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**“Bridging Knowledge Gaps between
Soils Research and Dissemination in Ghana”
(DFID Project R7516)**



**A case study of cover crop knowledge storage
and information flow**

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A Case study of cover crop knowledge storage and information flow

The case study set out to identify the constraints to the transfer of knowledge of soil fertility management in Ghana and to suggest improvements through the consideration of the case of knowledge transfer about cover crop technologies in the Brong Ahafo region. The case study assessed:

- knowledge storage at the international level, and implications for knowledge transfer to the National Agricultural Research System in Ghana
- knowledge storage and transfer within the National Agricultural Research System
- knowledge transfer to the National Agricultural Extension System and to farmers

Methodology

The following activities were carried out as part of the case study:

1. A cover crop knowledge base (cover crops.kb) was created using the Agroforestry Knowledge Toolkit for Windows (WinAKT) software (Dixon *et al.*, 1999; Sinclair and Walker, 1998 and Walker and Sinclair, 1998). This was intended to assess knowledge flow and to document knowledge storage. Internationally held knowledge of cover crops and knowledge held by members of the the National Agricultural Research System and the National Agricultural Extension System was entered. This was undertaken in Ghana, where the majority of information available concerns Mucuna species as these have been better researched than other cover crops and therefore the majority of the statements in the knowledge base are about mucuna. Knowledge about cover crops was taken from reviews, articles, conference proceedings, extension leaflets and interviews with national researchers and extension workers.
2. Members of the National Agricultural Research System who have worked with cover crops were interviewed to gauge their perceptions on the ease of access to information. Only a small number of researchers (four) could be interviewed due to the small number of researchers working on cover crops in Ghana, and their availability during the lifetime of the project (5 weeks for the case study), however their responses were revealing.
3. A database of sources of information about cover crops with particular emphasis on West Africa was created using Microsoft Access. Only major sources of easily accessible or recent information were considered. They include databases, mailing lists, websites, reviews and conference proceedings.

Constraints to knowledge storage and knowledge flow were assessed from the above.

The compilation and storage of knowledge generated through international research

Documented knowledge is stored, distributed and exchanged within the international community in the form of newsletters, websites, electronic discussion groups, databases, conferences, books and journals. A database of information sources on cover crops with particular reference to sources which synthesise large bodies of information or provide recent information on research and development activities in West Africa was created in Microsoft Access (cover crops.mdb) and may be consulted for further details. Undocumented knowledge is exchanged through networking activities which are facilitated through networks, conferences, newsletters, websites, electronic discussion groups and email.

Newsletters

The Centre for Cover Crops Information and Seed Exchange in Africa's (CIEPCA) Cover Crop newsletter carries recent information about cover crop research and development activities, with a focus on Africa. Its objectives include the collection, translation and dissemination of information on cover crops, documentation of adoption and facilitation of information exchange (CIEPCA, 1998). It carries abstracts of reports and articles, information on seed distribution, workshops, conferences and other sources of cover crop information. CIEPCA has also recently commenced publication of a further newsletter – Mucuna News, devoted to the food and feed potential of mucuna (CIEPCA, 2001b). The International Cover Crops Clearinghouse (CIDICCO), a Central American organization, also publishes a newsletter that might offer incites into farmer uptake of cover crops, but this is little received in Ghana.

Databases

A number of electronic databases with information on cover crops exist. Kiff *et al.*, (1996) Cover crops database contains information on 88 cover crops but has been rapidly superceded by IITA's LEXSYS (Legume Expert System) which has information on over 100 tropical herbaceous legumes with 45 searchable selection criteria (Weber *et al.*, 1997). It is designed to support on-farm researchers to select the most promising legume based technologies for specific farming systems for further trials. The Organic Resources Database synthesises a large body of data on the feed and plant nutrient quality of various organic substances and is intended for researchers studying the composition, decomposition and digestibility of tropical and sub-tropical plants (Gachengo *et al.*, 1998). Databases less relevant to Africa are the Illustrated Legume Genetic Resources Database being developed in Japan (MAFF, 2001) and the UC SAREP Cover Crop Database developed in the USA (UCSAREP, 2001). The International Legume Database and Information Service (ILDIS) provides information on the taxonomy, biogeography and phenology of legumes (ILDIS, 2000).

Websites

The International Development Research Centre (IDRC), Canada, CIEPCA, CIDICCO, the Management of Organic Inputs in Soils of the Tropics (MOIST) at Cornell University, USA and ECHO all have interesting websites with information on cover crop research and development activities, publications and links to other resources (IDRC, 2001; CIEPCA, 2001a; CIDICCO, 2001; CIIFAD-MOIST, 2001; ECHO, 2001).

Electronic discussion groups

There is an English language discussion group, MULCH-L with searchable archives. There are also French and Spanish language discussion groups - EVECS-L and COBERAGRI-L. All three are open to everyone. CCropnet is a restricted access discussion group for those researchers taking part in the Cover Crop Network's experimental trials in West Africa (MOIST, 2001).

Other sources

Conference proceedings and species reviews form the other sources of information devoted to cover crops in Africa. Carsky *et al.* (1998) reviewed mucuna targeting scientists developing and testing crop and/or livestock systems using this cover crop. The proceedings of two cover crop workshops held in West Africa are also available (Carsky *et al.*, 2000; Buckles *et al.*, 1998).

Table 1 : Internationally documented cover crop knowledge and its accessibility to researchers in Ghana

Form of storage	Sources of information about cover crops most relevant to researchers in West Africa	Information	Requirements for use
Newsletters	<ul style="list-style-type: none"> • CIEPCA newsletter 	<ul style="list-style-type: none"> • Information on recent regional developments in cover crops research and development. Gives other sources of potentially useful information 	<ul style="list-style-type: none"> • Distribution is free
Databases	<ul style="list-style-type: none"> • Mucuna News: developing multiple uses for a proven green manure/cover crop • Cover crops: a review and database for field users • LEXSYS 2.1(Legume Expert System) • Organic Resources Database version 3.0 	<ul style="list-style-type: none"> • Recent research on food and feed potential of mucuna • Cover crops and LEXSYS synthesise large amounts of information to enable users to make initial selections of promising species for field trials • Synthesises large amounts of information on plant nutrient and feed quality of various species and organic substances • Provide information on recent and ongoing research and development activities and refer readers to other sources of potentially useful information 	<ul style="list-style-type: none"> • Distribution is free • Computer access • Computer skills • Appropriate software • Computer access • Computer skills • Appropriate software • Internet access
Websites	<ul style="list-style-type: none"> • Management of Organic Inputs in Soils of the Tropics (MOIST) • Cover Crops for Sustainable Agriculture • CCropNet Web Site 		
Electronic discussion groups	<ul style="list-style-type: none"> • EVECS-L (list on Green Manures and Cover Crops for Soil) • MULCH-L 	<ul style="list-style-type: none"> • On-line discussion for exchange of information 	<ul style="list-style-type: none"> • Email access
Conferences and conference proceedings	<ul style="list-style-type: none"> • Buckles <i>et al.</i>, 1998 • Carsky <i>et al.</i>, 2000 	<ul style="list-style-type: none"> • Provide a forum for information exchange on recent regional developments in cover crop research and development 	<ul style="list-style-type: none"> • Invitations and funds to attend conferences, proceedings may be distributed free when requested
Journals and books	<ul style="list-style-type: none"> • Mucuna: herbaceous cover legume with potential for multiple uses. Resource and Crop Management Research Monograph No. 25 • Various other journals and publications 	<ul style="list-style-type: none"> • IITA's Mucuna monograph documents the state of knowledge on mucuna as of 1998 and is aimed at researchers in Africa • Recent research findings 	<ul style="list-style-type: none"> • Distribution is free • Access to recent journals

Documentation of knowledge within the National Agricultural Research System

Documented knowledge is stored, distributed and exchanged within the national research community predominantly in the form of conferences and conference proceedings, journals, theses and reports. These documents are found in the libraries of research institutes and in the keeping of individual researchers.

Journals and conference proceedings

Journals relevant to cover crop researchers include the Ghanaian Journal of Science, the Journal of the Ghana Science Association and the Soil Science Society of Ghana. However the publication of Ghanaian journals and conference proceedings is often delayed and several years of contributions may be published in one issue.

Internal documentation and reporting

Within the research institutions documentation and distribution of knowledge in the form of internal reports is relatively minimal. The Soil Research Institute and the Crops Research Institute both have annual reports but these are not produced every year. The National Agricultural Research Project produced a newsletter. During the case study the researcher was not referred to and did not find any internal reports or unpublished documents with relevant information on cover crops. This suggests that although some compilation of information on current and ongoing research may take place within institutes, including annual planning sessions where researchers present the results of their years work to their colleagues within the institute, this information is not then made easily available in written form. Cover crop researchers referred to their own notes and their published work to expand on points made during their interviews. Written reports are more common as part of external project requirements.

Knowledge transfer to and within the National Agricultural Research System

Access to documented agricultural information within information centres and libraries in Ghana

The provision of services by local information centers and libraries in agricultural research organizations in Ghana is largely dependent on recent receipt of external (non governmental) funding. Organizations that have received external financial support may be able to provide their researchers with recent journals, new books, CDROM search facilities and email and internet access. In the year 2000 these included FORIG (the Forestry Research Institute of Ghana) and GOAN (Ghana Organic Agriculture Association). Where libraries are underfunded journal subscriptions are out of date, there are few recent publications, cataloguing and shelving are neglected, there are no computers and staff are demoralized. Nevertheless, where other options are unavailable these libraries remain important sources of information for agricultural scientists due to their easy accessibility, although the resources available tend to be dated.

Within Kumasi there are a number of institutes and organizations focusing on agricultural research and extension that have libraries and information centers and researchers who do not have access to up-to-date resources in their own institutes are able to use the resources in other libraries. However not all the research organizations are in one part of the town and visiting the other institutes is only feasible when time and transport are available.

CTA (Technical Centre for Agricultural and Rural Cooperation) has provided a Question and Answer service on demand to researchers in Ghana since 1985. This service was modified and launched as GAINS (Ghana Agricultural Information Service) Question and Answer Service in February 2000. It is based in INSTI (Institute for Scientific and Technological Information of CSIR) in Accra and combines the functions of a search service and interlibrary loan. It responds to requests by sending out information in the form of abstracts, full length articles and lists of further references. The CSIR agricultural institutes, the Faculties of Agriculture at the three universities and MOFA all have access to it. Information resources available through GAINS include the GHAGRI database (the Ghana Agricultural Research Information database developed under NARP), CD Roms (e.g. CROPCD) and other resources. Requests using the service take about 2 weeks and can be applied for directly by email or through the librarian. A website is also planned. The system provides a way in which agricultural information resources built up through donor funds can be shared with all agricultural researchers in Ghana. Although not all researchers are aware of GAINS, it publishes a quarterly newsletter and this situation is likely to improve in future. CTA has also widely distributed the TEEAL CD ROM¹ to libraries and individual researchers (not all institute libraries have computers) and other CD ROMs are also available in a number of institutions. CD ROMs are generally 3 – 5 years old.

Use of available information on cover crops by researchers in Ghana

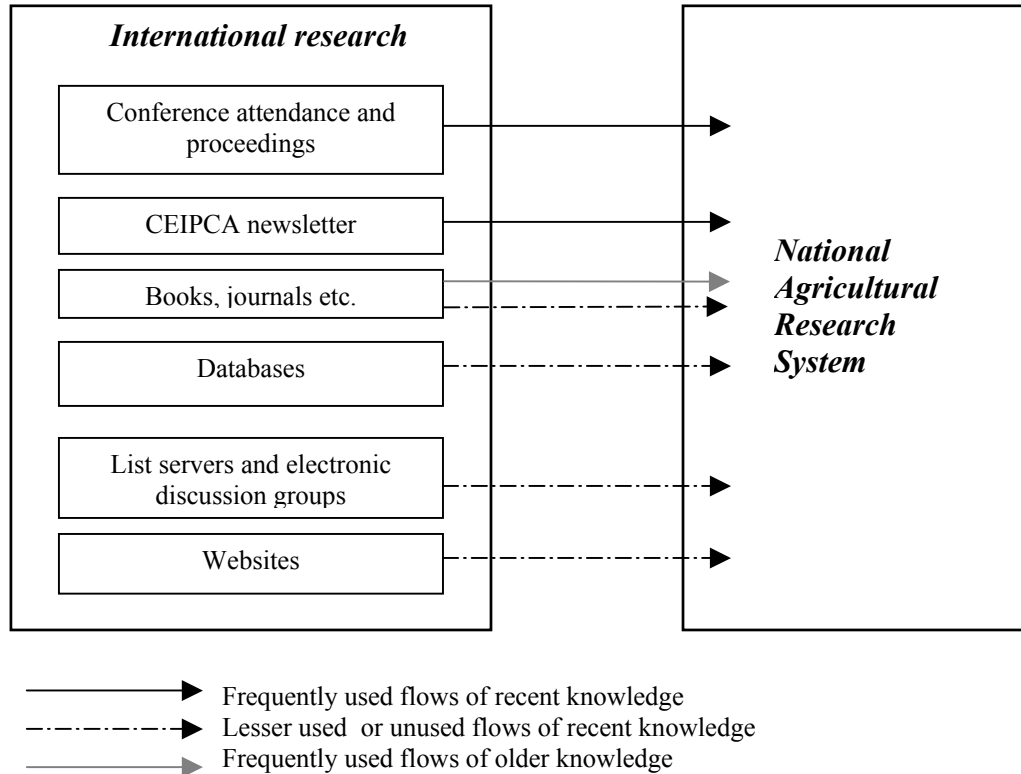
Interviews with cover crop researchers found that freely distributed newsletters, conferences (with attendance sponsored by external donors) and conference proceedings are important in the transfer of documented knowledge and the exchange of undocumented knowledge with international researchers. CEIPCA's newsletter is widely received by researchers in Ghana. However there is little use of cover crop databases, websites or electronic discussion groups due to the limited availability of computers and the internet. Researchers may also lack awareness of the utility of these types of resources although their application has been publicised in the CIEPCA newsletter.

Access to and use of recent books and other publications is greater amongst those researchers who have successfully established contacts with international organisations and researchers (which are facilitated by access to email and conference attendance). Books and journals in research institute libraries tend to be dated, but are used. Researchers who are part of the CTA sponsorship scheme can order up to 100 credits of books from CTA every year at no charge. Although literature searches through GAINS make

¹ TEEAL: The Essential Electronic Agricultural Library database which has full text versions of 130 of the worlds core agricultural primary journals

access to a wide selection of literature possible, it is still difficult to obtain articles published in the last one or two years, which may be necessary for a researcher to publish in international journals.

Figure 1: Knowledge flow from the research community to the National Agricultural Research System in Ghana



National and regional cover crop networking

The Ghana Cover Crop Network was created in 1999 in order to improve co-ordination amongst cover crop researchers and extensionists in Ghana. It is intended to improve information exchange and co-ordination of activities and to share experiences (Anthofer, 2000). It holds annual meetings in Kumasi. Within Kumasi and the Brong Ahafo region cover crop workers are aware of one another's activities but there is less communication with other areas of the country. The co-ordinator of the cover crop network based at CRI in Kumasi has served as a resource person on a number of externally funded projects, but other cover crop researchers are less well known.

IITA has evaluated the use of internet technologies for networking amongst cover crop researchers in national research and extension organisations, universities, NGOs, and international agricultural research centres through the Cover Crops Network (CCROPNET) experiment set up in January 1999 (Tarawali *et al.*, 2000). About 60 researchers working at 26 sites in 8 countries took part. They were divided into those who already had email access, those whom the experiment connected and those without email access. They established trials of two species of mucuna and communicated through email and an electronic discussion group (CEIPCA, 2001). Within Ghana 4 sets of trials were planned, and three were completed. Electronic networking was considered to facilitate management of the trials.

Constraints to knowledge transfer

Researchers in Ghana are overall at a disadvantage in terms of access to recent information for planning cover crop trials in comparison with their colleagues in developed countries or working in international research centres. Although it is possible to obtain access to information in Ghana it requires more effort and time and may need to be financed out of the researchers' own pocket.

Access to computers, email and the internet are very important for obtaining recent information and communicating with researchers in other countries, however access in Ghana is limited. Within the research institutes and the universities there are a large number of users to computers available. Besides installing the equipment, continued maintenance and staff training required for continuous functioning is costly and not always available. Amongst researchers, younger generations are more likely to have the knowledge and skills required to use computer facilities, but as more junior researchers, are less likely to have access. Senior researchers may have computers in their offices but belong to an older generation used to giving typing to a secretary to carry out and they may lack the skills to use them.

Internet and email facilities only arrived in Kumasi in the last few years. Internet cafes are a recent addition to the businesses of Kumasi, but their numbers are growing. Access to email and the internet is limited (frequently unavailable) within CSIR institutes and the universities. Scientists may use resources elsewhere (usually internet cafes) but must fund these using their own resources, and government salaries to do so are low. This situation appears to be similar in other parts of West Africa. Tarawali *et al.* (2000) noted that although the cover crop electronic networking experiment showed the medium of communication to have tremendous potential, the amount of communication possible was limited by technical and financial difficulties.

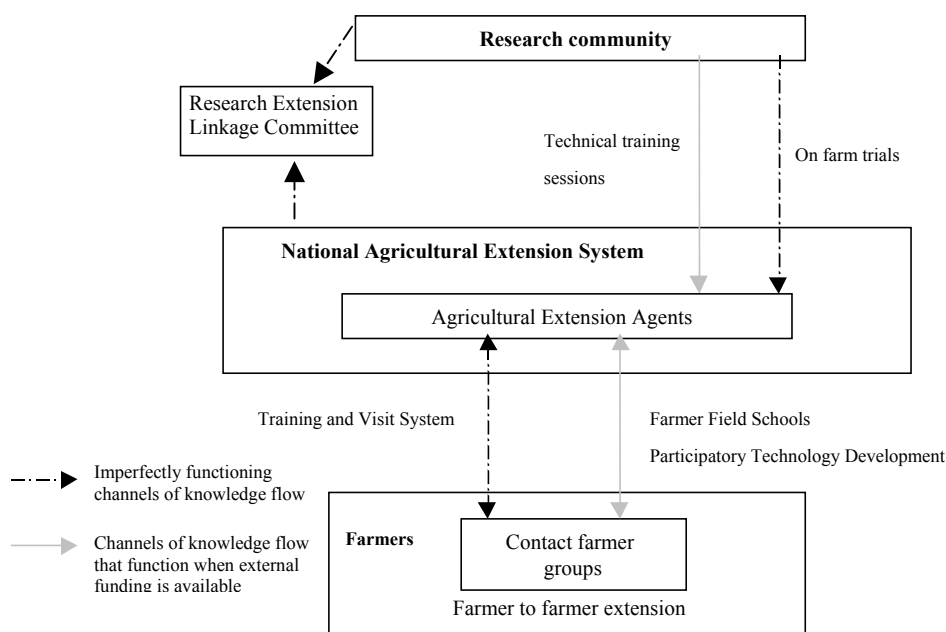
Due to the difficulties in publishing information in Ghana and the lack of internal reporting, a substantial amount of information remains undocumented and unshared with the rest of the scientific community. Researchers tend to be secretive about their research and unwilling to share the results until they have been published for fear that others will publish their work without acknowledging them. (An instance of this nature was found to have occurred in the cover crop case study). Furthermore there is less of a tradition of open sharing of information. Tarawali *et al.* (2000) notes that collaborators in the Ccover crop trials were not used to communicating through email informally and exchanging information freely. Competition between institutes to obtain donor funding for research (on which the salaries and careers of individual researchers depend) may influence cooperation.

Knowledge flow to the extension system and to farmers

MOFA's Unified Extension System approach uses the Training and Visit model. In addition a number of more participatory approaches including Farmer Field Schools and Participatory Technology Development have been implemented through donor assisted location specific projects.

There has been no coordinated extension program for the promotion of cover crops in the Brong Ahafo region and information about cover crops is not part of MOFA's usual extension messages. Knowledge transfer has taken place from the NARS to the extension system and farmers as part of externally funded projects and during the outreach work (on farm verification trials) of scientists from CRI. In the Brong Ahafo region the Sedentary Farming Systems (SFSP) and the Integrated Food Crop Systems Project (IFCSP) have promoted cover crops and green manures to farmers.

Figure 2: The National Agricultural Extension System



The Unified Extension System

The Unified Extension System channels all extension messages² through a single extension agent. It was supported by the World Bank through the National Agricultural Extension Project (NAEP) from 1992 to 1999. Under this system Agricultural Extension Agents (AEAs) attended monthly training sessions and visited groups of around 10 contact farmers every fortnight. AEAs held group meetings, demonstrated technologies and interacted with individual farmers. Technical review meetings, on farm trials and demonstrations, and Research Extension Liaison Committees (RELCs) were intended to ensure effective linkages between research and extension.

Under the Unified Extension System AEAs are expected to make 16 visits each month to relatively remote locations. Motorbikes, together with allowances for fuel and maintenance are considered necessary. Hence the system is relatively resource intensive and since the funding of NAEP has finished this system of knowledge transfer has broken down. RELC meetings are not held, extension agents do not receive regular monthly trainings and AEAs 'T and T' (finance for Travel and Transport that enables extension agents to meet their farmers) is not forthcoming.

² Cocoa and coffee were formally the remit of the Cocoa Services Division (CSD) until December 2000 when CSD field officers were redeployed to MOFA and cocoa came under MOFA's remit (MOFA, 2001).

Even during the lifetime of the project the funding available for extension activities was low and promotions were slow. Financial constraints are recognized in the new agricultural extension policy which notes that the release of funds from the Ministry of Finance is untimely and inadequate, and that there is over reliance by the government on external funding arrangements (MOFA, 2001). Salaries within MOFA are low for both junior and senior staff and T and T allowances are insufficient for the number of village visits that AEAs are expected to make. Morale within MOFA is therefore low, some staff are not well motivated, even the most dedicated cannot finance their work from their own pockets and all have to invest time in other income generating activities. Furthermore, the lack of finance available for extension activities has been compounded by the mismanagement of resources that has been known to occur within MOFA (whereby e.g. vehicles procured for specific projects are not made available for the activities for which they are intended).

MOFA has recently reviewed its agricultural extension policy in view the government's decentralization policy which has shifted the responsibility for extension service provision from central to local government (MOFA, 2001). District assemblies will eventually be responsible for the organization and funding of their own extension services while national and regional MOFA Directorates will focus on policy planning, co-ordination, technical backstopping, monitoring and evaluation. The new extension policy aims to deliver a 'more demand driven, client focused service'. It means to do this through the formation of Farmer Based Organizations (FBO) and by increasing user payment for extension services. It envisages that the private sector and NGOs will play a greater role in extension delivery although free public sector services will be maintained for small scale farmers. However there are currently no concrete plans for altering the T and V model of extension currently in use by the public sector, although other 'experimental' approaches to extension that are used by donor assisted projects will be monitored and human resource development will take place including the training of AEAs in alternative extension methods.

AEA trainings on cover crop use have only taken place through donor assisted projects where funds have become available and at the initiative of the project. Research projects implemented in collaboration with MOFA commonly utilize extension agents for carrying out on-farm work. The Integrated Food Crop Systems Project which was completed in 2000 undertook participatory experiments on farmers' fields using mucuna and canavalia species as green manures for tomato production. The Sedentary Farming Systems Project which has been in existence since 1996, is developing and promoting the incorporation of mucuna, canavalia and other cover crop species into farming systems in three pilot districts. Knowledge transfer about cover crops has also taken place through the outreach work of the Crop Research Institute whose researchers work with AEAs to test newly packaged technologies on farmers fields. However, researchers at the institute again complain that since funding from CIDA for the Ghana Grains Development Project has finished less outreach work has been carried out.

Promotion of cover crops through Participatory Technology Development: the Sedentary Farming Systems Project in the Brong Ahafo Region

The Sedentary Farming Systems Project (SFSP) which is funded by GTZ (the German Development Co-operation) was initiated in 1996 to develop sustainable sedentary farming systems in the Brong Ahafo region. The project operates in three pilot districts, each representing a different agro-ecological zone. These are Asunafo in the forest zone, Sunyani in the transition zone and Atebubu in the Guinea savanna zone. All the project's activities are carried out through the Ministry of Food and Agriculture whose extension agents act as the direct links between the project and the farmers (Anthofer, 2000).

Initially, for the soil fertility conservation and management element of the project, 15 farmers from each district known to be innovators attended a farmers' fora and each agreed to host one demonstration site comprising a test plot 20m x 20m and an adjacent plot of the same size representing farmer's practice. Soil fertility technologies offered to them included alley cropping, live stakes for yam, improved fallows, contour planting, animal manure and cover cropping. Extension agents carried out regular field visits and farmer field days and farmer-to-farmer cross visits were held.

The following year the number of farmers participating in each district was increased to 50. In 1999 the project adopted the PTD approach and the mucuna technology was developed with the aid of a German PHD student who worked closely with the extension agents and the farmers (Anthofer, 2000). In the

year 2000 the project recorded over 240 farmers working with cover crops in their three pilot districts (SFSP, unpublished). Mucuna predominated in the drier areas and Canavalia in the wetter areas where intercropping is more common and the potential of mucuna is limited. The technology was starting to spread from farmer to farmer without as much contact with the extension agent and community motivators aid AEAs to organise farmers.

The project has worked very closely with the agricultural extension agents who form direct links with farmers. Staff are carefully chosen and are generally the better motivated and hard working of the AEAs. Other higher level district MOFA staff are also involved. Staff have received training in PRA, problem identification and solution finding, community organization and mobilization and attend regular PTD meetings.

Since 1996 the project has learnt a number of lessons about technology transfer. Some of the obstacles to technology transfer which have been brought to light by the project's collaboration with MOFA are outlined below (GTZ/MOFA 2000a; GTZ/MOFA 2000b):

1. Absence of a pro-active approach on the part of MOFA District Directors of Agriculture and other district MOFA staff to gathering information about new and interesting technologies
Although the project has developed a number of interesting technologies in the three pilot districts, interest in and knowledge of the project in non-pilot districts in the Brong Ahafo region has been limited. District Directors of Agriculture have traditionally waited for directives from above or invitations from projects, rather than displaying a more pro-active approach to information gathering. Lack of funding for information gathering exercises and for implementation of resulting activities such as training sessions also contribute. However more initiative will be required from the MOFA district offices due to decentralisation, including the securing of funds for development activities.
2. Insufficient marketing of the outputs of research by agencies such as projects and NGOs to MOFA at district level (in the absence of the functioning of other pathways for the transfer of information)
Although networking activities exist for cover crops in Ghana through the Ghana Cover Crop Network, this is a highly specialised forum which might not be appropriate for District Directors of Agriculture. Projects could make more effort to publicise themselves and their activities to potentially interested parties in other districts and the workshop suggested a desk officer at regional level to improve effective networking.
3. Over burdening of extension agents with technical knowledge under the Unified Extension System
The Unified Extension System puts a large burden on extension agents in expecting them to be conversant with all agricultural topics. This is unrealistic. The workshop suggested that in future AEAs should play the role of facilitator between the farmer and source of information. This will modification of the type and form of information currently available at district level which is currently insufficient.
4. Packaging of technologies may require adaptation to specific target groups
The Brong Ahafo region may exhibit sufficient diversity for the presentation of technologies to require greater flexibility to satisfy the demands specific to different farming systems or target groups. Technologies such as cover crops need to be presented to farmers in ways in which farmers can perceive that they are relevant to their cropping systems.
5. Correcting farmers' mis-perceptions about the role of the project and its activities
The way in which extension agents hold group meetings and present technologies to farmers influences farmers perceptions about the role of the project and its activities. Group meetings held in places of local political, religious or other social or cultural significance (e.g. churches) influence attendance at group meetings and interest in project activities, potentially marginalising some members of the community. The same problems occur when the project aligns itself with existing institutional structures such as traditional or political leadership or uses pre-existing, inappropriate groups for its activities. Furthermore, farmers easily hold incorrect expectations about what a project will provide, and attempt to communicate their problems accordingly in PRA exercises e.g. constant reference to inadequate credit facilities and the expense of inputs in the expectation that the project can provide these. Extension agents must reshape expectations within

the community in a respectful manner and with an appropriate choice of language (e.g. not referring to ‘white people’ or ‘the project’).

6. Improvements in training of AEAs for more effective communication at village level

AEAs prefer to deliver packaged technologies as this minimises their requirements to think through the implications of the recommendations that they are making. AEA training should ideally take place in an environment closer to that the AEA will be working in (the village level) and include aspects and techniques applied in adult education. Trainings and workshops should include follow-up activities to support the implementation of the information obtained.

Knowledge transfer about cover crops

Fitting cover crops into farmers’ cropping systems

Looz *et al.* (in press) describes a number of potential cover crop systems for the Brong Ahafo region (table 2), most of which refer to mucuna which is the best researched cover crop in Ghana.

Table 2: Potential cover crop systems for the Brong Ahafo region (adapted from Looz et al., in press)

Cover crop	Crop	Integration of cover crop	Suitability – agro-ecological zone	Suitability – crop rotation
Mucuna	Maize	Long duration mucuna intercropped with major season maize at tasselling stage (mid June to mid July) and left to develop during the minor season	Areas with two rainy seasons	Maize/fallow
Mucuna	Maize	Medium/ early maturing mucuna planted at the onset of the minor season.	Areas with two rainy seasons	Maize/fallow where the maize is planted late (after April)
Mucuna	Maize	Mucuna fallow planted in the major season in March/April and followed by minor season maize.	Areas with two rainy seasons where minor season rains are now more reliable than major season rains.	Fallow/maize
Mucuna	Any	Long duration mucuna is planted and left for a year	Drier areas with only one rainy season	Land is out of use for a year
Mucuna	Yam	Mucuna intercropped with yam, the mucuna is planted in the minor season, two to three months prior to the harvest of the yam	Areas with two rainy seasons	Sole yam
Mucuna	Rice	Minor season mucuna fallows in upland or valley bottom rice production systems	Grown on residual soil moisture	Grown in rotation with rice
Mucuna or D. lablab	Perennial crops	Mucuna or D. lablab planted into a perennial crop such as older stands (2 years or more) of plantain for weed control	Forest zone	Intercropped with plantain
Canavalia	Plantain	Canavalia intercropped with plantain, planted three months after the plantain suckers.	Forest zone	Intercropped with plantain

Fitting cover crops into the farming system is generally a secondary consideration in soil fertility research until the ability of the cover crop to improve soil fertility or control weeds has been adequately proved. It has not been researched in on station trials in Ghana. However it is an essential consideration if the cover crop is to be adopted by farmers. The number of cover crop species available, the genetic variability within species such as mucuna and the variety of cropping systems that can be found in the Brong Ahafo region offers a great deal of potential for experimentation in this respect that has yet to be fully exploited. In this respect the SFSP has had more experience than research within CSIR which has concentrated more on the benefits to soil properties and ways of managing the cover crop that maximise biomass production.

Furthermore, mucuna is not suitable for all cropping systems that are found. The SFSP is confident in two maize/mucuna rotations (the first two entries in table 2) for the Sunyani district. However many

farmers intercrop maize with cassava , and in these instances mucuna is too aggressive to grow alongside the cassava, as well as for many of the intercropping and mixed cropping systems that are found in the Brong Ahafo region. The potential target group for mucuna may therefore be quite small and experimentation with a greater diversity of cover crops is justified. Canavalia has been successful in plantain based mixed cropping systems but other slower growing cover crops may also have potential in mixed cropping and intercropping systems.

Local experimentation with different cover crops where a diverse range of farming systems and cover crops are present is better suited to more participatory technology research where greater communication between farmers and researchers is required. Other more technical aspects of cover crop research, such as verifying the phenology of different mucuna genotypes is better suited to researchers within the CSIR institutes who would find it difficult to spare adequate amounts of time travelling to undertake fully participatory research or to visit different agro-ecological zones.

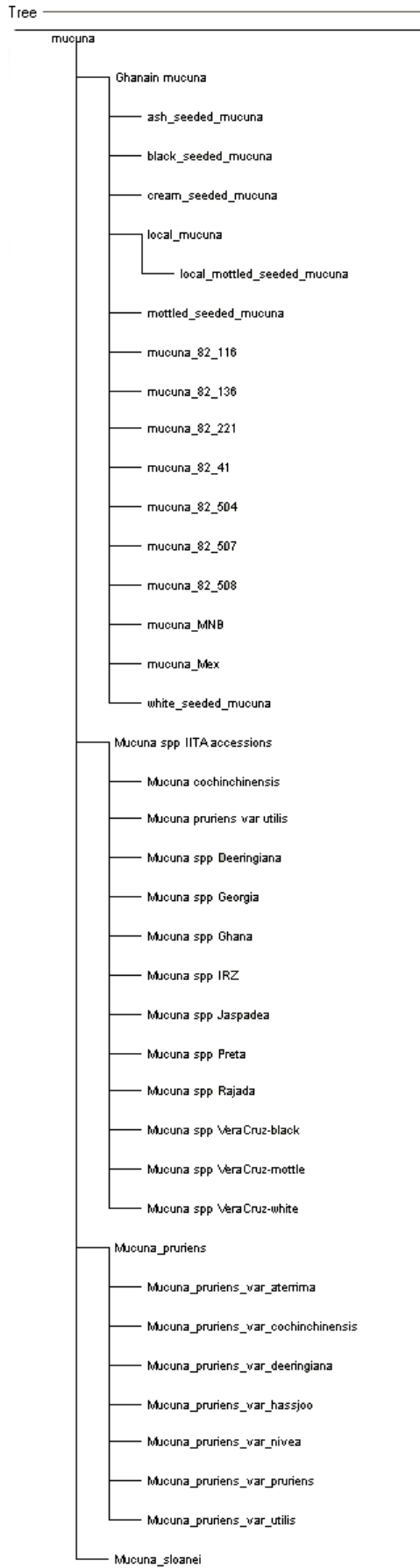
Using available mucuna genetic diversity

Mucuna exhibits a lot of genetic diversity and lack of common nomenclature hinders communication about different properties of mucuna genotypes which might be significant for facilitating choice of genotype for adaptation to different cropping patterns and environmental conditions. and Looz *et al.*, (in press) also suggests that more experimentation with mucuna varieties of different growing periods is required to adjust to local differences and rainfall pattern, especially in the savannah – transition zone.

In international research mucuna genotypes are generally given a name such as ‘*Mucuna spp.* Ghana’ and the origin of the seed might sometimes be stated. Within Ghana, mucuna varieties are frequently referred to simply as ‘*Mucuna pruriens*’, or as ‘local mucuna’ or ‘black seeded mucuna’ and seed source is generally not mentioned. Users of mucuna including NGOs and farmers usually refer to mucuna of different seed colours and duration.

Figure 3: Object hierarchy for *Mucuna* illustrating the different terminologies used for different *mucuna* genotypes

Hierarchy: *mucuna*



The need to research a greater diversity of mucuna genotypes (beyond *Mucuna pruriens* var. *utilis* and *cochinchinensis*) is recognised in Carsky *et al.*, (1998). Research is currently underway to clarify the taxonomy of mucuna and to evaluate the food potential of different genotypes which can have different L-DOPA content (CEIPCA, 2001).

Perceived benefits of using Mucuna

The benefits and costs of growing a cover crop are highly variable. An AEA estimated that the majority of farmers weed twice when mucuna is being sole cropped, whereas extension literature and researchers estimate that one weeding would be sufficient. Increases in the yield of maize after mucuna are highly variable depending on the initial fertility of the soil. More fertile soils benefit less from cover cropping, whereas yield increases are higher when cover crops are used on soils low in fertility. Crop management is also important. Estimates of yield increases in Ghana are as much as 100% under researcher management, whereas the SFSP estimates 50 – 60 % under farmer management.

Cover crop seeds and technology transfer

Extension agents view information on locally available seed sources as a vital part of the cover crop technology package that should be delivered to farmers. Without this information the extension agent is burdened by the farmer into attempting to provide seeds themselves and is unwilling to deliver the package.

Summary of constraints

1. There is insufficient information flow to and within the National Agricultural Research System:
 - a) The publication of journal and conference proceedings is often delayed
 - b) There is insufficient internal reporting within the agricultural research institutions and dissemination of research results within the national agricultural research system
 - c) Information is scattered in various libraries that make it difficult to access
 - d) Computer and internet facilities are limited in national agricultural research institutions making it more difficult for researchers to search for information and limiting networking activities
 - e) Co-operation and communication has been improved with the formation of the Ghana Cover Crop Network but could still be increased.
2. The national agricultural extension system is overly reliant on external sources of funding for the provision of extension services which has resulted in the current breakdown in the system of information transfer. Research results from participatory technology development do not reach beyond the project area.
 - a) District MOFAs are not active in seeking out the results of research
 - b) Research projects do not always reach district MOFAs in their networking activities
3. There are problems with the delivery of technologies by extension agents.
 - a) extension agents are better able to deliver packaged technologies than ones which make greater use of farmers' existing knowledge and encourage farmers to experiment with new technologies.
 - b) existing perceptions of farmers toward research and development activities need to be recognised before effective collaboration between farmers and researchers, extensionists and development workers can take place.
4. Increased attention is required to the targeting of soil fertility management technologies to specific groups of farmers and farming systems, with recognition of the scope of specific technologies in terms of the size of target groups. Alternative technologies need to be considered at an earlier stage in the research process if the technology has limited applicability due to the small size of the target group of farmers by whom it could potentially be adopted (even though the technology may have the greatest potential benefits in terms of improved soil fertility).

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