework has its own specificity, and the indicators it utilises may be too theme-specific for every AWM project. Taken together they give a balanced view of what indicator themes can be used for an AWM intervention.
- The synthesised indicator themes represented in table 1 can be used to: 1) analyse existing M&E frameworks to identify gaps or areas of improvement; 2) provide a starting point for thinking about necessary project-specific indicators; and 3) as a starting point for developing a baseline assessment.

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APPENDICES

APPENDIX A: INDICATOR THEMES AND MEASURES AT IMPACT LEVEL

Livelihood capital	Indicator theme	Examples of measures
Financial capital	Income and wealth	Net income generated (e.g. per ha, family, household)
		Changes in income/wealth relative to others
	Agricultural production	Net income by activity (crop, livestock, forestry and related)
		Total seasonal value of crop production (e.g. per command area, unit water consumed, unit water supplied)
	Cost of production	Total seasonal management, organisation and maintenance expenditure
	Sources of income	Revenue generated from off-farm land
		Different sources of family income (including employment)
		Consumption expenditure changes (including food consumption)
		Has independent income been created?
	Assets, savings	Proportion of output that farmers market annually
		Changes in wage rate
		In what form do people keep their savings?
		Do the savings give people security?
	Access to capital/credit	How often do people use financial credit? And when?
		From where do they access it?
	Business development	Number of households who started a business
Human capital	In/out migration	Change in in/out migration
	Agricultural training	Number of farms using introduced technologies
		Changes in behaviour
	Literacy level	Annual literacy rate
	Schooling	Number of schools in operation nearby
		Ability of parents to pay school fees
		Percentage of girls in school
		Number of children that go to school
	Health	Number of families/year receiving medical care
		Quality of health care
		Annual mortality rate
		Ability of family to pay for healthcare
		Accessibility of healthcare (i.e. distance to clinic)
	Food security/nutrition	Height for weight of children
		Height for age of children
		Length of hunger period
	Labour	Changes in labour needed
	Technology adaptation	Number of people taking up adapted technology
Natural capital	Soil	Soil salinity
		Soil fertility
		Tons of avoided sedimentation/ changes in soil loss

Livelihood capital	Indicator theme	Examples of measures
	Quantity and quality of water resources	Drainage water quality: biological
		Drainage water quality: chemical
		Annual low water flow
		Annual flood peaks
		Rainfall
		Changes in ground water table (i.e. water table rise) and well yield.
	Land use	Area under different crops (including fodder and food)
		Area of pasture and grazing lands
		Productivity of pasture and grazing lands
		Degraded land
		Rehabilitated land
		Area of water bodies
	Forest/vegetation	Changes in forest area (natural and planted)
		Biodiversity of forests (natural and planted)
		Change in forest use (timber and non-timber products)
	Biodiversity management	Areas under conservation (formally and informally)
		Connectivity/fragmentation of natural habitat
		Rate of deforestation
		Trends in abundance and distribution of selected species (flora, fauna)
	Production related	Quality of crop
		Differences in cropping pattern
		Difference in cropping intensity
		Change in cropping species
		Trends in use of agrochemicals
	Irrigation related	Water availability, surface and groundwater, availability downstream (inflow/outflow)
Physical capital	Infrastructure	Road and track practicable all year round
		Communications (i.e. radio, print, mobile phone, internet coverage)
		Changes in public transport
	Water infrastructure	Main system water delivery efficiency
		Delivery performance ratio
		Dependability of water delivery interval
		Overall scheme efficiency
		Improved control, enabling better distribution of available supplies
		Improved measurement, enabling better distribution and monitoring of available supplies
Livelihood capital	Indicator theme	Examples of measures

Livelihood capital	Indicator theme	Examples of measures
Physical capital	Water infrastructure	Increased security of supply (lowered risk of structure collapse or canal breach)
		Percentage of houses with access to clean drinking water
	Housing	Changes in housing
Social capital	Changes in exchange	Number of trained participants sharing knowledge
	Institutions/governance for resource management Adherence to equitable rules of operation	Has social organisation changed?
		Change in participation in social institutions
		Number of procedures, policies or regulations that were improved, added or eliminated
	Financial organisations	What financial organisations exist
		Who has access to financial organisations
	Collective action	Number of new groups formed
		Better linkages with other organisations and people
	Empowerment	How aware are people of their rights and other policies that impact them?
		Which groups are excluded from sources of information?
		Are different groups able to make their own choices or are they constrained by family pressure or local custom?
		Change in level of conflict
		Impact on women (decision making, health, life style and awareness)
	Equity	Are access rights secure?
		Is there equal access to resources?
		Who is excluded from which resources?
		Land distribution

APPENDIX B: INDICATOR THEMES AND MEASURES AT PROJECT LEVEL

Livelihood capital	Indicator theme	Examples of measures
Financial capital	Income and wealth	Agricultural Productivity and net returns at plot level, Farm profit
	Cost of production	Total seasonal management, organisation and maintenance expenditure
	Assets, savings	Change in livestock population
		Change in leased land
		Change in newly bought land
		Farm and household assets acquired
	Buyers and other value-chain participants of the targeted commodities integrate biodiversity criteria in the value chain	Trade volume of products adhering to biodiversity-friendly production practices and standards in a certain timeframe
	Financial products, biodiversity-friendly, available to the actors in the targeted commodities and countries	Number of Financial Institutes (FI) or commodity traders that adopt biodiversity-friendly financial products
		Number of traders accessing the biodiversity-friendly financial products
	Economic returns to investment	Net Present Worth (NPW), Benefit-Cost Ratio (BCR), and Internal Rate of Return (IRR)
Human capital	Agricultural training	Number of meetings small holders attended
		Number of demonstration plots visited or seen
		Percentage of population in intervention area adopting promoted AWM interventions
	Technology adaptation	Type of modifications made to technology Reasons for adaptation
Natural capital	Soil	Change in soil conservation areas
	Quantity and quality of water resources	Limits to well drilling due to arsenic levels Salinity filters
		Direct and indirect water use
		Duration of water availability for various uses (domestic and productive) by source
		Change in storage capacity of the landscape
	Production related	Yields (crops, forest, fruit)
		Number of farms that have changed production practices (i.e. adopted new production practices promoted by project)
		Change in crop diversification over certain timeframe
Physical capital	Water infrastructure	Change in surface water storage (e.g. capacity of ponds, tanks)
		Change in number of wells
		Change in seepage from canals and leakage from structures, resulting in change in conveyance
		Changes in infrastructure to improve access of livestock to system/infrastructure Increased canal and drain capacity, able to take design flows

Livelihood capital	Indicator theme	Examples of measures
Social capital	Institutions/governance for resource management	Increase in number of institutions over specific time-frame
	Policies	Number of policies that were added or improved to incorporate biodiversity concerns
		Number of entities that implemented recommended changes – i.e. sustainable management practices (BMPs), formal commitments to adhere to certain standards or P&C, adoption of land management plans
	Financial organisations	Fee water collection ratio
	Empowerment	Number of female participants in community organisations
		Amount of female representation in the management of water user bodies
Project Management	Management	Number of trained operational staff for water system
	Managed and monitored watershed area	
	Participation	Level of adaptation of work and staff to the local context
		Involvement of local people in project design and implementation
		Number of agenda items on biodiversity in village council meetings
		Involvement of local people in water management organisation
		Level of communication between community and extension agents
		Number of beneficiary families in poor communities supported

APPENDIX C: IDE SUGGESTED INDICATORS FOR M&E

Livelihood capital	Indicator theme	Suggested indicators in M&E framework of IDE
Financial capital	Income and wealth	Median of the amount and rate (per cent) of net annual income changes of project beneficiaries Farmers' net margin and sales volumes Percentage of retail price received by the farmer Percentage of net-income derived from crop sales
	Agricultural production	Not covered
	Cost of production	Change in use of purchased inputs by farmers Costs to obtain services
	Sources of income	Not covered
	Assets, savings	Farmers' risk management strategies to respond to market dynamics (prices, quality requirements, contract compliance, etc.)
	Access to capital/credit	Use of services by farmers and VC actors
	Business development	Not covered
	Economic returns to investment of donor	Total net farm HH income generated (absolute value and per dollar of donor investment)
Human capital	In and out migration	Not covered
	Agricultural training	Change in knowledge/capacity in production practices Abandonment rate of improved production practices Change in knowledge/capacity of farmers in proper use of inputs
	Literacy level	Not covered
	Schooling	Not covered
	Health	Not covered
	Food security/nutrition	Not covered
	Labour	Productivity per unit labour (i.e. implicit rural wage rate)
	Technology adaptation	Not covered
Natural capital	Soil	Soil quality: changes in salinity
	Water quality	Water quality: changes in salinity
	Hydrology	Changes in specific environmental parameters over the project period (e.g., groundwater levels) Water quantity: total water use relative to total resource availability
	Land use	Land use: change in irrigated area, slash-and-burn area, erosion Change in area for commercial production using improved production practices
	Forest/vegetation	Not covered
	Biodiversity management	Not covered
	Production related	Efficiency in natural resource use of traditional and IDE-promoted farming systems (irrigation, horticulture, crop varieties, etc.) Productivity per unit land Farmers' risk management strategies to respond to production condition dynamics (plagues, weather) Change in use of purchased inputs by farmers

Livelihood capital	Indicator theme	Suggested indicators in M&E framework of IDE
Natural capital	Irrigation related	Change in irrigated area using specific irrigation technologies Abandonment rate of specific irrigation technologies Change in productivity per unit water Change in knowledge / capacity in irrigation practice and efficient use of water resources
Physical capital	Infrastructure	Not covered
	Water infrastructure	Not covered
	Housing	Not covered
	Market	Body of evidence on market sustainability Ability among farmers to identify and respond to market opportunities Sales volume to the specific output markets (through the value chains) Number and organisational strength of marketing networks Change in number of service providers Change in number of clients of service providers
Social capital	Changes in knowledge exchange	Not covered
	Institutions/governance for resource management	Not covered
	Financial organisations	Number of smallholders/micro-small entrepreneurs (MSEs) linked with marketing networks
	Collective action	Not covered
	Empowerment	Qualitative impact on marginalised households and/or individuals within households
	Equity	Percentage of customers from marginalised groups
Project Management	Management	Not covered
	Participation	Cumulative and year-on-year increase in the number of project customers
	Customer satisfaction	Customer satisfaction with inputs (including quality, timeliness, etc.) Customer satisfaction with input suppliers (including service, technical advice, etc.) Customer satisfaction with services Quality of service to smallholders

APPENDIX D: MEASURES USED IN TWO IDE-INDIA EVALUATIONS

Livelihood capital and indicator themes of table 1	Internal assessment Impacts of Treadle pump (TERI report)	External assessment Impacts of Drip technology (Lemelson Foundation report)
Financial capital		
Income and wealth	Annual income	Increase in income
Agricultural production	Changes in cropping patterns Changes in size of cultivated area	Increased yield Factors leading to increase in income Higher cropping intensity Changes in cropping pattern Changes in input use Shift to high value crops
Cost of production	Cost of installation of pump Failure of the equipment, problems faced in operation, Cost of repair and maintenance	Decrease in cost of cultivation Cost of production
Sources of income	Primary and secondary occupation	Other sources of income
Assets, savings	Total land owned How is the increased income being utilised? For creating assets or for consumption?	How the increased income is being utilised (for creating assets or for consumption) How absolute saving in water was used (for irrigating more area and thus earn greater income?)
Access to capital/credit	Not covered	Not covered
Business development	Not covered	Not covered
Human capital		
In and out migration	Not covered	Not covered
Agricultural training	Not covered	Not covered
Literacy level	Not covered	Not covered
Schooling	Not covered	Not covered
Health	Not covered	Not covered
Food security/nutrition	Not covered	Change in food security
Labour	Hours of operation in rainy, winter and summer seasons Number of hours of diesel pump renting in rainy, winter and summer seasons	Not covered
Technology adaptation	Not covered	Not covered

Livelihood capital and indicator themes of table 1	Internal assessment Impacts of Treadle pump (TERI report)	External assessment Impacts of Drip technology (Lemelson Foundation report)
Natural capital		
Soil	Not covered	Not covered
Water quality	Not covered	Impact on source of water
Hydrology	Crops grown at present and before treadle pump adoption in rainy, winter and summer seasons	Change in area under cropping Average rainfall
Land use	Not covered	Not covered
Forest/vegetation	Not covered	Not covered
Natural capital		
Biodiversity management	Not covered	Not covered
Production related	Changes in cropping patterns	Increase in cropping intensity Changes in cropping patterns Extension of cropping season
	Not covered	Changes in inputs – level of inputs as well as type of inputs Changes in crop productivity
Irrigation related	Hours of operation in rainy, winter and summer seasons Number of hours of DP renting in rainy, winter and summer seasons	Changes in water use efficiency Savings in water used in absolute terms Change in area under drip
Physical capital		
Infrastructure	Not covered	Not covered
Water infrastructure	Device used at present, model, year of installation Use of diesel pump prior to treadle pump adoption Change in pattern of renting diesel pump (for non users) Diesel pump usage in rainy, winter and summer seasons	Not covered
Housing	Not covered	Not covered
Social capital		
Changes in knowledge exchange	Perception on treadle pump use (for non users) Perception on diesel pump use	Not covered
Institutions/governance for resource management	Not covered	Not covered
Financial organisations	Not covered	Not covered
Collective action	Not covered	Not covered
Empowerment	Not covered	Change in social status
Equity	Not covered	Not covered

APPENDIX E: MEASURES USED IN BASELINE ASSESSMENT OF RESOURCE-BASED LIVELIHOODS

Livelihood capital	Indicator theme	Measures used in Mkindo watershed, Tanzania
Financial capital	Income and wealth	Number of people dependent on similar use of resources
	Agricultural production	How much is sold and consumed?
	Cost of production	
	Sources of income	Proportion of income How much production is sold? Other sources of income? Relative importance of different sources of income
	Assets, savings	Other benefits from owning livestock?
	Access to capital/credit	
	Business development	
Human capital	In and out migration	
	Agricultural training	Have you had any training?
	Literacy level	
	Schooling	
	Health	Any health related issues?
	Food security/nutrition	
	Labour Technology adaptation	
Natural capital	Soil	
	Water quality	What is the water quality?
	Hydrology	Frequency of river water use How is water used? Was last year a good / normal / bad year for water availability? What are water rich and water poor areas?
	Land use	Area under crops, grazing, forest Quality of grazing land Seasonality of grazing area
	Forest/vegetation	How often is forest used? For what purpose?
	Biodiversity management	
	Production related	Type of crops, cropping pattern Use of fertilisers Number of harvests Average yield
	Irrigation related	Frequency of irrigation water use
Physical capital	Infrastructure	Where are the markets, how accessible are they?
	Water infrastructure	How is water transported to where it is needed? Reliability of water sources
	Housing	

Livelihood capital	Indicator theme	Measures used in Mkindo watershed, Tanzania
Social capital	Changes in knowledge exchange	
	Institutions/governance for resource management	Do you have issues with other users of land or water? How is the resource managed? What would improve crop or livestock management?
	Financial organisations	
	Collective action	Position in the community? How are communal resources managed?
	Empowerment	Who makes decisions about livestock and crop management? Who decides how to spend income from crops and livestock?
	Equity	Accessibility of water

APPENDIX F: METHODOLOGY FOR SYNTHESISED FRAMEWORKS

The frameworks used in the synthesis included: World Bank, 2008; IFAD, 2002; FAO, 1995; DFID, 1999; Layke, 2009; Palanisami *et al.*, 2009; UNEP, 2002; BACP, 2009; de Bruin, 2005. Several steps were taken to conduct the synthesis. First, a list was compiled of all indicators and their source. Similar indicators that were mentioned by multiple sources were summarised into one indicator that reflected the common information aim. When different units of measurement were mentioned, these were added between brackets. However, the scale at which the project operates affects which unit of measure is most relevant (e.g. field, crop, community, or watershed). Thus only the general description of the indicator was kept in the tables shown in appendices A and B.

Once the overall list of 138 indicators was generated, they were categorised according to the five capitals of livelihood assets: financial, human, natural, physical and social capital (DFID, 1999). Use of this framework for classification of indicators ensured that social, human, and environmental indicators would be included in the list. In some cases this division is too strict and one indicator could fall into several capitals. Those indicators were kept under the main asset they described. The examples of indicators and measures in the Appendices are a selection of the full list to represent the breadth of possibility but refrain from too much specificity. Care was taken to include indicators that were mentioned by most of the sources reviewed.

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