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Enhancing Crop-Livestock Systems in Conservation Agriculture for Sustainable Production Intensification

A Farmer Discovery Process Going to Scale in Burkina Faso

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FOREWORD

This is a story about how, through its PRODS/PAIA initiative (see Box 1), FAO assisted groups of farmers in five farming communities in the moist savanna zone of Burkina Faso to enhance their crop-livestock systems through Conservation Agriculture (CA) practices, including crop diversification, using an innovative farmer discovery process, to bring about agricultural intensification and improvement in livelihoods. FAO's assistance was delivered largely by working with national institutions, adding value to ongoing stakeholder resources and activities. Hence, this is a story about how FAO worked with a range of stakeholders including the farmers and their communities, and the research and extension stakeholders, to create convergence and enable a farmer-based discovery process to experiment with a set of fundamentally new principles and elements in their farming practices for integrated crop-livestock production intensification.

CA with its three essential components – no-till and minimum soil disturbance, crop diversification with legumes in crop rotations and mixtures, and building up of a mulch on the soil surface with plant residues of previous crops including cover crops -- constituted the new principles for simultaneously enhancing soil health, productivity and income, and ecosystem services. It is a story of positive intensification outcomes brought about by adapting 'proven principles and practices' of CA and crop diversification into existing crop-livestock systems through a farmer-based discovery process linked to coordinated technical support through FAO from a range of research and development stakeholders.

The positive outcomes offer a real promise and an opportunity for bringing about a large scale impact on agricultural productivity and livelihoods in the moist savanna zone of West Africa, often referred to as the potential 'bread basket' because of the zone's high productivity potential for integrated crop-livestock production. The conceptual elements draw substantially from new innovations in sustainable intensification in similar agro-ecologies in the savannas of Brazil. This publication describes the multi-stakeholder process which led the successful outcomes, and the opportunity for a greater change that now exists and should be harnessed for sustainable agricultural development, nationally and regionally.

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BOX 1 PRODS/PAIA

PRODS/PAIA initiative of FAO refers to the concept of integrated agricultural production systems (PRODS) as a priority area for interdisciplinary actions (PAIA) approach. The PRODS/PAIA approach was developed to foster strong collaboration and partnership with national and regional agencies, institutions and non-governmental organizations (NGOs), civil society and the private sector. The principal objective of the PRODS/PAIA effort is to promote a holistic system approaches and to better address the socio-economic dimensions of the introduction, adaptation, use and dissemination of appropriately validated integrated production systems technologies for intensification, including the social process of learning itself, e.g., farmer discovery process linked to Farmer Field Schools. Integration highlights the complex linkages that should be developed as farmers and rural communities shift from traditional production system to market-oriented intensified production systems and practices. Horizontal integration seeks to improve the nature of the system itself, e.g., from tillage-based to no-till with crop diversification and rotation, and soil cover with plant residues and mulches, and the management across the various components of the system, namely crops, animals, trees and fish. Vertical integration seeks to improve management of commodities through production, processing, marketing and distribution, which will result in added value for the produce to increase farm revenue.



OVERSIGHT AND ACKNOWLEDGEMENTS

A very large number of colleagues have assisted in the work reported in this publication. It is not possible to name every one of them individually. However, it must be acknowledged that without their dedication, and often voluntary service, it would not have been possible to carry out the pilot phase of the project, or the conceptualisation of the follow-up scaling process, reported in this publication. This publication is dedicated to them all.

The pilot project activities and the scaling-up process were overseen by Eric Kueneman from the Plant Production and Protection Division (AGP) of FAO in Rome with assistance from Brahim Kebe at the FAO Regional Office in Accra, and advice from staff of AGP, particularly Theodor Friedrich, William Settle, Caterina Batello and Amir Kassam, and the staff of the FAO Office in Burkina Faso.

The field work in Burkina Faso was coordinated by the staff from the Institut National pour de l'Environnement et de Recherche Agricoles (INERA) at Farako-ba, led by Souleymane Ouedraogo, with assistance from Estanislasse Sankara and Karim Traoré of INERA and from the staff of the Direction de la Vulgarisation et de la Recherche-Développement (DVRD) including Clement Combassere and Salou Traoré, and from the Direction Régionale de l'Agriculture de l'Hydraulique et des Ressources Halieutiques des Hauts-Bassins (DRAHRH/HB), the National de Semences Forestieres (CNSF), and the Women's Association.

The project benefited from collaboration with other FAO initiatives in Burkina Faso, particularly the Integrated Pest Management-Farmer Field School project (IPM-FFS), the Special Programme of Food Security (SPFS), and several international organizations such as CIRAD, IITA, ICRAF, ILRI, ICRISAT and FARA provided technical guidance and plant genetic resources to the project.

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Amir Kassam coordinated the preparation of this publication in collaboration with Eric Kueneman, Brahim Kebe, Anthony Youdeowei and Souleymane Ouedraogo. Magda Morales provided valuable assistance with the graphic design and formatting.

ACRONYMS AND ABBREVIATIONS

AGRA	Alliance for Green Revolution in Africa
BNF	Biological Nitrogen Fixation
CA	Conservation Agriculture
CAADP	Comprehensive African Agricultural Development Programme
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement
CIRDES	Centre International de Recherche pour le Développement de l'Élevage en Zone Soudanienne
CNSF	Centre National de Semences Forestières
CoP	Community of Practice
DRAHRH/HB	Direction Régionale de l'Agriculture de l'Hydraulique et des Ressources Halieutiques des Hauts Bassins(DRAHRH/HB).
DVRD	Direction de la Vulgarisation et de la Recherche-Développement
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária
FAAP	Framework for African Agricultural Productivity
FAO	Food and Agriculture Organization of the United Nations
FARA	Forum for Agricultural Research in Africa
FFS	Farmer Field Schools
FORC	Forestry Conservation, Research and Education Service of FAO
GAP	Good Agricultural Practices
ICRAF	International Centre for Agroforestry Research
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFAD	International Fund for Agricultural Development
IFDC	International Fertilizer Development Centre
IITA	International Institute of Tropical Agriculture
INERA	Institut National de l'Environnement et des Recherches Agricoles



ILRI	International Livestock Research Institute
IPM	Integrated Pest Management
IPPM	Integrated Production and Pest Management
MoA	Ministry of Agriculture
MoAR	Ministry of Animal Resources
NGO	Non-Governmental Organization
NRM	Natural Resource Management
PAIA	Priority Areas for Interdisciplinary Action
PRODS/PAIA	Integrated Production Systems/Priority Areas for Interdisciplinary Action
R&D	Research & Development
SARD	Sustainable Agriculture and Rural Development
SOM	Soil organic matter
SPFS	Special Program for Food Security
UN	United Nations
UNPC-B	Union Nationale des Producteurs de Coton du Burkina (National Cotton Growers' Union of Burkina)

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CHAPTER 1

Introduction

Despite its high productivity potential, the current agricultural land use pattern in the moist savanna zone of Sub-Saharan Africa (Figure 1, zones 7, 8 and 9) and its development prospects for livelihoods and sustainability are beset with serious constraints. These arise mainly from poor soil health and therefore low soil productivity, due to a combination, on the one hand, of soil inversion tillage practices, which degrades soil porosity, organic matter and soil biota, and sub-optimal soil, crop and pest management practices, and on the other of sub-optimal crop diversification and crop residue management, and poor integration of livestock in the production system.

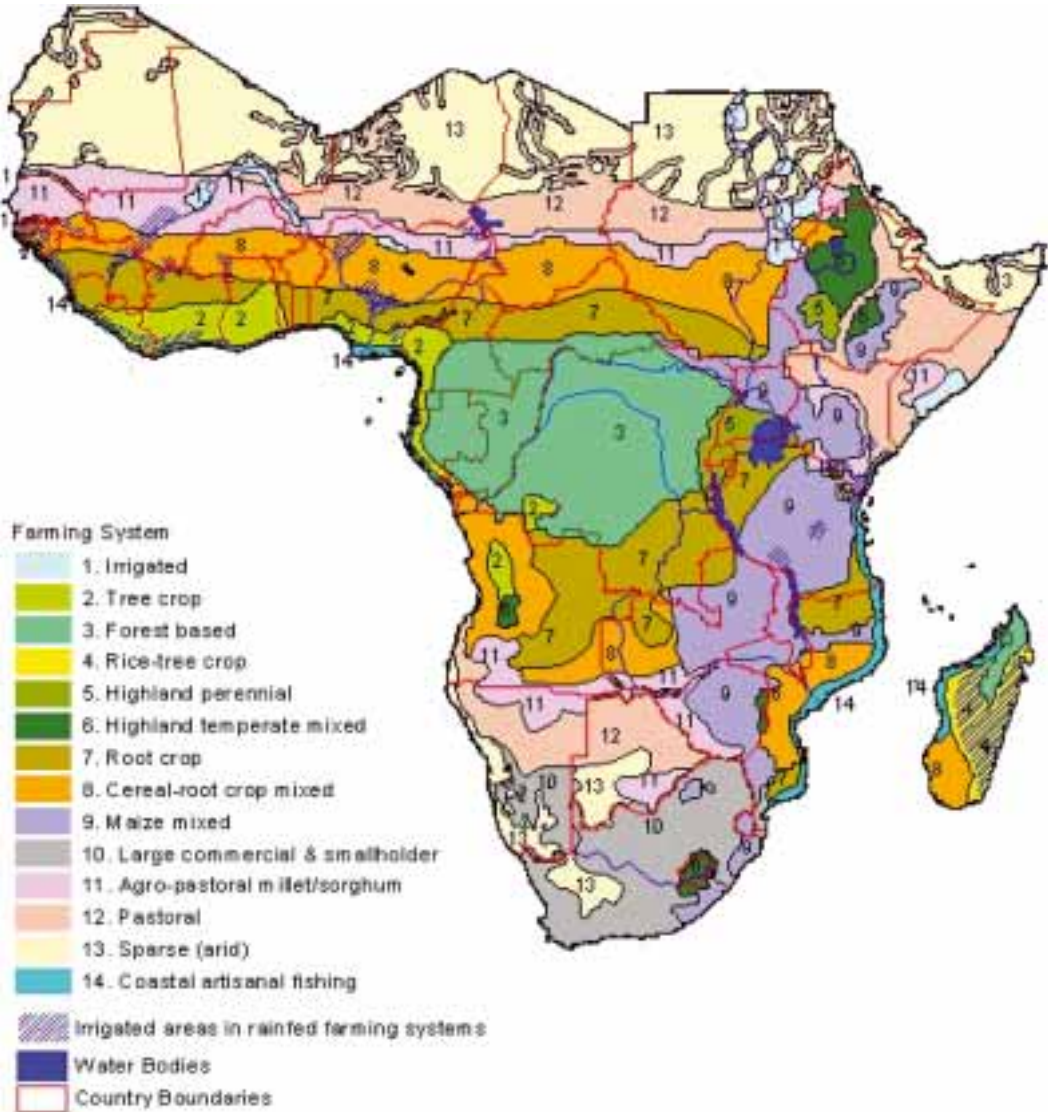
From the economic and livelihood viewpoint, cotton and livestock constitute the bulk of cash income, where as the main food crops are maize, sorghum, cowpea and groundnut. However, the liberalization and globalization of the cotton trade calls for improvements in the competitiveness and productivity of the cotton production system, in terms of reducing the costs of production and raising factor productivities and yields. In the case of livestock production, the main constraint to increasing livestock productivity and output is the lack of adequate supplies of good quality livestock feed in the dry season produced at a competitive cost and without jeopardizing household food security. The need to improve cotton productivity and expand its production, the need to improve livestock feed supplies and expand livestock production of a range of animals as well as strengthen food security implies that: (a) the dominant cotton-cereal-legume production systems in the moist savanna ecologies must be based on efficient management of soil and water and of production inputs such as nutrients, labour and energy and efficient and minimum or no use of pesticides; and (b) the cropping systems must be diversified with high biomass fodder and legume crops, and be managed efficiently to produce increased outputs of fodder and feed, as well as food and fibre, and managed to ensure the gradual improvement and rehabilitation of soil quality over time. Experience

has shown that amongst good farming and crop management practices that can make a significant contribution to meeting these implied needs are practices such as Conservation Agriculture (CA) and integrated pest management (IPM) disseminated through Farmer Field School (FFS) approaches.

Based on multi-stakeholder work facilitated by FAO during the recent years, there are promising prospects for agricultural change in the moist savanna zone in South Western Burkina Faso. And this has enormous implications through scaling-up for harnessing the potential of the moist savanna agro-ecologies that could help provide food, feed and fibre for Africa. New agricultural technologies, particularly the widening of crop choices, and Conservation Agriculture (CA) practices and linking crop production with livestock have been tested and adapted by farmers in the cotton growing areas of the moist savanna and are being disseminated through farmer field schools (FFS). This experience lends support to the notion that a spiral of rehabilitation of land productivity can be established based on integrated production systems in CA. Consequently, new horizons are opening up for agricultural intensification in the moist savanna ecologies of West Africa more generally.

There is now little doubt that the introduction of CA technologies and practices offer enormous potential to simultaneously rebuild and enhance soil fertility, land productivity and agricultural output and farm income. For example, based on similar technologies and practices, over 20 millions hectares of land in the savanna ecology in Brazil have been sustainably intensified and diversified, and similar evaluation is being achieved in other countries in Latin America and in Asia. More recently there is growing evidence of successful soil health and fertility management for agricultural intensification on both large and small-scale farms using CA practices in Africa from countries as diverse as Ghana, Kenya, Madagascar, Malawi, Morocco, Sudan, South Africa, Swaziland, Tanzania, Tunisia, Uganda, Zambia and Zimbabwe, covering a range of agro-ecological and socioeconomic conditions. The fact that CA is now practised on almost 100 million hectares worldwide implies that the principles on which it is based are recognised by farmers as one major potential alternative for enhancing soil fertility and for sustainable agricultural intensification in Africa and internationally.

FIGURE 1
Farming systems in Sub-Saharan Africa. Zones 7, 8 and 9 include the moist savanna ecologies.



Source: Dixon, J. and Gulliver, A. (2001). Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO and World Bank, Rome and Washington D.C.

CHAPTER 2

An analysis of farming systems constraints and opportunities for improvement

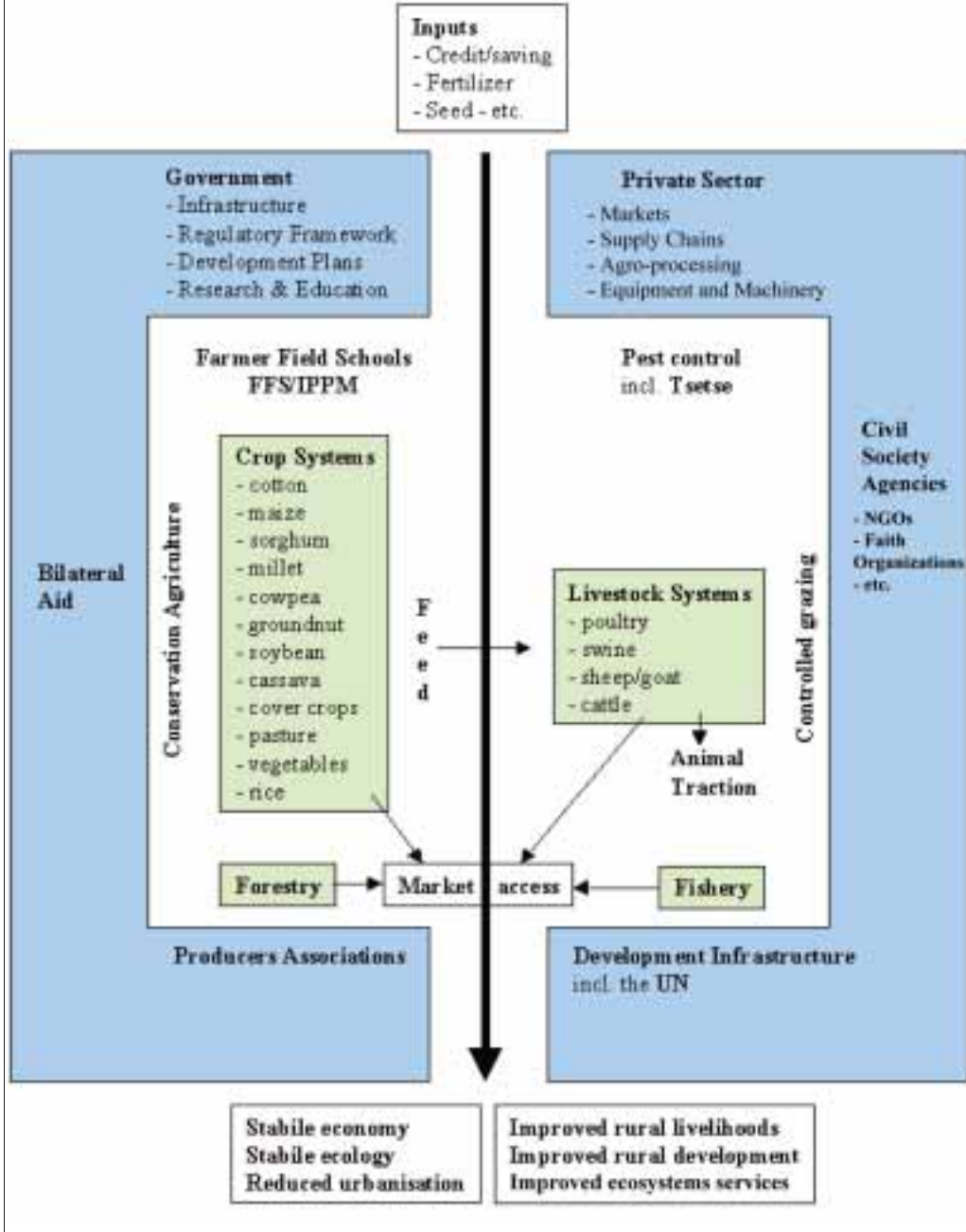
In 2001, an analysis of farming systems in south western Burkina Faso and their constraints was conducted based on participatory rural appraisals to develop a vision of what could be achieved by farmers with right knowledge and multi-stakeholder support in the potential 'bread basket' moist savanna ecology of West Africa for integrated crop-livestock production systems. This established a strategy of an experimental participatory approach to testing the introduction of new concepts and elements into the existing cereals- and cotton-based smallholder farming systems to:

- (a) expand crop choices that would increase the production of livestock feed (dry season needs and grain concentrates for the peri-urban poultry sector) while ensuring adequate biomass supply for soil quality recovery;
- (b) integrate Conservation Agriculture practices as a means to improve and optimize soil-crop-water-nutrient management for sustainable production intensification, given the poor current state of soil nutrient fertility, variable rainfall climate, and inadequate biomass availability; and
- (c) diversify and expand the range of food, feed and tree crops and their integration with livestock into the existing cotton- and maize-based systems.

The tree component provides multiple benefits including erosion control, biofuel and fruit but also a living fence to enable control of grazing to protect crop residues essential for soil protection in CA systems. The conceptual elements draw substantially from the new innovations in sustainable intensification in similar agro-ecologies in the savannas of Brazil (see also Landers, 2007¹).

¹ Landers, J.N. (2007) Tropical crop-livestock systems in conservation agriculture: The Brazilian experience. Integrated Crop Management, Vol.5. FAO, Rome.

FIGURE 2
Overall concept of partnerships and interactions for enhancing crop-livestock interactions for sustainable development production intensification





As the PRODS/PAIA strategy formulation evolved, it became clear that the vision of what could be aimed at and achieved could be best described as the integration of crop-tree-livestock systems in Conservation Agriculture with controlled grazing and pest control as illustrated in Figure 2.

The integration between crops and livestock would be enhanced mainly through the feed (fodder and grain) supply from the diversified crop systems. The integrated production and pest management Farmer Field Schools (FFS-IPPM) would not only ensure good practices in pest control but also serve as the learning sites for new knowledge and technology, and the testing, adaptation and integration of new principles and practices such as new crops or rotations, new soil management practice, new crop husbandry practices, which would be managed through on-farm farmer-discovery benchmark sites.

Feed was considered a serious limiting component to pull producers out of poverty. Thus, new selected crops coupled to practices that address soil degradation (i.e., the need for soil health recovery) are included in the model. CA is a promising approach to rehabilitate degraded lands but living fences are required to protect crop residues from livestock, and FFS are needed to enable farmers to understand and learn the new choices and their implications. The range of benefits in productivity and crop-livestock integrations that could be offered by expanding crop choice through the introduction of new crops are illustrated in Figure 3.

Over the period 2002-2007, FAO supported a 5-year production system intensification and diversification project with the Institut National pour de l'Environnement et de Recherches Agricoles (INERA) at Farako-ba and the Direction de la Vulgarisation et de la Recherche-Developpment (DVRD) in five villages near Bobo Dioulasso in south western Burkina Faso to test and select technologies capable of overcoming the limitations associated with low productivity of the cotton-based crop-livestock production systems. This pilot project introduced and tested improved technologies for soil management, crops and livestock aimed at raising productivity through a benchmark "farmer-participatory discovery" process that not only validated their relevance but also established a body of evidence and a "community of practices" (CoP) ready to support a larger scale dissemination of the promising technologies and practices.

This publication describes the experience and 'work in progress' on a farmer discovery process of capacity building that was delivered through the FAO's PRODS/PAIA initiative to farmers in five farming communities around Bobo Dioulasso in the moist savanna zone of south western Burkina Faso to bring about sustainable production intensification and improvement in livelihoods, food security and ecosystem services (see Figure 4 for a farming systems map of West Africa).

FIGURE 3
Summary of new crop introduction and beneficial utilization
by PRODS/PAIA farmers

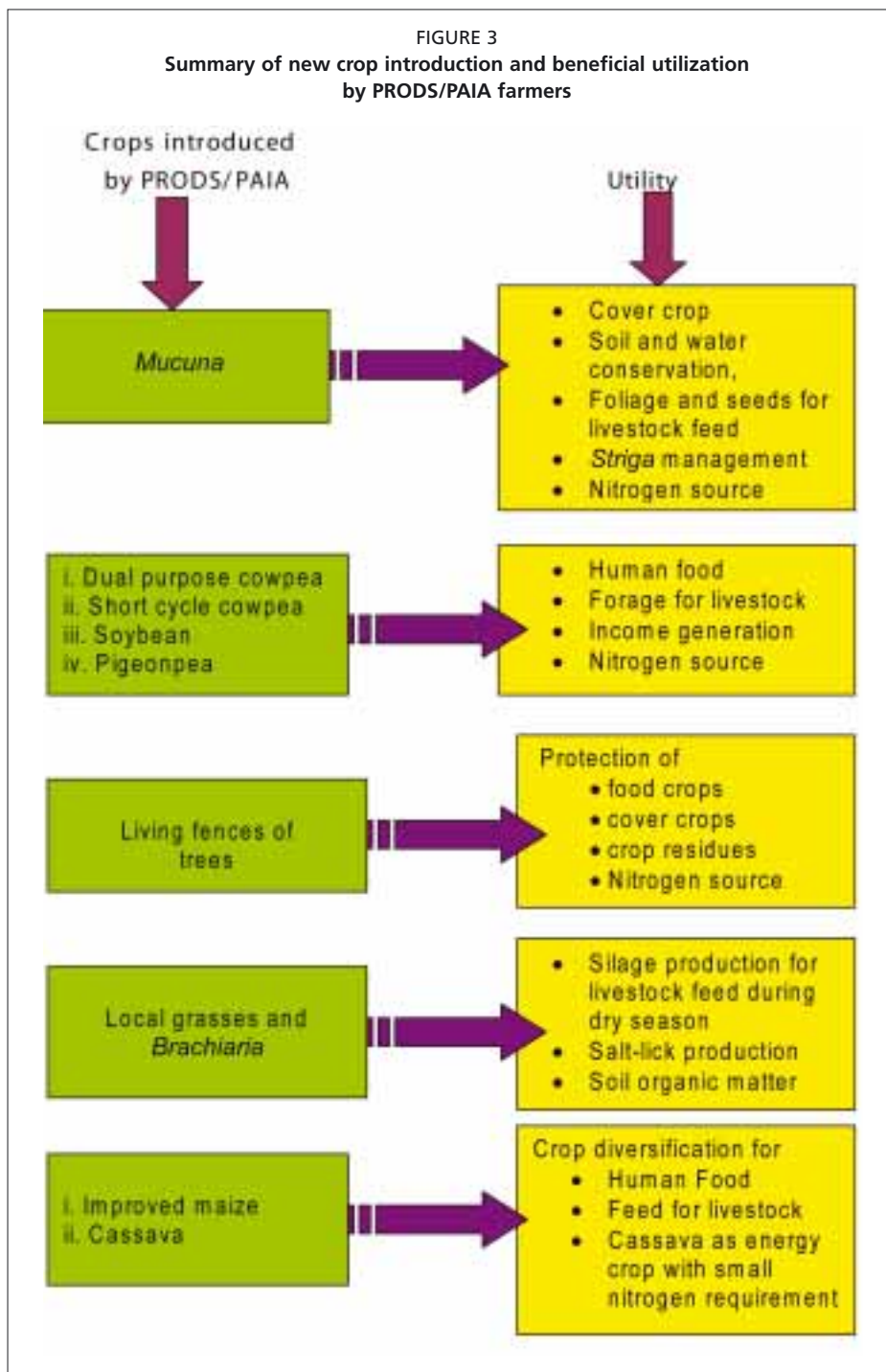
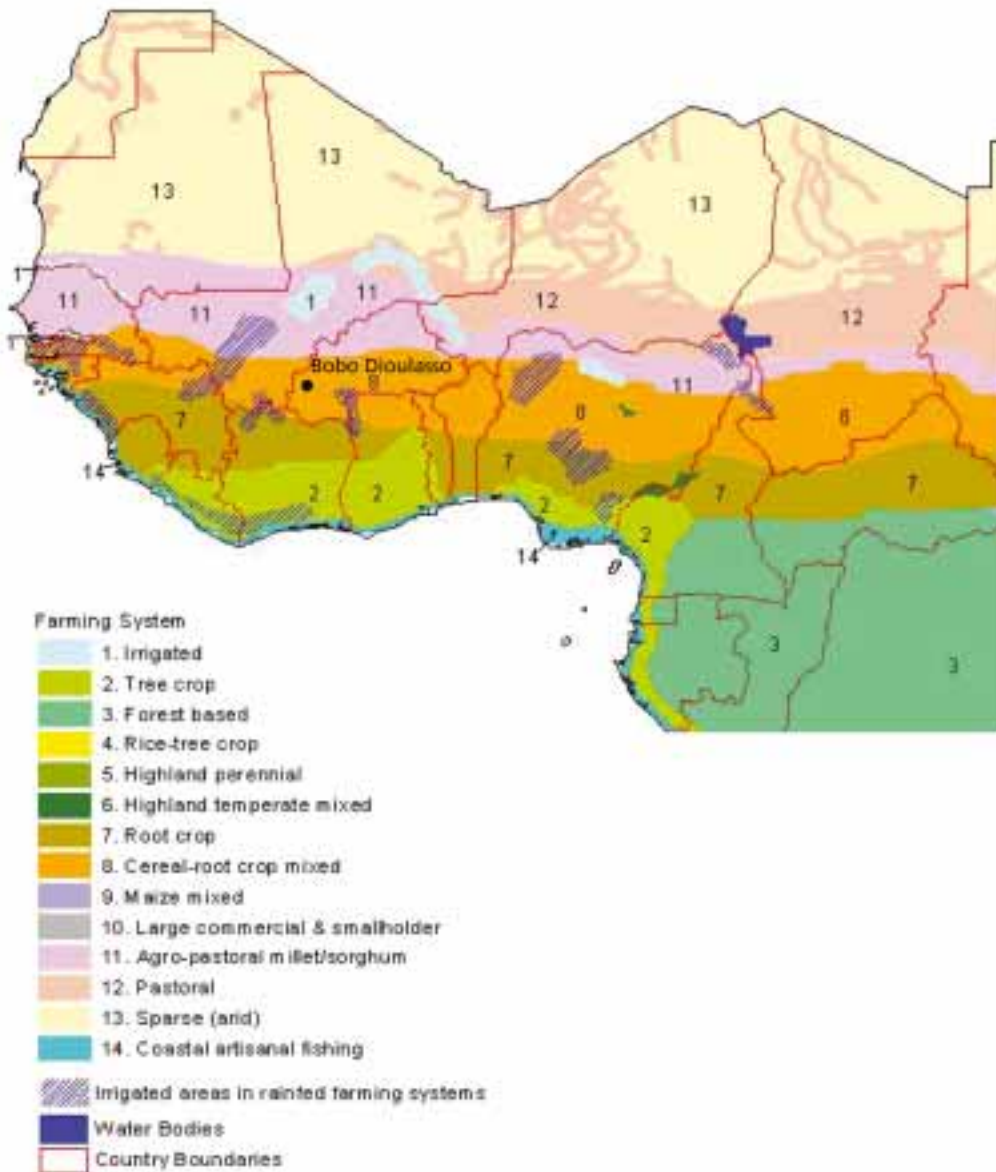


FIGURE 4

Integrated production systems in West Africa. PRODS/PAIA sites in Burkina Faso are located near Bobo-Dioulasso in farming system zone 8 dominated by mixed systems of cereal-cotton-legume crops with livestock



Source: Dixon, J. and Gulliver, A. (2001). Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO and World Bank, Rome and Washington D.C.

CHAPTER 3

Implementing the PRODS/ PAIA pilot project in South Western Burkina Faso

The “entry point premise” derived from a joint FAO/CIRAD mission in 2001 was that production systems that would increase livestock feed availability of good quality during the dry season would help small holders to enhance incomes from livestock products. However, any food and feed production increase in the project area had to be accompanied by simultaneous improvement in soil moisture supply and in soil health.

For improving soil moisture supply, and therefore the length and quality of growing season, rainfall water supply and within and between year rainfall variability had to be managed such that there would be maximum effective rainfall leading to improved soil moisture regime and minimum rain water runoff and soil erosion.

For increasing soil organic matter and biotic activity, it was necessary to minimize or avoid soil disturbance while maximising return of crop residue through crop diversification and crop rotation involving legumes and live mulches, and fodder crops.

Based on evidence from other countries with similar agro-ecology, it was agreed that all the above required changes in the farming system and benefits there from are best offered by the principles and practices embodied in CA systems (see Box 2). CA systems are specifically aimed at simultaneous improvement in soil health, soil biotic activity, and soil moisture supply, leading to improvement in crop productivity and biomass output. Further, the increase in crop diversification, crop productivity and biomass output is the basis for improved integration of livestock with crops in the farming system, and increased income from livestock products (Figures 2 and 3).

BOX 2 Conservation Agriculture

CA is a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment. CA is based on enhancing natural biological processes above and below the ground. Interventions such as mechanical soil tillage are reduced to an absolute minimum, and the use of external inputs such as agrochemicals and nutrients of mineral or organic origin are applied at an optimum level and in a way and quantity that does not interfere with, or disrupt, the biological processes. CA is characterized by three principles which are linked to each other, namely:

1. Continuous minimum mechanical soil disturbance.
2. Permanent organic soil cover.
3. Diversified crop rotations in the case of annual crops or plant associations in case of perennial crops.

Conventional “arable” agriculture is normally based on soil tillage as the main operation. The most widely known tool for this operation is the plough, which has become a symbol of agriculture. Soil tillage has in the past been associated with increased fertility, which originated from the mineralization of soil nutrients as a consequence of soil tillage. This process leads in the long term to a reduction of soil organic matter. Soil organic matter not only provides nutrients for the crop, but it is also, above all else, a crucial element for the stabilization of soil structure. Therefore, most soils degrade under prolonged intensive arable agriculture. This structural degradation of the soils results in the formation of crusts and compaction and leads in the end to soil erosion. The process is dramatic under tropical climatic situations but can be noticed all over the world. Mechanization of soil tillage, allowing higher working depths and speeds and the use of certain implements like ploughs, disk harrows and rotary cultivators have particularly detrimental effects on soil structure.

Source: www.fao.org/ag/ca/

The five farming communities in the cotton zone in moist savanna zone were selected as PRODS/PAIA sites based on the existence of the following enabling conditions for agricultural change:

- Effective demand for agricultural produce arising from the urban population in Bobo Dioulasso, and elsewhere in the country, and extensive market for livestock through regional trade.
- Good ecological potential for mix-farming and diversification.



- Existence of basic experience with agribusiness and cooperative management through cotton production.
- Potential for further integration of livestock with opportunity for improvement in the supply of feed resources.
- Need for improving and rehabilitating soil health and productivity potential through CA principles and practices.
- Presence of national and international research, technical assistance and agricultural development activities involved with farming communities, e.g., Institut National pour l'Environnement et la Recherche Agricoles (INERA), National de Semences Forestieres (CNSF), Direction Regionale de l'Agriculture de l'Hydraulique et des Ressources Halieutiques des Hauts-Bassins (DRAHB/HB), Women's Association, FAO and its various initiatives including FFS, IPM training, and SPFS, CIRAD, CGIAR Centres such as IITA, ILRI, ICRAF, ICRISAT, and more recently EMBRAPA and AGRA.

Thus, project field activities were set up and implemented in farmer-discovery benchmark sites in five pilot locations in south western Burkina Faso (Karaba in Tuy Province, Klesso, Bama/Banaroudougou in Houet Province, Kounséni /Banzon and Dandé in Kenedougou Province) around 25 to 110 km from Bobo Dioulasso that offered effective demand for agricultural produce, particularly livestock products. Field activities included the on-farm testing of technologies for crop diversification and intensification, including fodder and feed development for livestock intensification, and the application of technologies for Conservation Agriculture (CA) involving minimum or no till and crop rotation and cover management for sustainability and intensification. New crops in the rotation included *Brachiaria*, *Mucuna*, soybean, dual purpose cowpeas, pigeonpea and cassava. All this formed one of the two entry points of the initiative, based on the 2001 FAO/CIRAD joint mission, to address the declining fertility levels of arable lands, and to enhance intensification of integrated systems.

In two of the five farming communities, the process of farmer-participatory discovery at the benchmark sites was linked to Farmer Field Schools for Integrated Production and Pest Management (FFS-IPPM) demonstration and training activities for pilot dissemination was set up (see Figure 5). This formed the second entry point of the initiative aimed at the development and testing of farm family dialogue and analysis of constraints and opportunities to enhance productivity and livelihoods through the intensification of the crop-livestock-forage-tree integrated production system.

A community planning exercise involving 15 villages around Bama and Karaba was carried out in 2002 to integrate farm households' and communities' views into PRODS/PAIA project activities and to promote their participation

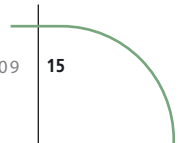
FIGURE 5
**An Integrated Pest and Production Management
 Farmer Field School (FFS-IPPM) linked to a PRODS/PAIA
 Benchmark farmer discovery process site**



(women and men) in future project activities (see Figure 6). National crop production and extension agents worked with farmers in their fields in testing new options for production intensification and diversification, such as new dual purpose cowpea and living fences (See Figure 7). Throughout implementation of the project activities, FAO staff and the farmer groups and national partners engaged in intensive and regular consultation especially after each monitoring field visit.

FIGURE 6
A household in the PRODS/PAIA village at Karaba





CHAPTER 4

Farmer benchmark-discovery process: A proof of concept for scaling

Based on the results of the pilot project, INERA and DVRD were able to establish a range of new findings regarding farmer-based discovery process and improved technologies as constituting the '*Proof of Concept*' to support the conclusion that the outcomes of the pilot project can be scaled up to promote the expansion of sustainable crop intensification in the moist savanna areas of Burkina Faso and more generally in similar African ecologies. The key activities and findings are as follows.

FARMER BENCHMARK-DISCOVERY PROCESS

The approach to develop and test technologies and to train farmers through farmer-discovery benchmark sites linked to Farmer Field Schools, which is coupled to monitoring and evaluation has proved to be efficient. Production technologies were introduced to farmers for testing and adaptation through a participatory process through some new ideas like CA practices with living fence were innovations introduced from outside the region. Selected farmers participated fully throughout the entire process of setting up field experimentation sites and managing the experiments (see Figure 8) including crop management, harvesting, recording of crop performance, post-harvest processing, preparing livestock feed and silage making and marketing.

A split-plot design to test the effect of tillage and no-till on crop performance and production was established in the maize-cotton system. Three treatments of cereal/legume crop combinations in association with cover crops and six treatments of cereal/legume rotation were laid out in the project benchmark sites. Fields were protected from damage by roaming livestock and other mammalian pests by planting close stands of living fences of *Acacia nilotica* and *Zyziphus mucronata* (see Figure 9) around the experimental field margin.

FIGURE 8
Farmers participating in setting up experimental benchmark field sites



FIGURE 9
Farmer-managed benchmark site with maize-cowpea-cotton-*Brachiaria-Mucuna* crops protected by a living fence from damage by livestock



INTEGRATED CROP-LIVESTOCK-TREE SYSTEMS IN CONSERVATION AGRICULTURE (CA)

CA was introduced into the PRODS/PAIA pilot project because FAO has shown conclusively in many countries with similar ecology that the adoption of this practice, especially by smallholder farmers, can promote significant increases in productivity of crops such as maize, soybean, vegetables and others. The practice of CA, which increases soil organic matter and soil



biota, improves soil structure, soil moisture and nutrient availability, and productivity, is based on several productivity enhancing principles, including:

- minimal disturbance of the soil, for example instead of tilling or ploughing the land, farmers plant crops directly into the soil to improve soil porosity, builds up soil organic matter and beneficial soil biota leading to improved soil health and productivity;
- providing soil cover with crop residues and/or cover mulch crops such a *Mucuna* to prevent loss of the top soil, suppresses troublesome weeds, while at the same time adding biologically-fixed nitrogen to keep the soil fertile; and
- crop rotation and crop mixtures, which involve farmers growing more than one sole crop in a mixed pattern, either in rotation or as intercrops.

These principles are applied simultaneous in order to achieve the best results, allowing farmers to produce improved yields of food and other biological products on a sustainable basis, save on labour and materials, and engage in revenue generating activities. Additionally, CA practices allow the integration of crops with livestock production in a mutually beneficial manner. This is because CA calls for crop diversification with high biomass crops including legumes to generate soil cover, fodder and crop residues, and improve soil fertility and nutrient cycling.

Minimum soil disturbance and no-till:

PRODS/PAIA activities related to minimum or no-till were established in cotton- and maize-based production systems with CA practices that included the following:



FIGURE 11
Direct seeder (animal drawn) imported from Brazil



- i. land preparation for planting using animal drawn trampling knife rollers which achieved the most minimal disturbance of the soil while flattening the vegetation and residues including from cover crops.
- ii. direct seeding using hand operated Brazilian made jab planters (*Cannes planteuses*) (see Figure 10) and animal drawn disc seed drills (see Figure 11) to minimize soil disturbance during seeding and to achieve more efficient plant spacing.

Crop diversification for multiple utility:

Burkinabe farmers traditionally grow a restricted range of subsistence crops, mainly the cereals maize, pearl millet, sorghum, and the legumes groundnut and sprawling variety of grain cowpea, locally called *niebe*. PRODS/PAIA project extended the range of crops in the cropping system to improve crop mix and crop rotations to raise farm incomes, enrich diets, improve soil fertility, and increase biomass for fodder and silage and for soil cover with cover crops and residues.

Technologies for crop diversification in the cotton- and cereal-based systems under CA practices included:

- (i) Diversification of cereal-legume associations (maize, sorghum, millet with long season grain cowpea) with improved cereals and four legumes – early maturing cowpeas, soybeans, dual-purpose cowpea and *Mucuna* for the following value added:
 - Early cowpeas (60 days) and dual purpose cowpeas (see Figure 12) for grain and fodder of higher nutritional value especially during the dry season, as well as a source of biological nitrogen;



FIGURE 12
Dual purpose cowpeas for grain and fodder



FIGURE 13
The 2+4 sorghum-cowpea crop component of the sorghum-early (60-day) maturing cowpea-goats/sheep systems developed by IITA and ILRI



- Integrated crop-livestock systems developed by IITA and ILRI (e.g., the 2+4 sorghum or maize-cowpea-goats/sheep system) (see Figures 13 and 14). The cowpea haulms from the first 60-day crop are used to feed confined goats and sheep (Figure 14) and the manure is returned to the cereal fields;

FIGURE 14

The livestock component (confined goats and sheep) of the integrated crop-livestock system based on the cereal-early maturing cowpea cropping developed by IITA and ILRI



- Soybean for vegetable oil, for which there is a high demand, and a source of fodder and feed concentrate, and of biological nitrogen;
- *Mucuna* as a cover crop (see Figure 15) to provide soil cover to prevent top soil loss, increase effective rainfall, suppress weeds and add biological nitrogen;
- Feeding livestock with locally processed *Mucuna* seed rations to increase meat and milk production, and improving feed rations with legumes for dry season feeding.

FIGURE 15

Mucuna surrounded by living fence in rotation with no-till maize and cotton



(ii) *Brachiaria* spp. (see Figure 16) plus local grasses for production of silage through pit silage method for livestock (see Figure 17, and next section for details), including salt-lick production; root masses of sown grasses

FIGURE 16

PRODS/PAIA introduced the high biomass grass, *Brachiaria ruzizensis*, to improve availability of livestock feeds during the dry season



FIGURE 17

Women managing pit silage making with *Brachiaria* and local wild grasses



also increase soil organic matter and keep soil surface protected (see Figure 18); this is particularly effective in the light-textured soils where building soil organic matter is so difficult.

(iii) Introducing cassava as a 'new' crop (see Figure 19) in the cropping system for food security, and an energy source for food and feed rations.

(iv) Integrating agro-forestry with crop production by planting living fences of fodder trees such as *Acacia* and *Ziziphus* to protect the crops and crop residues from livestock during the dry season (see Figure 20).

Furthermore, as a result of improved supply of better quality livestock fodder and feed (see next section), the range of livestock reared by farmers was

FIGURE 18
Soil cover with *Brachiaria* residues



FIGURE 19
Cassava (left), growing luxuriantly, is one of the new crops promoted by the PRODS/PAIA project to diversify crop production



expanded by the introduction of better management practices for cattle, sheep, goats, chicken and guinea fowls, through FAO's support to a companion activity – The Special Programme on Food Security.

INTEGRATION WITH LIVESTOCK PRODUCTION

Silage and salt-lick production:

Extensive cultivation of the high biomass grass, *Brachiaria ruziziensis*, was introduced to farmers in the PRODS/PAIA sites to encourage them to use this grass, among other locally available plants for silage production (Figure 16).

FIGURE 20

Integration of crop production with agro-forestry: Living fences surround farm of no-till maize and cotton after *Mucuna* soil cover



The production of livestock in the Oubritenga province of Western Burkina Faso, in particular, is precarious due to shortage of feeds and the prolonged severe dry periods when livestock, especially small ruminants experience high weight losses and in some cases, may even die. Although cotton seed is sometimes used to feed livestock to supplement available feeds, this has not been sufficient. Furthermore, farmers were encouraged to collect crops wastes of several leguminous plants including *Mucuna*, fodder cowpea, grain cowpea and soybean for incorporation into livestock feed rations during the dry season.

Despite these efforts, the dry season availability of feeds for livestock continues to constrain sustainable livestock production. Consequently, PRODS/PAIA introduced a silage production technology to farmers and further organized training for women farmer groups in silage production using locally available herbage, such as grasses, cereals and salt.

The silage production technology introduced by PRODS/PAIA is as follows (see Figure 17): Naturally growing wild grasses, mainly *Andropogon gayanus*, *Brachiaria ruziziensis*, *Digitaria ciliaris* *Echinochloa* and *Pennisetum pedicellatum*, are harvested at the early flowering stage when the moisture content is about 30 – 40%. Green cereals residues of poorly developing maize, rice, sorghum or millet crops are also harvested for use in silage production.

Silage pits measuring 3m x 1m x 1m are dug by hired male labour and harvested herbage is packed in 5 -10 cm layers into each pit which contain about 4 tonnes of herbage. The layers of herbage packed into the pit are compacted by rolling a 200 litre metal drum filled with water over them after which, common salt is sprinkled on the herbage. When the pit is full, it is covered with soil and thick black plastic sheeting and further compacted

to seal the pit watertight. The herbage is then left to ferment and cure for about 3 weeks after which it is ready and collected for feeding to livestock. Before using the cured silage to feed livestock, it is aired for 24 hours to allow noxious gases formed during herbage fermentation to escape, which could be poisonous to animals.

Sprinkling salt in the herbage during silage production produces salt-laden soil as a by-product, which constitutes salt lick which livestock love to eat. Further production of salt-licks is achieved by making the pit 20 cm deeper to accommodate a layer of fine sand or kaolin clay on which about 0.5 kg of salt is spread prior to placing the layers of herbage into the pit for silage production. When the silage is cured, this salt laden sand or clay is compacted into 40 x 20 x 10 cm wooden frames, and sun dried to produce 2.5 kg salt-lick blocks.

Through FAO/INERA collaboration, extensive studies in Western Burkina Faso showed that the opportunity cost of silage and salt lick production using this technology, is low with a cost-benefit ratio of 527%, and therefore highly profitable and beneficial to small holder livestock farmers. Feeding Azaouak cows on silage supplements resulted in a dramatic tenfold increase in milk production, while ewes fed on silage supplement maintained milk yields throughout the year.

Farmers quickly adopted this silage production technology not only to successfully feed livestock during the dry season but also as an income generating opportunity through the sale of silage and salt-lick blocks. To widely disseminate this now popular technology, PRODS/PAIA conducted group training courses in silage and salt-lick production in several villages not only to build farmer capacities to produce silage and salt licks, but also to facilitate promotion of farmer-to-farmer dissemination of the practice. Thus between year 2002 and 2003, the numbers of beneficiary farmers increased 120 (80 women, 40 men) to 537 farmers (352 women and 185 men). The technology has now spread by farmers to 12 farmer groups in 17 villages, each consisting of 50 – 80 farmers.

Thus through the introduction of forage technology for the production of livestock feeds, farmers successfully increased the levels of animal production and enhanced their farm incomes. Furthermore, farmers were encouraged to judiciously collect crop residues of several leguminous plants including *Mucuna*, fodder cowpea, grain cowpea and soybean for incorporation into livestock feed rations during the dry season, while leaving soils covered to protect them from erosion and to increase soil organic matter.

Mucuna seed processing for value added livestock feed:

The introduction of *Mucuna* as a cover high biomass crop to enhance soil and water conservation, improve soil fertility and minimize soil erosion and degradation was widely adopted by farmers who produced the cover crop on a

FIGURE 21

Sawadogo Salam Lassane, the proud Burkina farmer who developed the *Mucuna* seed processing technology



large scale. High production of *Mucuna* now posed the challenge of maximum utility of this crop, particularly the abundant seeds harvested from the crop.

One innovative farmer, Sawadogo Salam Lassane (Figure 21) at the Dande village community decided to experiment with several processing methods and successfully developed a *Mucuna* seed processing technology for the production of livestock feeds for cattle, sheep and goats. *Mucuna* seeds contain a heat labile toxin, so the use of fire wood for cooking the seeds, to enable seed use, may be a limitation for some farm families.

Feeding livestock with processed *Mucuna* seed rations was highly successful. Sheep fed on feed including boiled *Mucuna* seeds increased their weight by at least 35%, and milk production in goats was significantly increased. Through adopting this processing technique, farmers were able to significantly increase their farm revenue from the sale of fattened livestock as well as the production and distribution of *Mucuna* seeds to neighboring farmers.

BENEFITS AND OUTCOMES FROM PRODS/PAIA

According to the participating farmers, PRODS/PAIA project produced highly significant positive innovations and changes not only to the individual lives of rural farming families, but also provided new directions in the patterns of rural community life and development. The PRODS/PAIA project introduced farming technologies adopted by farmers that have enabled them to enhance the productivity potential of the land, achieve more sustainable increases in agricultural production, natural resources conservation and environmentally sound farming practices, improved food security, higher farm incomes which have contributed significantly to the attainment of better and sustainable rural livelihoods and to the fight the dehumanizing effects of rural poverty.

Case studies undertaken across the five participating farming communities, based on interviews of farmers, national partners and policy-makers, illustrated a range of benefits and outcomes resulting from the PRODS/PAIA project. Some of the highlights are as follows.

Case Study 1: Klesso Village

1. Planting *Mucuna* cover crop and cowpea improved soil fertility *Striga* control and gave significant increases in overall crop production; *Mucuna* leaves and other fodder were very useful for feeding livestock to increase family income
2. Crop yields were higher when legumes were rotated with cereals such as maize
3. The PRODS/PAIA technology introduced and adopted did not increase the cost of labour for crop production
4. By adopting PRODS/PAIA technologies, cowpea and maize production were increased to such an extent that we were able to store products and sell them at much higher prices to increase farm revenue. With increased farm income, there was an improvement in family livelihood.

Case Study 2: Karaba Village

1. Farmers learnt lessons in soil conservation, and in sustainable and increased agricultural production
2. After harvesting their cotton, farmers practiced crop rotation technology involving “dual purpose” cowpea and maize which helped to increase food and agricultural production
3. *Mucuna* cover crop was highly effective in soil conservation and controlling soil erosion which had been prevalent in their farms. *Mucuna* foliage and the transformed seeds were also useful as feeds for their livestock; *Mucuna* foliage was highly nutritious, giving rise to well developed and healthy animals that fetched higher market prices according to farmer consultations.
4. Residue from farm harvests were also used for feeding livestock
5. The introduction of living fences effectively protected their crops from damage by roaming animals and stealing of crops by intruders
6. Soybean production increased to the extent that the Karaba village farming group association won contracts to supply soybean seeds to a commercial soya processing company. This resulted in significant increases in farm incomes
7. Through participation and adoption of PRODS/PAIA technologies, two of their members, Mr Fankani Tini and Mr. Tiki won the annual National Merit award (*Ordre du Merite du developpement Rural*) in October 2005 for Excellence in agricultural production.



Case Study 3: Dande Village

- 1 Adopting zero tillage practices resulted in better and healthy growing plants than when crops are grown in ploughed fields
- 2 The Dande area is characterized by serious land pressure since the migrant/settler farmers there cultivate the same land for over 20 years resulting in low soil fertility. Crop rotation involving cowpea and maize, and the use of *Mucuna* cover crop, resulted in improved soil conditions, reduction of *Striga* infestation and consequently in higher cowpea and maize yields. Increased crop harvests translated to increased farm income for them and they were able to satisfy their domestic food needs and have surpluses for sale in local markets.
- 3 The successful development of *Mucuna* seed processing and utilization for livestock feed by one of their innovative farmers, Sawadogo Salam Lassane, opened up excellent opportunities for wide-scale increased livestock production in their locality. Livestock fed on 1kg/day of processed *Mucuna* seeds rapidly increased in weight, weak animals were quickly revived and milk production in dairy animals was drastically increased.
- 4 Because of the success farmers achieved with the *Mucuna* seed processing, they undertook extensive training of other farmer groups outside the project in *Mucuna* cultivation and seed processing for the general benefit of farmers in their country.

Case Study 4: Tanghin Kossodo Women Group. (*Groupement pre-coopertif féminin Song-Waoga de Tanghin Kossodo*)

The Tanghin Kossodo Womens Farmer Cooperative Group was formed in the Province de l'Oubritenga. The Group consisted mainly of 26 women but they admitted six men into the group. Three Action Groups, namely (i) Traditional Chicken Production, (ii) Small Ruminant Management and (iii) Cattle Fattening, had been established to promote village commercial enterprises.

Following participation of this group in PRODS/PAIA, the major activities undertaken on a large scale included silage production and livestock production. Through participating in the PRODS/PAIA project, the farmers achieved the following:

1. Adopted a silage production technology, with salt added to provide salt-lick as a by-product of silage production. The salt-lick is vital for rapid and full development of livestock. Farmers here now undertake continuous production of silage for sale to generate extra income to purchase more livestock for fattening and to educate their children. Consequently their economic standards have improved with additional financial resources now available to allocate for family expenses and to expand their agricultural production businesses

2. By feeding animals with the silage and salt-lick supplement, ewes maintain milk production throughout the year; Azaouak cows fed on silage and salt-lick supplement produced 10 liters of milk each day throughout the year
3. Silage production technology was now disseminated through publications and conducting regular training courses for farmer groups from surrounding villages. Furthermore, farmer Groups from other parts of Burkina Faso, from Ghana, Niger, Congo and Benin have undertaken study tours to the *Tanghin Kossodo Women Group* for practical experience in silage and salt-lick production
4. Following the outstanding success achieved with cattle production through the use of locally produced silage and salt-lick, the Cattle Fattening Action Group of this Tanghin Kossodo Women Cooperative has received supply contracts from entrepreneurs in Ghana for fattened cattle. The successful development and organization of this enterprise has significantly improved community life in the Oubritenga locality.
5. With improved economic status, several farmers have been able to build many more and better houses to accommodate their extended families

Case Study 5: Training and capacity building in integrated production intensification

With the adoption of sustainable agricultural production practices introduced by the PRODS/PAIA project, the rapid dissemination of these technologies and good agricultural practices were promoted through extensive participatory group farmer training and capacity building activities. Training was conducted in the following topics:

1. Participatory Community Planning – This was attended by 140 farmers (65 males and 54 females) from eight villages to assist farmers to identify training needs for agricultural production
2. Silage production – involving 2,000 farmers were trained in 30 silage production sites, to increase availability of livestock feed resources including salt licks
3. Use of conservation agriculture equipment – for six lead farmer trainers and four supervisors, to promote agricultural production in the context of environmental resources conservation application of chemical pesticides
4. Training in the processing of *Mucuna* seeds for livestock feed – involving 500 farmers from the five PRODS/PAIA sites to increase the availability of rich livestock feeds and salt lick as well as generate income through the sale of prepared silage
5. Use of *Mucuna* for soil fertility enhancement and *Striga* control; potential seed are for feed when boiled for several hours to eliminate toxins.



A CONVERGING PARTNERSHIP – A COMMUNITY OF PRACTICES (CoP)

In general, with the introduction of Conservation Agriculture practices and additional crops (e.g., forage and food legumes, grasses, fodder trees), there was an increased demand for capacity building for dissemination of promising technologies for biomass management and livestock feed delivery in integrated crop-tree-livestock systems. With training support for farmer capacity building and technology fine-tuning, the CA technologies, particularly minimum or no-till in crop rotation with cover crops, are ready for scaling of sustainable crop intensification that offers optimum productivity and greater competitiveness. Minimum or no-till as one of the components of CA to improve soil organic matter and the soil biotic activity it supports, as well as to improve soil porosity, is particularly suitable and convenient for planting early, for improving soil fertility and moisture availability, for extending the rainfed growing season, and for reducing energy requirement. Selecting cover crops, including live mulch and fodder crops such as *Mucuna* and *Brachiaria*, combined with main food crops will at times be necessary to ensure that soil surface remains covered with plant material all year including the long (5-6 months) dry season. One size does not fit all situations; knowledge and understanding choices are essential.

There is now in existence a converging partnership – a Community of Practices (CoP) -- in place requiring the inclusion of critical input and output technology supply elements to ensure cost-effective scaling and impact.

Since 2004, FAO, the Ministry of Agriculture, the Ministry of Animal Resources and the Institute of Environmental and Agricultural Research have accompanied the National Cotton Growers' Union (UNPC-B) in the promotion of Good Agricultural Practices emphasising IPM through capacity building (training of facilitators and farmers) in the complex cotton-cereals-livestock cropping systems of South Western Burkina Faso. So far, through a companion activity which has subsequently merged as of 2007, 35 FFS facilitators and 822 small farmers have been trained. The initial activities of this programme were funded by the Norway government. Since 2007, the programme has been funded by the sub-regional Integrated Production and Pest Management (IPPM) Programme through the Dutch government. The IPPM-FFS network in Burkina Faso is expected to expand to some 200 field schools. It is run by national institutions, facilitated by the FAO-guided project.

CHAPTER 5

Going to scale with farmer discovery process in Burkina Faso

The remarkable successes achieved by PRODS/PAIA pilot project in south western Burkina Faso clearly demonstrate how an FAO field project implemented with the extensive participation of national as well as regional and international development partners can significantly impact on the agricultural production and livelihoods of smallholder farmers in a moist savanna agro-ecological environment that can be difficult and hostile.

The PRODS/PAIA project successfully collaborated with other FAO projects in western Burkina Faso, especially, the Special Programme for Food Security (SPFS), the Sustainable Agriculture and Rural Development (SARD) initiative, and the Integrated Pest Management Farmer Field Schools (IPM/FFS). The PRODS/PAIA project introduced and adopted CA practices in cotton and maize production systems as an entry point. There was an outstanding impact at farm level as described by the participating farmers not only in all the project sites, but also amongst farmers in neighbouring communities who consistently demanded the technologies introduced by PRODS/PAIA.

The IPPM-FFS programme has trained facilitators and farmers in western, south western and eastern Burkina Faso, and the proposed process will extend its activities to these regions. The scaling process will promote on-farm farmer-participatory discovery and adaptation of promising pipeline technologies which will feed into FFS. Since 1996, FAO has introduced FFS in Burkina Faso through a rice-based initiative in the Valley du Kou and in several other locations involving cotton and vegetable production systems.

As a result of the pilot project outputs, INERA, DVRD and the farmers were able to establish the following outcomes, namely that:

- Technologies for crop diversification and crop and livestock intensification are ready for scaling. There is a great interest for soybean as vegetable oil;

- With training support for farmer capacity building and technology fine tuning, the Conservation Agriculture (CA) technologies, particularly minimum or zero tillage in crop rotation with cover crops, are ready for scaling (these correspond to NRM technologies in association with several crop commodities) and further adaptation. Minimum or zero tillage is more convenient for early growers, and for soil fertility and moisture management in the resulting extended growing season;
- There is an increased demand for capacity building for dissemination of the promising technologies for biomass management and livestock feed delivery in integrated crop-tree-livestock systems;
- There is in existence a converging partnership in place requiring the inclusion of critical input and output technology supply elements to ensure cost-effective scaling and impact. Recently, plant breeders have expressed their interest for fodder species for on-farm high biomass production, fodder quality management and seed access; and
- The integrated approach in place both to develop and test technologies and to train farmers (Benchmarks sites + Farmer Field Schools + Monitoring and Evaluation) in a participatory process has proved to be effective.

The above positive outcome from the pilot project, though anecdotal but confirmed from technical field visits, provides a strong justification for a follow-up ‘going to scale’ process that can strengthen the essential input and output supply chains in support of adoption and scaling up of the dissemination of promising technologies for crop diversification and intensification, CA for sustainability and intensification, and livestock feed delivery for optimal integration of crop-livestock relationships.

Consequently, a “Going to Scale in Burkina Faso” process is proposed, within the context of the current government’s policies for agriculture development, with the main focus on capacity building and empowering of farmers and local agribusiness entrepreneurs to promote the sustainable diversification and intensification of crop-livestock production systems based on Conservation Agriculture practices in the moist savanna ecology of Burkina Faso, with the ultimate goal of reducing extreme poverty.

Thus, INERA and DVRD, in collaboration with FAO, are jointly proposing to scale-up the effort to reach a meaningful number of farm families and impact. The integrated and participatory approach successfully applied by FAO-INERA-DVRD will promote proven technologies and practices. The scaling-up process includes on-farm farmer-discovery benchmark sites, Farmer Field Schools (FFS), “Community of Practices” and monitoring and evaluation protocol to assess the performance of the programme.



GOAL, APPROACH AND OBJECTIVES

Within the context of the current government's policies for agriculture development, the overall goal of the scaling-up process is: *to support the implementation of the Ministry of Agriculture's strategy to harness the agricultural productivity of crop-livestock systems in the moist savannas in Burkina Faso for livelihood and agribusiness development based on good agricultural practices.*

The integrated and participatory approach successfully applied by FAO-INERA-DVRD-DRAHRH, and linked to government agricultural development policies of promoting Good Agricultural Practices and farmer participatory empowerment through capacity building, is being proposed to promote proven technologies and practices. This approach will include an expanded network of on-farm benchmark sites as a generator of relevant and adapted technologies and practices for dissemination, Farmer Field Schools (FFS) process for participatory learning, the "Community of Practice" and Monitoring and Evaluation protocol to assess the ongoing performance and intermediate impact of the programme.

The scaling process has the following four major objectives:

Objective 1: The scaling up of adoption of CA technologies for intensification and fine tuning in benchmark sites of minimum or zero-till technology in crop rotations with cover crops and crop mixtures with legumes, grasses and fodder trees. This objective includes a component activity on strengthening the input supply especially for no-till direct planting equipment and knife roller technologies from local manufacturing or commercial importation.

Objective 2: The scaling up of adoption of new crop technologies for sustainable biomass and crop intensification (e.g., new crop mixtures with legumes, grasses and woody perennials), and for crop-livestock integration, diversification and intensification, including farmer-based seed supply systems for new crops and varieties such as early and dual purpose cowpea, *Mucuna*, soybean, pigeonpea, sorghum, *Brachiaria*, cassava and trees. The objective includes the activity for the introduction and testing the improved cereal-legume associations (e.g., the 2+4 cereal-cowpea cropping systems developed by IITA involving medium and short duration cowpeas with maize and sorghum, and the tree legume-cereal associations developed by ICRAF).

Objective 3: The scaling up of adoption of technologies for biomass management for mulch and soil cover, for livestock feed (fresh fodder and silaged, *Mucuna* seeds), and for livestock feed delivery for livestock intensification in integrated crop-tree-livestock systems (IITA/ILRI Sorghum/Cowpea/Confined Goat Technology). This objective includes the maximising

of biomass availability from grasses, cereals legumes (including dual purpose types) and trees with maximum BNF input, and feed from other sources such as fodder legume seeds, cassava, soybean, etc. The use of controlled grazing and technologies for silage-making to supplement quality fodder during the dry season will be a central component of livestock feed biomass strategy.

Objective 4: The consolidation and strengthening of the converging partnership or the “Community of Practice” for innovations dissemination with inclusion of critical national and international stakeholders for input and output supply services including credit, seeds, equipment, plant nutrients etc., to support the implementation of the scaling up strategy of the MoA. This objective includes the activities of advocacy and awareness raising as well as providing training for capacity building, through FFS and other mechanisms including benchmark sites network, to public and private sector stakeholders, including for strategic planning, supply and output delivery services, credit provisioning through the *warrantage* system and for enhancing participation of women farmers and entrepreneurs.

To deliver the above four objectives, the following programme strategies will be followed.

For Objectives 1: Dissemination of proven technologies and practices for diversification and intensification of the crop-livestock production systems will aim at the optimization of the crop rotations and the biological processes in the soil-plant-animal systems for efficient enhancement of economic productivity, biomass production, soil health and fertility enhancement, and of integrated pest management for efficient control of all pests including the use of botanical and biological pesticides. The application of the Integrated Production and Pest Management (IPPM) strategy will ensure that priority is given to alternatives to agrochemicals (i.e., botanical and biological pesticides or the enhancement of biological control agents). Agrochemicals will only be recommended when there is an evidence of the failure of these alternatives and under strict application of good agricultural practice and the use of certified safe equipment. Farmers attending FFS will select what is suitable to their physical and economic environment. Crop management training will include the management of climatic risks. For production and distribution of seeds, farmer-based seed supply systems will be promoted, including capacity building training.

For Objective 2: Dissemination of proven practices of minimum or zero tillage, protection of soil cover, enhancement of soil biota, soil organic matter accumulation and soil porosity development, integrated management of weeds, enhancement of rainfall infiltration and soil moisture holding capacity, and efficient storage, mobilization and uptake of plant nutrients will aim at a better soil-plant-nutrient-water system management. Training



will address capacity building in the use of Conservation Agriculture technologies. Through integration with livestock and compost making, it will aim at optimizing nutrient use efficiency. The IPPM strategy will promote alternatives to chemicals, (e.g., crop cover and residue management, mechanical and biological options) from the beginning. The dissemination of these technologies will be done directly through the IPPM-FFS network to reach a maximum number of beneficiaries. In the first year, attention will be paid to those CA technologies that are ready to be scaled through the IPPM-FFS network e.g., cover crops, high biomass legumes and grasses, residue management, weed suppression and depletion of seed reservoir, living fences etc. Alongside, in the first year, farmer-discovery bench-mark sites including larger on-station sites will be used to further evaluate these and other CA technologies, particularly minimum or zero tillage and direct seeding practices before they are introduced into the IPPM-FFS curricula. Living fences will be established in the IPPM-FFS as has been done successfully in the Bama FFS site.

For Objective 3: Dissemination of proven practices for biomass production and conservation strategy (silage, hay and cereal residue treatment with urea) for smallholder livestock producers in integrated systems will aim at maximising biomass availability from grasses, cereals and legumes (including dual purpose types) and trees with maximum BNF input. It will also aim at increasing the production of feed from other sources such as fodder legume seeds, cassava, soybean, etc. in order to give more options to farmers in relation to their own constraints and potentialities (land tenure for example). The use of technologies for silage-making to supplement quality fodder during the dry season will be a central component of livestock feed biomass strategy.

For Objective 4: Advocacy activities and awareness raising for policy support and other key stakeholders will be undertaken to consolidate the converging partnership or the community of practice to serve as a platform for innovations dissemination. Training for capacity building will be provided through FFS and other mechanisms to stakeholders including private sector for inputs (herbicide, equipment, seeds) and output supply chain services (linked to livelihoods of producers, output delivery service providers, consumers), for strategic planning and workshop facilitation, and for the provision of credit and consideration of *warrantage* system for accessing finance. Efforts will be made towards enhanced participation of women farmers and entrepreneurs.

The FAO coordinated IPPM-FFS regional programme has trained facilitators and farmers in western, south western and eastern Burkina Faso, and the proposed scaling-up process will extend its benchmark site activities to these regions. The on-farm farmer-participatory discovery and adaptation of promising pipeline technologies will feed into the FFS network. The scaling-up process will expand its benchmark site network to up to 10, and scaling will

be through at least 100 IPPM-FFS sites over a five year period, implemented at the rate of 10 IPPM-FFS (first year), 20 (second year), 30 (third year), and 40 (fifth year).

EXPECTED OUTPUTS AND OUTCOMES

Key outputs will relate to: (1) increased capacity building through the IPPM-FFS approach: increased number of trained farmers and increased farmer capacity to adopt and manage technologies for diversification and intensification in crop-livestock systems; and (2) strengthening farmer support system: increased number of service providers in the input and output supply chains.

Increased capacity building will relate to numbers of farmers trained and applying technologies in the following areas:

- Crop diversification and intensification for the market
- Marketing
- Livestock diversification and intensification for the market
- IPM for pest control
- Conservation Agriculture technologies for sustainable soil system management and crop-livestock intensification
- Equipment and its use, crop rotation, cover crop
- Farmer-based seed supply systems
- Silage making and biomass management for livestock feed
- Compost making and biomass management for soil fertility.

The strengthened farmer support systems will relate to numbers of agribusiness stakeholders trained and/or integrated within the “community of practice” (Platform for innovations dissemination) with the objective of delivering inputs and outputs services in the following areas:

- Inputs supply agribusinesses enabled to supply inputs and farm equipments etc.
- Outputs service agribusinesses enabled to process and deliver primary produce and processed products to markets
- financing.

Key outcomes will relate to absolute and percent change in livelihood, economic development and environmental benefits in terms of number and type of people affected including also from reduced labour requirement resulting from the adoption of CA practices, expansion of area under new practices, changes in agricultural productivity and primary and secondary biological output, and enhancement of soil productivity and ecosystem services, resulting from the above outputs. Quantifiable impact targets will be



defined to reflect expected changes in:

- Area and people under different crop and livestock diversification technologies and CA intensification technologies, including women, elderly farmers, and the physically weak:

We expect 5,000 participants in the 200 FFS that will be organized during the 5 years of the project. If each participant represents a household, then a total of 5,000 households will be directly affected by this project. The FFS convey hundreds of non-targeted farmers during field days. An average of 150 farmers is expected to visit each FFS. So a total of 30,000 farmers will be exposed to the new technologies and practices. One third of these farmers are generally female.

- Productivity and output of crop and livestock products:

Based on previous results in the cotton-based FFS, the expected yield increase is about 30% for cotton and 40% for maize. The gross margins with cotton will increase 2.5 times and that of maize 2.8. The cropping area for soybean and cassava is expected to double as there is a growing interest for these crops. Feed production will be integrated in the cropping systems and will be more accessible and available all year round.

- Food production, availability and nutrition dimension of food security: Food production will increase by about 30%. With crop diversification, more food should be available all year round; nutrition and food security will be improved.

- Food marketing.

- Livelihood parameters, particularly income and social services being accessed, with emphasis on rural women:

The overall livelihood of affected populations will improve. The sources of rural women incomes will be diversified.

- Resilience of the production system to abiotic and biotic stresses, sustainability of the land resource base, and enhancement of ecosystem services:

Land management will be sustained through the dissemination of new adapted technologies (cover crops, legumes, fodder crops etc.). Conservation Agriculture technologies will impart greater climate change adaptability to the production system leading to: (a) improved soil moisture growing conditions, reduced impact of rainfall variability and droughts on yields, and reduced pest and disease problems; (b) improved rainfall infiltration, minimum runoff and soil erosion; (c) increased soil Carbon sequestration through higher levels of humic and non-humic SOM and soil biota, and improved aquifer recharge and stream flow.

THE WAY FORWARD WITH THE 'COMMUNITY OF PRACTICES'

One of the main strengths of PRODS/PAIA was the direct farmer participation, including the use of their farms as demonstration sites, farmer training activities and participation in field days for sharing of experiences and information exchanges between farmer groups within Burkina Faso and other countries in the West Africa sub-region. Many of the faced problems to improve agricultural productivity lie at the interface between productivity improvement, sustainable natural resource management, markets, policies, and institutions. Formal research and extension systems are stretched thin, farmers often lack access to necessary resources, and many stakeholders in agricultural value chains are left out of the innovation process development and dissemination. Policies and conventional practices have often skewed existing groupings and patterns of interaction so that innovation processes are not responsive to the welfare needs of the farmers.

The evidence from the Burkina Faso experience suggests that the most successful innovations development and dissemination have come about by bringing together all relevant stakeholders to co-design interventions, learn from one another, and change the norms and practices that comprise the institutional context. In other words, success is about the capacity of whole systems to innovate and integrate. Behavioural changes in all concerned stakeholders is necessary.

The term "Community of Practices" (CoP) is used to describe the context in which stakeholders interact. CoP is comprised of a set of stakeholders who are bound together by their individual interests in a shared issue, objective, challenge or opportunity, dealing with which will improve livelihoods, businesses and/or other interests. The leverage points for making a significant difference lie mostly in the interaction between the different components or actors in the system, rather than in strengthening any one component on its own. Strengthening interaction is largely a matter of bringing about institutional and behavioural changes. To improve agricultural productivity of the moist savannas in Burkina Faso by dissemination of proven technologies and agricultural practices will require a large partnership within the CoP.

To scale up the successes of the PRODS/PAIA, there is a need to strengthen the CoP through the building up of the capacity of farmers in the strategic practices e.g., IPM, soil fertility and biota management through Conservation Agriculture principles and practices, short-term and longer-term climatic risk management, and knowledge brokering and management, through the training of trainers (ToT) approaches being implemented in the FFS networks for capacity building. Such approaches including farm life schools and junior schools implemented within participatory community development initiatives can make farmers become 'experts' and self-confident. Such ToT approach in Farmer Field Schools has trained 3 million farmers in IPM principles and



practices in Asia, and with appropriate curriculum and field based training and testing it would be possible to train a large numbers of framers in integrated plant-pest-soil-water-nutrient management. Since 2001, 25,000 farmers have been trained in three countries in West Africa, and the second four-year phase now beginning aims to train 130,000 farmers. The focus is on the quality of training and the efficiency of the ToT approach, including self-sustainability through for example auto-financing schemes in which farmers hire extension agents through savings and microloans. Such scheme would be relevant in future expansion of the PRODS/PAIA approach in West Africa.

The extensive interest generated by the evidence of success of PRODS/PAIA in the five locations in Burkina Faso encourages farmers and national partners to request that this ‘Community of Practices’ in intensified integrated production systems be further strengthened and extended to many more sites in the moist savanna zone not only in Burkina Faso but also to other countries in West Africa with similar agro-ecologies. Such expansion and scaling up of the successful approaches can be achieved through support from international and regional donors and development partners which have established on-going community agricultural development programmes in West Africa. Other international donors can be brought into the stakeholder partnerships within the CoP to systematically promote the large scale intensification of integrated land and production management systems through participatory community development programmes across Sub-Saharan Africa. Various forms of market responsive Conservation Agriculture approaches and of farmer-based “innovation and learning” processes of knowledge generation and transfer would have a central role in different situations in such programmes.

The technology inputs from CIRAD, IITA, INERA and DVRD are already captured within the existing “Community of Practice” (CoP). Planning Unit of MoA, UNPC-B, Ministry of Animal Resources (MoAR), ICRAF, EMBRAPA, CIAT, ILRI, IFDC, AGRA and other partners from the private sector e.g., banks, rural engineering firms, agricultural input and service providers, will join the partnership initiative to support and facilitate the technology adoption and scaling up process, and input and output supply service for technology delivery such as credit, equipment, seeds, plant nutrients, produce processing and delivery, etc. Agrochemicals such as plant nutrients and herbicides may be required in the beginning for corrective action but subsequently any further use of herbicides and any other pesticide would be confined to a judicious minimum application only as part of the broader IPPM strategy in use in the FFS network.

The FFS model for knowledge dissemination and farmer learning has been adopted by the Ministry of Agriculture in Burkina Faso as the agricultural extension model for the future, and the Farmer Field School network is being expanded nation-wide. Also, the Direction of Extension

& Research-Development (DVRD) has established a unit dedicated to the promotion of good agricultural practices. Consequently, the proposed scaling-up process will fully embrace FARA's Framework for African Agricultural Productivity (FAAP) principles and guidelines for improving institutional arrangements for implementing Pillar IV of the Comprehensive African Agricultural Development Programme (CAADP). It also responds to the call for agricultural adaptation to climate change, which will be increasingly essential for smallholder livelihoods in the savanna ecologies of Burkina Faso and in West Africa. In all this, stakeholder involvement across public, private and civil sectors including AGRA, EMBRAPA, CGIAR System, IFAD, CIRAD, FARA must provide the driving force for R&D commitment and new knowledge for crop and livestock diversification, and for rehabilitating land productivity for sustainable agricultural intensification. Convergence with crop and livestock filed activities for development, such as those of IFAD, AGRA, EMBRAPA, etc, is considered as highest priority.

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This is a story about how FAO assisted groups of farmers in five farming communities in the moist savanna zone of South Western Burkina Faso to enhance their crop-livestock systems through Conservation Agriculture (CA) practices, including crop diversification, using an innovative farmer discovery process, to bring about agricultural intensification and improvement in livelihoods. FAO's assistance was delivered largely by working with national institutions, adding value to ongoing stakeholder resources and activities.

It is a story of positive intensification outcomes brought about by adapting 'proven principles and practices' of CA and crop diversification into existing crop-livestock systems. FAO worked with a range of stakeholders including the farmers and their communities, and the research and extension stakeholders, to create convergence and enable a farmer-based discovery process to experiment with a set of fundamentally new principles and elements in their farming practices for integrated crop-livestock production intensification.

The positive outcomes offer a real promise and an opportunity for bringing about a large scale impact on agricultural productivity and livelihoods in the moist savanna zone of West Africa, often referred to as the potential 'bread basket' because of the zone's high productivity potential for integrated crop-livestock production. The conceptual elements draw substantially from new innovations in sustainable intensification in similar agroecologies in the savannas of Brazil. This publication describes the multi-stakeholder process which led the successful outcomes, and the opportunity for a greater change that now exists and should be harnessed for sustainable agricultural development, nationally and regionally.

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