

Fertilizers and Sustainable Agricultural Development

Progress Report

A Project Executed
by IFDC With
Financing From IFA
and USAID

December 2002



Introduction

The Integrated Soil Fertility Management (ISFM) project, coordinated by IFDC, an International Center for Soil Fertility and Agricultural Development, provides support to 7 West African countries and over 20 governmental and nongovernmental organizations to develop and promote more intensive and yet sustainable agricultural technologies from the grassroots to the regional level. The ISFM project is, in fact, the synthesis product of two separate projects, the 'Fertilizers & Sustainable Agricultural Development' (F&SAD) project, financed by the International Fertilizer Industry Association (IFA), and the 'Farmers for the Future' project, financed by the United States Agency for International Development (USAID). In the past four years, the ISFM project has developed an innovative approach to agricultural development, involving not just farmers, researchers and extension workers but also bankers, traders – including inputs dealers and fertilizer enterprises. The holistic approach, based on the agribusiness system at the regional level, combines participatory methods to develop and extend ISFM strategies and support institutional changes that facilitate effective linkages between farmers and the 'market.'

Integrated Soil Fertility Management (ISFM) for Sustainable Agricultural Intensification

ISFM-based intensification strategies are based on the combined use of soil amendments and chemical fertilizers. Different amendments exist, and their requirement depends on the need for improved soil organic matter status and improved pH-level. Limestone can be used to improve the pH-level; soluble sources of P and phosphate rock are frequently used to increase the availability of P. The more difficult challenge is to improve the status of organic matter in the soil. More and better organic manure is needed. ISFM strategies that integrate crop residue recycling, (green) manure, fodder crops or agro-forestry can eventually improve the availability and quality of organic matter.

Emphasis in ISFM strategies is on improving the agronomic efficiency of the 'external inputs' that are being used, in particular, of inorganic fertilizers.



Visit of IFDC trainees to the Office Togolaise des Phosphates (OTP).

The ISFM project facilitated contacts between the OTP and input dealers (in Benin) and farmer organizations (in Togo) for the purchase of natural phosphate rock. Phosphate rock is used on pilot sites that are located close to the OTP. It is used in particular on leguminous crops like soybeans and the *mucuna* cover crop.

The project works directly with over 2,000 farmers, who are experimenting with different options of ISFM strategies. Through ‘open field’ days, farmer-to-farmer exchanges, information dissemination campaigns and study tours a much larger number of farmers has been reached. In Katsina State in Northern Nigeria, for instance, more than 2,000 farmers are now practicing the maize-soybean rotation, and apply a combination of urea, compound (NPK), and triple superphosphate (TSP) fertilizers.



ISFM partner talking to government officials in Katsina State.

Policy makers in Northern Nigeria are recognizing the impact of the ISFM project. The open field days are important events that attract many representatives of farmer groups from various villages and regions, extension agents, regional policy makers, and representatives from the private sector: seed companies and fertilizer enterprises.



Rural retailer with his stock of fertilizers. Zaria, Northern Nigeria.

The private market in Northern Nigeria is much larger than in any other West African country. Retailers, both individually and collectively, procure truckloads of fertilizers from Lagos. However, many of them are engaged in other businesses as well (in particular construction materials) and have limited knowledge of the quality and use of the produce they are selling.

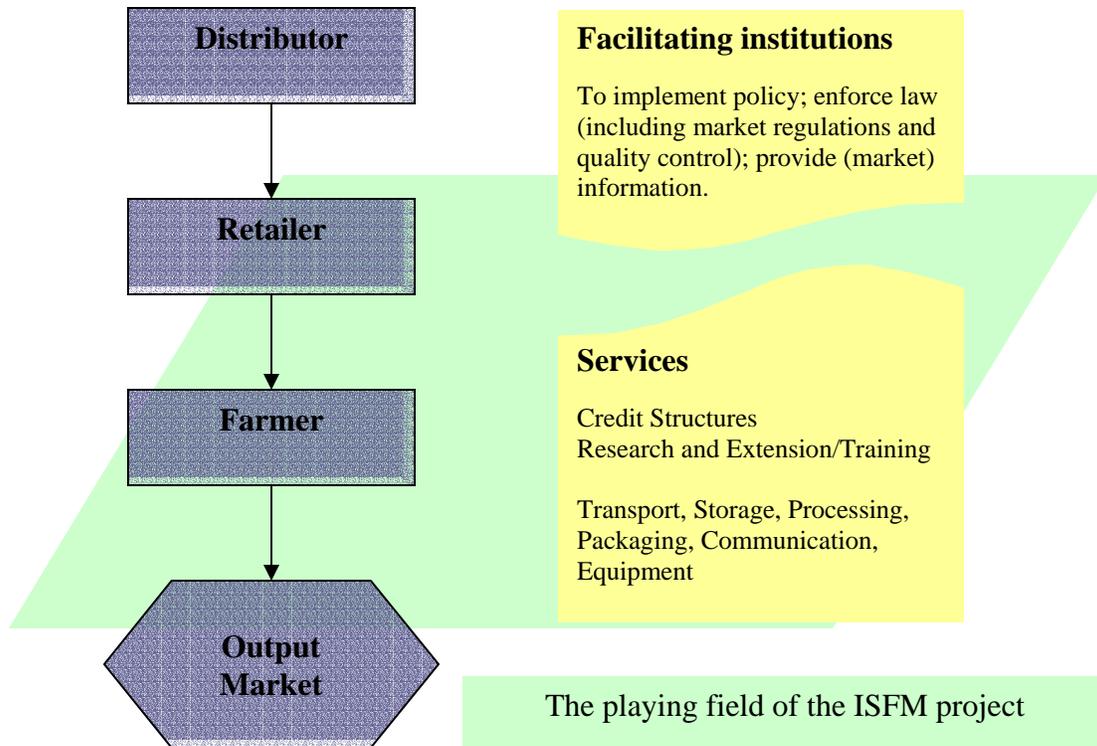


Luc Maene, Director General of IFA, honored by the villagers of Djaka kopé on a rainy day in Southern Togo.

Background to the ISFM Project

The F&SAD project started its first activities in 1996 in three West African countries: Togo, Benin and Niger. In 1999 the F&SAD project became the key activity in a new program: the Input Accessibility Program. This program explicitly focuses on the adoption process and combines the participatory development of technological packages with measures that facilitate institutional change and, in particular, improve the linkages between farmers and input (including credits) and output markets. Partnerships have been extended to extension services, rural development projects and nongovernmental organizations. Farmers, bankers, traders and policymakers at the local level have become the key stakeholders. Funds from IFA (F&SAD project) and USAID (Farmers for the Future project) were combined to increase the scale of IFDC’s village- and regional-level projects and improve on training and advisory tasks.

The Agribusiness System and the ISFM Project



The ISFM project is a grassroots project that is designed to enhance the capacities of farmers and local entrepreneurs to anticipate and adapt to structural changes that characterize economic development in West Africa. In particular, the project envisages supporting farmers to enter the market and small entrepreneurs to develop agribusiness enterprises that provide farmers with timely and good quality inputs. IFDC cannot do this alone! It works closely with partner institutions, both public and private, that constitute a first core group of 'change agents.'



Training of colleagues and farmer representatives in Katihoe, Southern Togo.

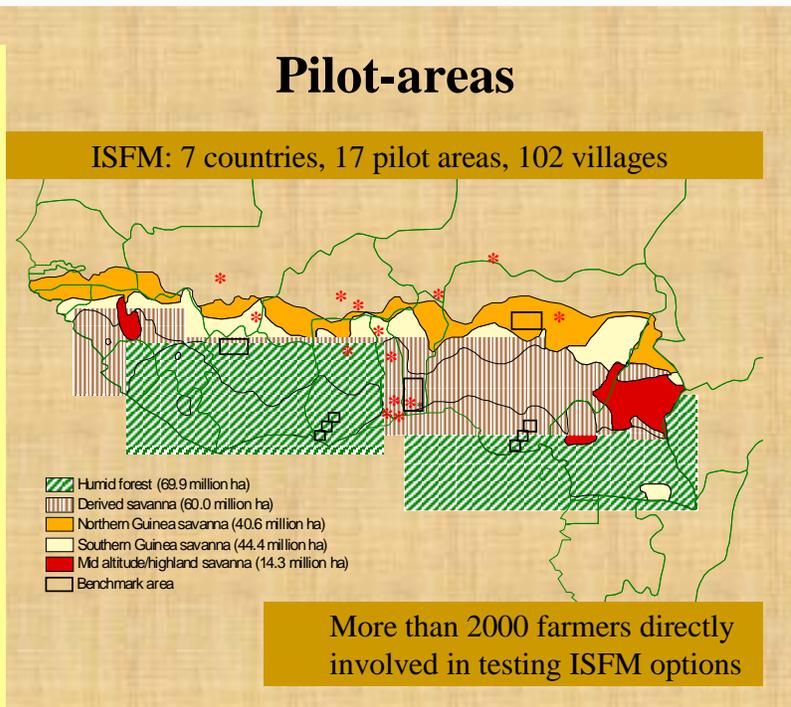
Training

IFDC places considerable emphasis on training the (field) staff of the partner institutions. Training programs are targeted to their needs and often consist of several modules including technical aspects of ISFM technologies, economic analyses, institutional aspects related to the integration of farmers in the market, association building, management of small savings and credit schemes and storage warehouses and farmer-to-farmer extension. Training of the trainers is an important component of each course to enable partner institutions to train their colleagues and other potential 'change agents' (like farmers themselves).

Strategic Site Selection

Strategic site selection implies choosing regions with some comparative advantages to produce crops and/or livestock for the local, regional, or (inter) national market. These regions are called pilot zones. In these zones villages and target farmers are chosen who are more likely to adopt ISFM and are able and willing to share their experiences with other farmers from neighboring and other villages in the region.

IFDC collaborates with both international and national agricultural research institutes to develop new ideas on ISFM technologies for different agro-ecological zones. Some of this research is executed in the benchmark areas that are indicated on the map. Technological options that appear to be of interest for the ISFM village-level projects are considered for experimentation through a participatory screening process that involves IFDC, the partner institutions, and the target farmers. Farmers' experiments and alternative ideas are also taken into account. The process results in the design of '(mutual) learning' plots, i.e., experiments set up with the farmers to test and fine-tune ISFM options.



The Gaya region in Southern Niger is one of the pilot areas of the ISFM village-level projects. The pilot villages in this region are all easily accessible and situated near the main roads to optimize the 'demonstration' impact of ISFM experiments and the exchange of information.



Regional Markets

Preference has been given to regions with a relatively high potential for intensive food crop production oriented toward local food markets. In areas with important export crops (cotton) we progressively focus on increased sustainability, coupled with the diversification of the cropping (and livestock) systems. Diversification of cropping systems will protect farmers from widely fluctuating world cotton prices (or on the prices offered by state-marketing boards). However, such a strategy will only be viable if effective linkages can be established with growing (or emerging) local markets for food products.

Results of the ISFM Project

ISFM is now established in 17 pilot regions in West Africa, as it indeed provides a feasible pathway for sustainable agricultural intensification – and a way out of the vicious cycle between poverty and land degradation. However, it's far from an easy road. Market reforms are often only marginally implemented; (unequal) competition between state structures distributing (subsidized) inputs, and input retailers is common. Both factor and product markets are very thin. Assistance in building a farmer's association is an important part of the project. It enables farmers to compare prices at different markets, to collectively negotiate with public and private sectors dealing with grains and commodities, and to decrease the costs and risks of market integration. Besides, it is a powerful tool to extend the successes of the project to a much larger group of farmers.



Some Results of the Integrated Soil Fertility Management Projects at the Village Level

	<i>1998</i>	<i>2002</i>
Number of countries involved	3	7
Number of pilot areas	7	17
Number of villages where experiments are carried out	28	102
Number of farmers participating in collaborative action research	231	2150
Number of NGOs and GOs involved in research and extension of ISFM through the project	6	23
Number of farmer organizations involved in research and extension of ISFM ¹⁾	(15)	(105)
Number of farmer-managed credit systems that have been set up and function independently	0	13
Number of rural banks directly involved in ISFM development through an agricultural investment fund	0	9

1) The number of farmer organizations is a rough estimate; in many of the villages farmers have set up a village committee to manage input distribution and/or storage of agricultural produce (to be reimbursed to the credit system); such a village committee often comprises several 'solidarity groups,' which we didn't count.

Compound Fields in Matiga, Northern Togo

Increasing cash income is the best stimulus for farmers to turn soil mining into sustainable production. In many cases fertilizers can best be used on the more fertile soils and not on the poorest or most depleted soils. Compound fields often offer the best chance of making fertilizers profitable. Farmers in Northern Togo succeeded in increasing maize production by almost 1,000 kg/ha using 50 kg/ha of urea, while the same dose resulted in an increase of only 370 kg/ha on bush fields.



Highlights

While average maize yields are approximately 1,000 kg/ha, average values for farmers' adaptive trials are between 2,500 and 5,000 kg/ha, depending on the zone (soudanian, guinean, coastal), rainfall distribution, soils and management factors. Farmers who have been able to continue using ISFM technologies on the same plots have reported increasing yields and gradually better soils (darker, with higher moisture-holding capacity). Yields on ISFM plots are economically profitable, with Value-Cost-Ratios well above 2 and returns to labor far above local salary rates. While over 2,000 farmers belong to the ISFM farmer groups, they have shared their experiences with a much larger group through the farmer-to-farmer extension and open-field days. The 'learning plots' that have been installed in the pilot villages often attract a much larger group of interested farmers. Farmer organizations that have been set up to provide the ISFM group with seeds, chemical fertilizers and in some cases also phosphate rocks are progressively serving a wider community of farmers. Many of them have to pay cash for fertilizers. The farmer groups have succeeded in extending credit to many of its members to buy fertilizers. Some have deposited their revolving fund as a guarantee fund – the ultimate goal. Others have started to add their savings to the revolving fund.



Credit structure (CMEC) and warehouse of the Farmers' Union (CAP 'Centrales d'Autopromotion Paysanne') in Northern Togo: Partners of the ISFM Project.

In 2001 the farmers' union in Northern Togo received a credit (in kind) from the European Union of 40,000,000 FCFA (about US \$60,000) to distribute fertilizers that were purchased from private distributors in Lomé at a 20% higher price than the subsidized price of fertilizers available from the government services. Since demand for fertilizers was much higher than the amount of subsidized fertilizers available, the farmers' union was able to distribute all the fertilizers to the farmers on a fifty-fifty basis (one bag of subsidized fertilizer and one bag of unsubsidized fertilizers).

The scale of adoption varies between the regions and impact – though very clear in practice (see examples below) – is difficult to quantify. However, there is ample reason to suppose that for every ISFM farmer there are between 5 to 10 farmers who want to join the group and who have already started their own experimentation. ISFM practices start on small plots of 0.25 to 0.5 ha, but have evolved in most pilot sites to 0.5 to 1-2 ha. If all farmers buy an average of 175 kg of fertilizers (which is probably an underestimation since on average ISFM farmers use between 200 and 300 kg/ha of fertilizers

and sometimes higher such as in the case of irrigated rice), they easily purchase 2,500 tons of fertilizer. For all these farmers, and particularly small-scale women farmers, their income was positively influenced and they have improved their abilities to enter the market and to respond to new challenges.

Irrigated Rice in Southern Togo



The ISFM project has conducted N, P, and K fertilizer dose experiments in farmers' rice fields in the irrigated rice area of the Zio valley, Southern Togo. It concerned two different types of experiments with the aim of obtaining efficient N, P, and K fertilizer doses for the main soil types. Despite the existence of considerable soil fertility differences between the main soil types in the rice valley, the extension service had been using only one fertilizer recommendation for irrigated rice, that is 122 kg N + 30 kg P₂O₅ + 30 kg K₂O on a per-hectare basis.

The results showed that the efficient doses of N, P and K were different for the main types of soils. Economic analyses were done for optimum conditions (low input prices, high rice prices, low interest rate on credit) and sub-optimum conditions (high input prices, low rice price, high interest rate on credit). The table below presents the efficient/optimum doses for the main soil types under varying economic conditions and compares them to the farmers' practice.



Soil Type	Optimum conditions	Sub-optimum conditions	Farmers' practice
Clay soils	100 N + 15-30 P + 15-30 K	76 N + 15-30 P + 15-30 K	69 N + 22,5 P + 22,5 K
Loam soils	120 N + 45 P + 45 K	100 N + 30 P + 30 K	68 N + 29 P + 29 K
Sandy-loam soils	120 N + 60 P + 60 K	100 N + 45 P + 45 K	97 N + 36,5 P + 36,5 K

P = P₂O₅

K = K₂O

In contrast with the recommendations from extension services, farmers apply different fertilizer doses to different soil types. The results of the experiments show that they are correct in doing so. Further gains in efficiency of fertilizer use can be achieved through activities that will lead to optimum economic conditions and through activities that integrate the use of organic fertilizers with mineral fertilizers. The ISFM project assists farmers in setting up self-managed, small-scale, rural credit-savings banks. The project also supports farmers' efforts to organize the provisioning of inputs. The ISFM project is investigating, with the farmers, in what way the integrated use of organic matter (e.g., recycling of rice straw) with mineral fertilizers can be further optimized.



Female farmers' group in the Gaya Region, Southern Niger.

With the inception of the ISFM project in 3 villages in Niger, the number of villages has increased rapidly. ISFM farmer groups (almost all are female farmers' groups) have been set up in 12 villages. After a study tour to Northern Togo, the farmers' groups decided to increase their revolving fund as fast as possible by integrating their savings and other income-generating activities. The funds are used to buy chemical fertilizer (NPK 15-15-15) on the commercial market in Benin, instead of waiting for subsidized fertilizer distributed by the government.



Learning plot (with different maize varieties) in Sinsuègèné, Southern Burkina Faso.

In Southern Burkina Faso, the intensive maize cultivation system – which had almost disappeared in this region because of degrading soils – is spreading fast. Because of easy access to the market in Ouagadougou, capital of Burkina Faso, the farmers have almost no difficulty in selling their produce.



Racks drawn out of the solar drier in the Tamale Region, Northern Ghana (pepper and okra).

Soybeans are being cultivated in Northern Nigeria and in Southern Togo to diversify the cropping system. In Northern Ghana the ISFM project has focused on pepper production because this constitutes an important source of income for the female farmers in the region. To improve the integration of agriculture and livestock, the cultivation of cowpea is rapidly being adopted in southern Mali. Cowpeas with P-fertilization are highly productive and, with proper advice on animal husbandry practices, they can provide additional fodder to keep a healthy stock of animals. Cowpeas (fodder) can also be used for animal traction and improvement of the efficiency of the whole cropping system, whether planted afterwards with cotton or with maize. In Niger, farmers give priority to sorghum (instead of millet) for the 'zai' – practice. They are experimenting with small doses of fertilizers in each hole to improve productivity.

The Way Ahead

The ISFM grassroots network now links more than 20 research and extension organizations, both public (GO) and private (NGOs). In 2002 the project focused on the process of participatory development of ISFM strategies within the chosen pilot areas. Despite several demands (e.g., from Opération Haute Vallée du Niger [OHVN] in Central Mali, Institut d'Economie Rurale [IER]/Equipe Système de Gestion des Ressources Naturelles [SPGRN]-Niono in the Niger delta, Institut National des Recherches Agricoles du Benin [INRAB] in Central and Northern Benin, Kaduna and other northern states in Nigeria), it was decided not to extend the number of pilot areas given present staffing at the Africa Division of IFDC and available budget. Extension to other villages within the same pilot areas – but with lower budgets and investment of project staff – was encouraged as a first step to identify the opportunities for scaling up. The ISFM project has been very successful in addressing gender roles in the various pilot villages. The village meetings with the gender specialist of IFDC are very much appreciated, and many farmers – both male and female – acknowledge that she has brought new ideas into their village. The ISFM project hopes to extend its efforts to improve participation of female farmers in the target regions.



Meeting on gender issues and ISFM in Ahohoué, Southern Benin, Organized by IFDC Staff.

There is a general acceptance of the fact that most farmers are female. There is also agreement on the fact that women are very often more reliable clients of credit structures. Finally, the income of women is directly related to food security. Despite this, women are still very much neglected in development efforts. In the ISFM project, female farmers participate. Gender roles are discussed at the village level to stimulate female and male farmers to work together. In Benin the female farmers have become the leaders in the ISFM farmer group.

The ISFM Project and Cotton-Based Production Systems

The ISFM project has increased its activities in the cotton zones of Southern Mali. This was partly due to the considerable progress being made by the Malian partner institutions, among others with the production and testing of the seed-fertilizer equipment. The prototype that has been tested this year appears to be of considerable interest to the farmers. In the near future ISFM activities in the cotton zones – also in Burkina Faso and Benin – are likely to grow. In addition to addressing the difficulties farmers are facing with declining cotton yields and, as a consequence, of fertilizer-use efficiencies, the project will assist partner institutions, farmer organizations, and the private sector to develop new strategies in the face of incomplete and sometimes even 'uncertain' market reforms. Farmers have been provided with inputs and credits without having to go far. This will change, and in some areas these changes are already underway. Private structures and farmer organizations are supposed to fill in the 'gaps' that go along with the restructuring of the marketing boards (like the Compagnie Malienne pour le Développement des Textiles [CMDT] in Southern Mali – see the epilogue).

The ISFM project can play an important role, empowering farmers, rural retailers and their organizations to efficiently adapt market reforms and to take up new and more dynamic roles in the near future.



From the International ISFM workshop, Abomey – January 2001 – with Dr. Breman (IFDC) and the Minister of Agriculture of Benin.



The ISFM project is a small-scale project, with a total budget of around US \$300,000 per year. The project profits from substantial work already executed in the region and partnerships with government organizations (GOs) and NGOs in various parts of West Africa. Despite limited resources, the ISFM project is demonstrating a viable approach to sustainable agricultural intensification in well-targeted areas in West Africa. The limited scale, however, also constrains its potential to trigger private-sector development in the pilot areas. For large-scale extension of the project within the pilot zones, more funds will be needed to implement a large number of ‘learning plots’ and rural knowledge centers, to enable farmers in the pilot zones during a short transitional period, to increase fertilizer-use efficiencies and engage in adaptive experimentation, to train extension and, more generally, to develop the capacities of GOs and NGOs to provide timely advice and support, to ensure adequate monitoring and evaluation, and to strengthen professional capacities of farmers’ organizations and of input dealers (and their networks). Strengthening of the ISFM project is underway. In 2003, an IFAD-sponsored project will complement the ISFM project. It will specifically strengthen the technical aspects of ISFM, thereby leaving room for the ISFM project to focus more on the agribusiness system as a whole. With the assistance of IFDC Africa, the African Development Bank project in the Bazega region in Burkina Faso, which recently started, will extend the ISFM approach to the whole region. Increased collaboration with national-level projects will also contribute to ease the strain on regional-level private sector development.



Farmers planning their future in West Africa .



Epilogue

REPUBLIQUE DU MALI

MISSION DE RESTRUCTURATION DU SECTEUR COTON (MRSC)
COMPAGNIE MALIENNE POUR LE DEVELOPPEMENT DES TEXTILES (CMDT)

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CESSION D'ACTIFS DE LA CMDT EN ZONE OHVN-KITA
POUR LA CREATION D'UNE NOUVELLE SOCIETE COTONNIERE PRIVEE

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AVIS D'APPEL D'OFFRES

En exécution du plan d'action de la Lettre de Politique de Développement du Secteur Coton (LPDSC), le Gouvernement de la République du Mali a décidé de susciter la création d'une nouvelle Société Cotonnière dont la zone d'intervention couvrira la zone OHVN actuelle et l'actuelle région CMDT de Kita. La nouvelle Société Cotonnière reprendra les actifs actuellement détenus par la CMDT dans ces zones.

Les actifs CMDT à acquérir par la nouvelle société cotonnière privée sont les suivants :

- ◆ Usine d'égrenage de Ouélessébougou (immeubles, installations, équipements). Cette usine est située en zone OHVN. Elle est en cours d'achèvement. Elle aura une capacité d'égrenage journalière de 320 tonnes de coton graine ;
- ◆ Usine d'égrenage de Bamako (immeubles, installations, équipements). Cette usine est située en zone OHVN. Elle a une capacité d'égrenage journalière de 104 tonnes de coton graine ;
- ◆ Usine d'égrenage de Kita (immeubles, installations, équipements). Cette usine est située dans la région CMDT de Kita. Elle a une capacité d'égrenage journalière de 320 tonnes de coton graine ;
- ◆ le bâtiment, siège de la Direction Régionale de la CMDT à Kita, sis dans la ville de Kita ;
- ◆ les autres immeubles et installations situés dans la région CMDT de Kita (magasins, logements ZAER, etc...).

Invitation for a Bid on Part of the CMDT Structure

CMDT operates mainly in Southern Mali and is the principal cotton marketing board of Mali. It collects the cotton produced from the farmers at (or beforehand) fixed prices and provides them with inputs (seeds and fertilizers) and extension services. The CMDT is gradually being restructured (and privatized). Fertilizer distribution for the production of food crops is, for instance, abandoned. Extension services have become more limited and oriented only to cotton production.



IFDC staff, ISFM partners, and farmers in M'Peresso, Southern Mali.

Farmers in Mali are very concerned about the restructuring of the CMDT and related market reforms. The ISFM project assists farmers in adapting to these changes and to take a more assertive attitude.

Table 1. Overview of Pilot Zones and Villages in the Integrated Soil Fertility Management (ISFM) Project

<i>Country (direct partner institutions) zone (villages)</i>	<i>Ecological Zone¹⁾</i>	<i>Dominant crops (farming system) involved in experimentations</i>	<i>ISFM Potential²⁾</i>	<i>ISFM menu (i.e., technical options promoted)</i>
Benin (CENAP, INRAB and CARDER) Klouékanmé region (Akimé) Ifangni region (Banigbé)	Coastal Savannah Coastal Sav/ Degr. Forest	Maize, Cassava Maize, Cassava, Oil Palm	B2 B2	HYV, PR, CF, ImprF (a.o. mucuna), CResR,
Burkina Faso (UGFS, PDL/Z, PGRN/Bzg) Zoundweogo province (Kougbaga, Goghin) Kadiogo province (Sinsèguèè)	Southern Sudanian Southern Sudanian	Sorghum (Mixed farming) Sorghum, Horticulture (Mixed farming)	B2 B2	HYV (maize!) PR, CF, CResR, ImprF, Leg (cowpeas, groundnuts), OM, Fodder
Ghana (SARI, MoFA) Tolon-Kumbungu district – close to Tamale (Mbanayili and 5 other villages)	Southern Guinea	Maize, Groundnuts (Horticulture)	B2	HYV, CF, Leg (groundnuts), CResR, OM
Mali (IER/SPGRN, OHVN) Koulikoro region (5 villages) Sikasso region (M'Peresso near Koutiala and Noyaradougou near Sikasso)	Southern Sudanian Northern Guinea	Cotton, Maize (Sorghum) Cotton, Maize (Sorghum) (Mixed farming)	A1/2 A1/2	(<i>planning stage</i>) HYV, PR, CF, CResR, OM, Fodder
Niger (INRAN) Malgorou region (Goumandey and 5 villages) Malgorou region (Sokondji-Birmi) Konni region (Guider-Idder)	Southern Sudanian Southern Sudanian Northern Sudanian	Sorghum, Millet, Horticulture Irrigated Rice Millet (Sorghum)	B2 A2 B2	HYV, CF, CResR, Leg (cowpeas, groundnuts), OM (zaï), Fodder
Nigeria (ABU, IAR, (IITA)) Zaria region (Tsagamawa, Alhazawa, Dabai, Kahutu, Sa'i in Katsina State)	Northern Guinea	Maize (Groundnuts)	B2	HYV, CF (incl TSP), Leg (a.o. soyabeans), CResR
Togo (ITRA, ICAT, CREMA, RAFIA) Valley of Zio (Mission Tové, Assomé, Kovié) Zio region (Bolou) Yoto region (Yotokopé and 3 other villages) Lac region (Masséda and 5 other villages) Vo region (Atchavéglo and 4 other villages) Northern region (Naloate, Matiga)	Coastal Savannah Coastal Savannah Coastal Sav/ Degr. Forest Coastal Savannah Coastal Savannah Southern Guinea	Irrigated rice (Maize, Manioc) Maize (Horticulture) Cotton/ Maize (Relay cropping) Maize, Cassava Maize, Cassava Sorghum, Maize (Mixed farming)	A2 B2 A1/2 B2 B2 B2	HYV, PR, CF HYV, PR, CF, CResR, ImprF, Leg (cowpeas, groundnuts), OM, AgrF, Fodder

Notes:

- 1) Coastal Savannah: 210 – 270 growing days; Southern Guinea: 180 – 210; Northern Guinea: 150 – 180; Southern Sudanian: 120 – 150; Northern Sudanian: 90 – 120.
- 2) See section 4. Situation A: high actual potential for ISFM; Situation B: high medium term potential for ISFM (if among others fertilizer use efficiencies are higher); 1 = ISFM oriented on export crops; 2 = ISFM oriented on food crops and local/regional food market linkages.
- 3) PR = phosphate rock, CF = chemical fertilization (urea, NPK, TSP), Leg = Leguminous crops (rotation, strips), ImprF = Improved fallows (cover crops), AgrF = agroforestry, OM = organic matter production (litter and cattle pens, compost) and application, Fodder = fodder crop production, CResR = Crop residue recycling, HYV = High Yielding (i.e. improved) Varieties. Soil and water conservation methods are applied on all fields.