What is the technology?
AWD is a water-saving irrigation technology that farmers apply to save irrigation water use (and costs) without yield penalties. The rice field is alternately flooded and not flooded. Water depth is monitored using a field water pipe.

A perforated PVC pipe (10 cm diameter, 30 cm long, 5mm slot size at spacing of 5*5 cm) installed 10 cm above surface and 20 cm below surface. A number of such pipes are installed – with proportional distance. When water depth reaches 15-20 cm below the ground surface, irrigation is supplied. Depth of water supply in each irrigation cycle is about 5 cm (above ground surface). This applies in the transplanting phase: AWD implementation begins after direct wet seeding or transplanting. And from the 'booting' stage to ripening (milky stage) sufficient water level is maintained. To test if the pipe has been installed properly, when the field is flooded initially, the water level inside the tube and outside in the field should be the same.

The number of days between flooding and non-flooding will depend on a number of contextual factors (soil type, crop growth stage etc.). Since farmer needs to control water, rainfed rice cultivation is not suitable for AWD. Benefits of AWD include reduced irrigation costs and increased yields (both from increased acerage of rice – more water available – and yield benefits from appropriate irrigation). And while AWD reduces methane emissions (contributing to lower agricultural GHG) it does increase nitrous oxide emissions.

When were CGIAR involved in its development?
AWD was one of the water-saving technologies developed by IRRI and NARS partners within the water working group of the Irrigated Rice Research Consortium (IRRC) [IRRI outcome statement in 2006 PM]. IRRI started with Philippines and expanded to other countries in the SE Asian region (Myanmar, Vietnam, China etc.).
Clearly, IWMI was also involved along with CSIRO and specifically Chinese and Philippines NARS partners [IRRI outcome statement in 2010 PM].

Which CGIAR centers / CRPs have been involved in its development and what has been their role?
IRRI and IWMI along with NARS and research partners like CSIRO (clear attribution to IRRI work here, pg 4). But in some countries like China, AWD concepts developed independent of IRRI.

How might we define adoption?
A basic check would be the proper installation of the pipe used to monitor water level in the field, adequate number of pipes in each of the plots the farmer claims to have adopted AWD in, and if the farmer "dries" the plot between flooding.
Adoption is an on-going/continuous process – since the rice field needs to be alternately flooded and not flooded. Self-reporting on practice could be sufficient. However, since water depth and number of days field is dry can vary from one farmer to another, specific data (e.g. # of days between flooding, depth of water level in pipe) on this could be collected.
A 2001 synthesis suggests yield loss can be as high as 70% (hence, "Safe AWD"). Also note that one study developed an AWD score because farmers do not practice pure AWD – the score was based on the frequency with which farmers allow their soil to dry.

Which countries are relevant for a study of adoption?
Bangladesh, Philippines, Vietnam, China, Myanmar, Lao PDR. However, it may be helpful to prioritize sub-regions within each of these countries based on proportion of rainfed versus irrigated rice cultivated area (across seasons).

What evidence do we already have?
A number of publications documenting reduction in water usage for irrigation (15-30%), and the resulting reduction in irrigation costs as well as increased yields (5-10%) [Link to a good review]. At a larger scale, AWD can have positive environmental impacts by reducing withdrawal of groundwater for irrigated rice, and relatedly a reduction in GHG emissions (both methane from rice fields, and savings if motor pumps are engaged in such withdrawal).

Policy-wise, examples:
1. Philippines passed an order recommending AWD as a water-saving technology in Sep 2009. [40,000 farmers estimated to have adopted AWD since 2006, as of 2008, and it increased by another 40K by 2011 - 80,000 farmers]
2. Bangladesh's Department of Agricultural Extension (DAE) was asked to scale up AWD based on piloting results (on 460 demonstration plots, 25 districts). Combined with Syngenta's initiative – the target in 2010 was stated as 120,000 ha of Boro rice.
3. Syngenta trained 1200 employees with an intention of working with 50,000 Bangladesh farmers on AWD.
4. Vietnam's Ministry of Agriculture and Rural Development has targeted 3.2 mha of rice cultivation areas by 2020. [Around 40,000 farmers estimated to have adopted AWD]

Ideas / priorities for new data collection?
1. Expert opinion – with representatives from the extension system promoting AWD in the countries/sub-regions. Speak with Departments of Agriculture and Irrigation as well – in some countries, AWD is enforced by controlling irrigated water available to farmers.
2. HH survey – as a first step, follow-up any IA studies that have been done by IRRI (and IWMI)?
3. Remote sensing – there might be strong potential for remote sensing images to capture dry rice fields – the images would have to be taken in quick succession than normal though (intervals of 5-10 days)?

Conservation Agriculture

What is the technology?
Full CA adoption is conceived as being a package of 3 practices:

- Minimum soil disturbance / zero-tillage
- Permanent soil cover / mulching
- Crop rotation (FAO insists more than 2 crops, inc. 1 legume)

CA helps to protect the soil from erosion, particularly on sloping land. From a farmer's perspective, adoption can be profitable if there is a cost saving resulting from a lower number of plough passes than under conventional tillage, but this is dependent on the farm being mechanized to start with.

When were CGIAR involved in its development?
The origins of CA are in the years following the dust bowl in the US, and later in a farmers' organization in Argentina in the early 1980s. CIMMYT played a role in promoting adoption by helping test the technology in other regions - South Asia (Indo-Gangetic Plains) in the early 1990s and Sub-Saharan Africa (2000s). CIMMYT presumably feel that their role is in studying the technology to help facilitate the process of adoption where it could be beneficial to farmers.

Which CGIAR centers / CRPs have been involved in its development and what has been their role?
CIMMYT (Indo-Gangetic Plains; SSA)
ICRISAT to a lesser extent, in same regions
ICARDA in Central Asia

How might we define adoption?
In the Nebraska Declaration on CA (ISPC, 2013), the ISPC note that there is no fixed recipe for CA and an appropriate mix of practices is the only "optimal" package for a given farm, rather than a blanket recommendation.

For purposes of collecting data on adoption, certainly the constituent three practices listed should be studied and perhaps reported separately. These are not binary variables – the amount of tillage and the % of soil cover (and its duration in the season) are all relevant factors influencing soil health.

Which countries are relevant for a study of adoption?
SSA: Malawi, Zambia, Zimbabwe, Tanzania, Mozambique
South Asia: Bangladesh, India, Pakistan, Nepal
Latin America: Mexico
Central Asia / Middle East: Kyrgyzstan, Uzbekistan, Tajikistan, Turkmenistan, Kazakhstan, Iraq, Syria

What evidence do we already have?
FAO AQUASTAT reports area but there is little clarity on the basis for these figures – they come from a network of national-level experts.
Only limited evidence of adoption in SSA, despite lots of activity from CGIAR – suggests getting good adoption data should be high priority.
Erenstein has carried out a number of village-level surveys – where the village is the unit of analysis rather than the HH – in the Indo-Gangetic Plains. Bangladesh and Nepal not well documented.
CIMMYT and Mexican Government have out in major effort to promote conservation agriculture in Mexico.
Central Asia / Middle East: Possibly significant adoption of zero-tillage in Central Asia in large-scale mechanized systems. Iraq and Syria impossible to study at the moment.

Relevant papers / sources:
Arslan et al (2014) AGEE – Zambia
Andersson and D'Souza (2014) AGEE – Zimbabwe, Malawi and Zambia
LSMS-ISA Tanzania

Ideas / priorities for new data collection?
1. Expert opinion – We have data from FAO AQUASTAT but there are potentially significant sources of bias, as for any expert elicitation process, so comparing other methods to a few countries' AQUASTAT data would help calibrate these.
2. Remote sensing – Has been shown to work in a few papers (Daughtry et al, 2006 – for Iowa). There are likely many researchers working on this in CGIAR.
3. HH Survey – This is an LSMS-ISA priority area for Malawi, Tanzania, Uganda, Ethiopia

Cocoa Integrated Crop and Pest Management (ICPM)

What is the technology?
Cocoa Integrated Crop and Pest Management (ICPM) is a set of practices relating to good crop husbandry, pest and disease management, rational pesticide use, farm renewal, cocoa quality, including post-harvest operations like fermentation and drying (David 2005). Cocoa ICPM is often promoted through Farmer Field Schools (FFS).

When were CGIAR involved in its development?
Information on link between IITA research and specific cocoa ICPM practices is unclear. This will need to be clarified with IITA.
STCP started educating farmers via Farmer Field Schools (FFS) in 2003 (David 2005). It appears that they adapted a technique used in other contexts to fill the gap in extension systems (refer Grant Agreement EU-Cocoa Sector Support Programme – Phase 2)

Which CGIAR centers / CRPs have been involved in its development and what has been their role?

IITA – specifically Sustainable Tree Crops Programme. While they role in testing alternate extension delivery systems (FFS and Video Viewing Clubs) is clearer, role in development of specific cocoa ICPM practices needs documentation.

How might we define adoption?
While the broader practices (pruning, shade management, weeding, spraying fungicides till pod is moist but not until runoff, pod breaking fermentation and drying) can be named/identified, these crop management practices are site-specific and plant-specific. E.g. how much shade would depend on cocoa being grown as a mono-crop or with other trees. Cocoa ICPM encourages farmers to manage by observation. At the same time, evaluations of FFS suggest that some practices are taken up/more prevalent than others, and this could be the basis of classification (high, medium, low prevalence).

Which countries are relevant for a study of adoption?
All key countries where cocoa is grown, and where the Sustainable Tree Crops Program has pioneered Farmer Field Schools (FFS) techniques since 2003 to promote cocoa ICPM. That is, Ivory Coast, Ghana, Nigeria, Cameroon. And possibly, Liberia (IITA annual report 2007).

What evidence do we already have?
Gockowski et al. 2010 in their case study of 225 Ghanaian cocoa farmers found "Production practices were significantly modified in the year following training with notable increases registered in both the number of producers planting hand pollinated hybrid cocoa seedlings and in the area planted to hybrids. The effectiveness of pesticide application on farms of trained participants was significantly higher following training…In sum, farmer field school training and subsequent changes in management practices are estimated to have resulted in a net production increase of 14% for the average farmer field school participant." [DOI: 10.5191/jiaee.2010.17304]

Gockowski et al. 2009 found 59,126 households across 5 countries participating and benefitting from FFS. Same study estimates that the 12,000 cocoa farmers trained between Oct 2006 and Sep 2008 increased gross returns by 38% as a result of program efforts. The total ICPM hectarage of cocoa in 2007/08 was around 35,000 ha (Table 4). [IITA Outcome Evidence 6 in PM 2010).

Additional numbers to examine here http://www.researchintouse.com/nrk/RIUinfo/PF/CPP05.htm.

Velarde and Tomich 2006 state that FFS has improved skills of 13,000 farmers in three years and an additional 26,000 benefitted from farmer-to-farmer knowledge transfer.

Ideas / priorities for new data collection?
1. Expert opinion – from a subset of Farmer Field School trainees (master trainers?) in the STCP target countries. Focus Group Discussions (FDGs) with farmers as well, particularly for estimates of practices like pruning.
2. Potentially traders who sell insecticides/fungicides – indirectly determine reduced usage of fungicide for black pod
3. HH survey – A number of surveys to determine knowledge uptake and self-reported farmer behavioral/management practice change through Farmer Field Schools (FFS) have been done (in 2005 and 2009). There was also a survey of 4,426 hhs (4,034 produced cocoa) in Cameroon, Ghana, Ivory Coast and Nigeria in 2001/02 (Gockowski 2007), but unless the questionnaire captured cultivation practices it may not be helpful. However, independent confirmation of sustained cocoa ICPM (since 2009) in farmer fields would be helpful (a distant second step is increased cocoa yield in these countries and attribution to cocoa ICPM). Such a survey could help determine, for instance, if farmers have moved beyond initially (easily) adopted practices.
4. Potentially cocoa dealers – perceptions on quality of cocoa and increased production practices?

Agroforestry – "Fertilizer Trees"

What is the technology?
Ajayi et al (2006) "The cycle of fertilizer tree fallows begins when tree species are established as a pure stand or intercropped with food crops and they are allowed later to grow for one or two more years. The tree fallows are cut between 12 and 36 months after planting and the foliar biomass is incorporated into the soil during land preparation. The complete cycle of fertilizer tree fallows is a fallow phase of one or two years followed by a cropping phase (mainly maize) of 2-3 years. The major plant species used are *Sesbania sesban, Tephrosia vogelli, Tephrosia candida* and *Cajanus cajan*."

When were CGIAR involved in its development?
1988 through to now

Which CGIAR centers / CRPs have been involved in its development and what has been their role?
ICRAF. Ajayi et al (2006): "ICRAF's research and development efforts can be summarized as consisting of two main phases. The first was from 1988 to around 1996 when the focus was on research, firstly researcher managed research and then an expansion into farmer managed research…. the emphasis of ICRAFs efforts shifted after 1996 following the conclusion that the improved fallow system was beneficial both biologically and financially. Research areas began to reflect those associated with wider use, such as improving effectiveness and reach of seed and nursery systems, on institutional mechanisms for managing potential conflicts between tree growing and free grazing, identifying best-bet locations for testing or promoting improved fallows, and how to manage pests that may be associated with improved fallow species."

How might we define adoption?
Ajayi et al (2006) are thoughtful on this, though recognizing that the technology is in a early phase. "Those that have planted for a second time (on a reasonable size of land) might be called adopters while those still in a first cycle might best be called users. Some socioeconomic research took place before there were any true adopters while other studies have lumped together first time planters and among those planting repeatedly. To avoid confusion, we have opted to use the terms 'use' and 'users' though we realize that in many cases, this reflects bonafide adoption."

Which countries are relevant for a study of adoption?
Malawi, Kenya, Zambia, Zimbabwe, Tanzania, Niger

What evidence do we already have?
For Zambia, Ajayi et al present annual estimates over the years 1996-2003. The growth in numbers over that time (from approx 100 farmers in 1996 through to 77,500 farmers in 2003) seem to be somewhat dependent on a specific World Vision project which ended in 2002. We also have Arslan's paper, and the Zambia Rural Incomes and Livelihoods Survey (RILS), on which to draw for more updated summary data. Not clear if these species feature, or whether there are reliable data on fallows.

For Malawi, Tanzania and Niger we can look at LSMS-ISA options. The Niger case – of "Greening the Sahel" – is one that has attracted a lot of attention. The consensus is that farmers have planted a lot of trees in recent years. How much of that is fertilizer trees is unclear – the spur for planting them came from a policy that granted people tenure to trees on their land, preventing a tragedy of open access outcome where people would come into neighbouring farms and cut trees down.

For Kenya and Zimbabwe, ICRAF may have similar publications to the Ajayi paper.

Ideas / priorities for new data collection?
ICRAF are thinking a lot about how to define and measure adoption on of agroforestry generally. Any survey involving botanical experts identifying tree species will be costly to implement.

Integrated Soil Fertility Management (ISFM)

What is the technology?
Vanlauwe et al (2010) define ISFM as: "a set of soil fertility management practices that necessarily include the use of fertilizer, organic inputs and improved germplasm, combined with the knowledge of how to adapt these practices to local conditions, aimed at maximizing agronomic use efficiency of the applied nutrients and improving crop productivity. All inputs need to be managed following sound agronomic principles."

They distinguish between responsive fields (where improved germplasm and fertilizer will result result in yield gains) and non-responsive fields (where organic matter first needs to be built up before yield gains are seen).

When were CGIAR involved in its development?
The work to map out the diversity of African soils carried out by CIAT Tropical Soil Biology and Fertility Institue since the 1970-80s (Pedro Sanchez in particular) led to a focus on identifying specific constraints to the fertility and productivity of farmers' fields. Steep fertility gradients have been recorded within the same field, based on inherent differences SOM content, but also the history of management of the field. ISFM is proposed as a step-wise process for increasing fertility of even quite unresponsive soils.

Which CGIAR centers / CRPs have been involved in its development and what has been their role?
This work originates with CIAT and the TSBF in particular. IITA have also been involved since Vanlauwe moved there.

How might we define adoption?
Vanlauwe et al (2010): "Complete ISFM comprises the use of improved germplasm, fertilizer, appropriate organic resource management and local adaptation…. The different steps are part of ISFM, but only when all steps are taken can one expect maximal AE (agronomic efficiency) or 'complete' ISFM. For instance, a farmer adopting good agronomic practices for applied fertilizer is going to improve the AE of those inputs and is thus implementing one component of ISFM. However, land managers can only be considered complete ISFM practitioners when they also recycle organic inputs, plant improved germplasm, and the use the required accompanying measures."

Which countries are relevant for a study of adoption?
Kenya (in particular), Rwanda, Burundi, DRC

What evidence do we already have?
SPIA co-funded a follow-up survey in Kenya to a set of farmer-managed on-farm trials. Karen Macours and Rachid Laajaj from the Paris School of Economics continue to work with Bernard Vanlauwe on examining the adoption dynamics in 96 villages in Siaya province.

Currently not aware of any large-scale adoption survey. Given the knowledge-intensive nature of the technology, adoption is perhaps unlikely to spread spontaneous very easily outside of project areas where the approach has been introduced to farmers through a concerted effort in farmer field schools and similar.

Ideas / priorities for new data collection?
Expert opinion – Would need cooperation with Van Lauwe and colleagues.
HH survey – Currently unclear on countries and districts that we would prioritise for data collection.
Remote sensing – Not going to work with this set of practices.

Micro-dosing – precision-farming technique to improve fertilizer use

What is the technology?
Apply small quantities of fertilizer with the seed at planting time or as top dressing 3-4 weeks after emergence. Farmers apply about 2-6 grams of mineral fertilizer in the hole where the seed is placed at the time of planting. However, this technique can be time-consuming and laborious. Some farmers mix the seed and mineral fertilizer together. But if the mix ratio is not appropriate, this can damage seed or young plant, particularly if there is insufficient moisture. Farmers also report difficulties in ensuring the correct dose of fertilizer is applied.

Correcting for soil deficiencies can help the plant root systems develop better to capture more water (therefore, increasing yields). Maize, millet and sorghum are susceptible to striga (weed), and micro-dosing can help the plant can tolerate effects of striga.

When were CGIAR involved in its development?
ICRISAT developed this precision-farming technique starting mid- to late- 1990s , starting with simulation modeling on resource-allocation constraints in semi-arid regions of Southern Africa in collaboration with CIMMYT. University of Hohenheim and International Fertilizer Development Center are also said to have been involved in this development.

Which CGIAR centers / CRPs have been involved in its development and what has been their role?
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How might we define adoption?
Identifying the practice is simple: placement of *mineral fertilizer* along with seeds in the hole during planting, or spreading of *mineral fertilizer* as top dressing. Note, farmers in many countries have a traditional practice of digging holes and filling it with manure in hard soils before the rains start – to ensure rain water is captured in the hole.

Which countries are relevant for a study of adoption?
West/Central Africa: Mali, Burkina Faso, and Niger
Kenya – East Africa
Southern Africa: South Africa, Zimbabwe, Mozambique
In these countries, micro-dosing is promoted in combination with warrantage, and this could be worth documenting.

What evidence do we already have?
All of the below are claims made in various documents

5. 25,000 sorghum and millet farmers in West Africa reported to have adopted micro-dosing as of 2009, with a target of 500,000 for the next few years.
6. In Zimbabwe, the claim (July 2012) is that 170,000 households increased cereal production yields, resulting in reduced food imports. Wide-scale testing of micro-dosing technique was initiated in 2003/04 by ICRISAT – with claims that at least 160,000 households received support each year.
7. 1.2 million hectares exposed to micro-dosing practice – unclear if this is just Niger.
8. Winrock International (per outcome statement in 2007) intends to promote micro-dosing with warrantage in 6150 rural communities across 3 regions in Mali.
9. AGRA has targeted 360,000 farmers in West Africa (Niger, Mali, Burkina Faso) for micro-dosing (ICRISAT "jewels" blog as well as 2010 annual report) by end of 2012.

[Evidence on impacts – Winter-Nelson et al. 2013, Impact of Fertiliser Microdosing Research and Development in semi-arid Zimbabwe]

Ideas / priorities for new data collection?
1. Expert opinion – of agricultural extension workers, as well as fertilizer (and maybe even seed) dealers. The latter might be able to report on proportion of clientele who they think practice micro-dosing based on conversations they have.
2. HH surveys – self-reporting on micro-dosing with/without Zia. Potentially, follow-up on older surveys – especially pilots – to get a sense of average attrition rates as well as diffusion over time. For instance, Mali 900 demonstration plots implemented in 2010. Trials with 5000 farmers in Niger since 1996.
3. Drones or remote sensing – indirectly to get a sense of areas where the practice of digging holes and planting is common?